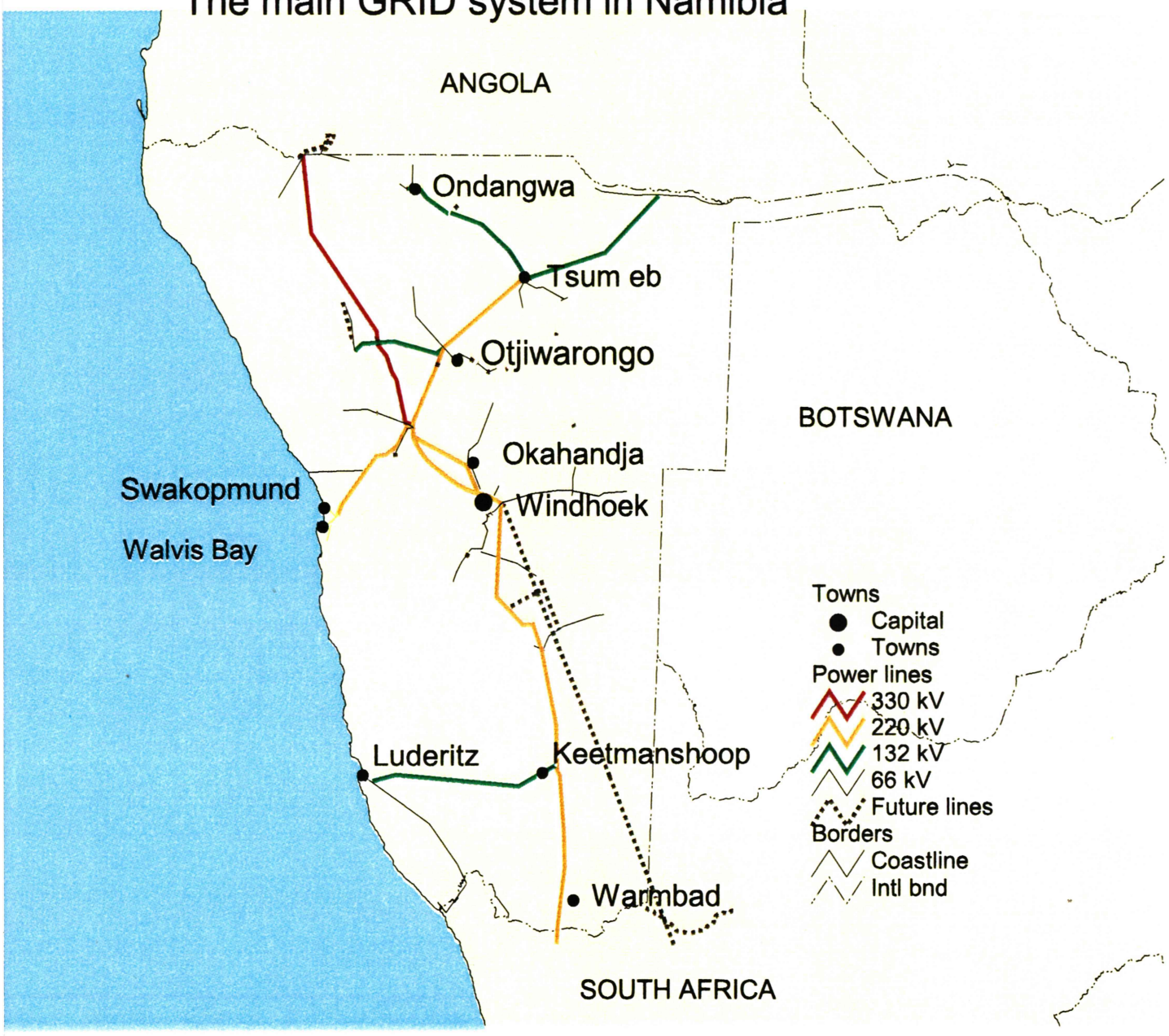
NVE
NORWEGIAN
WATER RESOURCES AND
ENERGY ADMINISTRATION

MEMORANDUM

Introduction to GIS
Report from a fact-finding mission
at the Ministry of Mines and Energy in Namibia

The main GRID system in Namibia



MEMORANDUM

TITLE Introduction to GIS. Report from a fact-finding mission at the Ministry of Mines and Energy in Namibia	AVAILABILITY: open
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ABSTRACT

This is a report from a fact-finding mission carried out to inform MME what GIS is and what tasks it can handle. In addition meetings where held to find out what data, software and know how are available in Namibia. Based on this information and knowledge of the tasks MME has, the report suggested in which fields GIS could be a useful tool.

Digital data on topography and infrastructure in scale 1:1000.000 are available for MME at a low cost. In the beginning of using GIS it is enough to have that scale map.
The transmission lines are digital. Data needed to collect by MME in addition are mostly point data with attributes. In Namibia use of desktop GIS is growing and software, training and support are available.

The report concludes that MME has the main basis for taking advantage of GIS. They have tasks where GIS can be a tool to help in the decision making process in the MME, Energy Directorate, and the data needed are either available or easy to collect for a number of objectives. Initiation begins with specification of which task GIS shall handle from start, get software and hardware after an inquiry and train persons to handle data and system. Success is dependent of allocation of personnel resources as project leader, to collect data and to handle software and hardware task.

SUBJECT TERMS

GIS, Geographic Information System,
spatial data,
software and hardware requirements

RESPONSIBLE

Terje Gimming
Co-ordinator

CONTENTS

1 Background

Geographic Information System (GIS) is a computer -based tool for mapping and analysing features and events on earth. A standard GIS system has the capacity of storing, retrieving, analysing, manipulating, displaying and integrating environmental, economic and social data in a single system.

The need for monitoring MME's different activities and the energy resource base in Namibia resulted in a proposal to consider GIS as a future tool to enhance the background for decision making in the MME.

This is a report from the fact-finding mission that was carried out between Friday 6 and Friday 13 February 1998. The objective of the mission was to inform MME what GIS is and what tasks it can handle and thus give MME a basis to enable them to chart a course towards a functional GIS.

The report includes findings in Namibia, some further enquiries carried out in Norway and a proposal for the course ahead to a functional GIS at MME.

2 Working methods

During five days I had meetings with eight persons at MME and learned about their projects looking for GIS possibilities in each project. Some of these possibilities are presented later in this report.

In addition I had meetings with Geological Survey, The National Remote Sensing Centre and the office of The Surveyor General. The objectives of these meetings were to discover available base map data, use of software and available software support in the country. Appendix B includes minutes from these meetings.

3 Brief explanation of GIS facilities

A GIS has three major facilities for combining data:
1. Spatial operations: Queries where location is an issue.
2. Data linkage: Connecting table data with spatial data using a common identification.
3. Spatial linkage: Joining two layers with distributed data to create a new layer containing the characteristics of both.

To be able to use these facilities spatial data with attributes are necessary. Functions for capturing and storing both spatial and table data including functions for editing and querying on existing data are a part of a GIS.

These facilities for combining data are used in GIS analyses to better understand a complex world. The results can be presented on maps on screen or on paper.

A complete GIS contains GIS software, hardware, data and personnel with know how in using the system and handling the data.

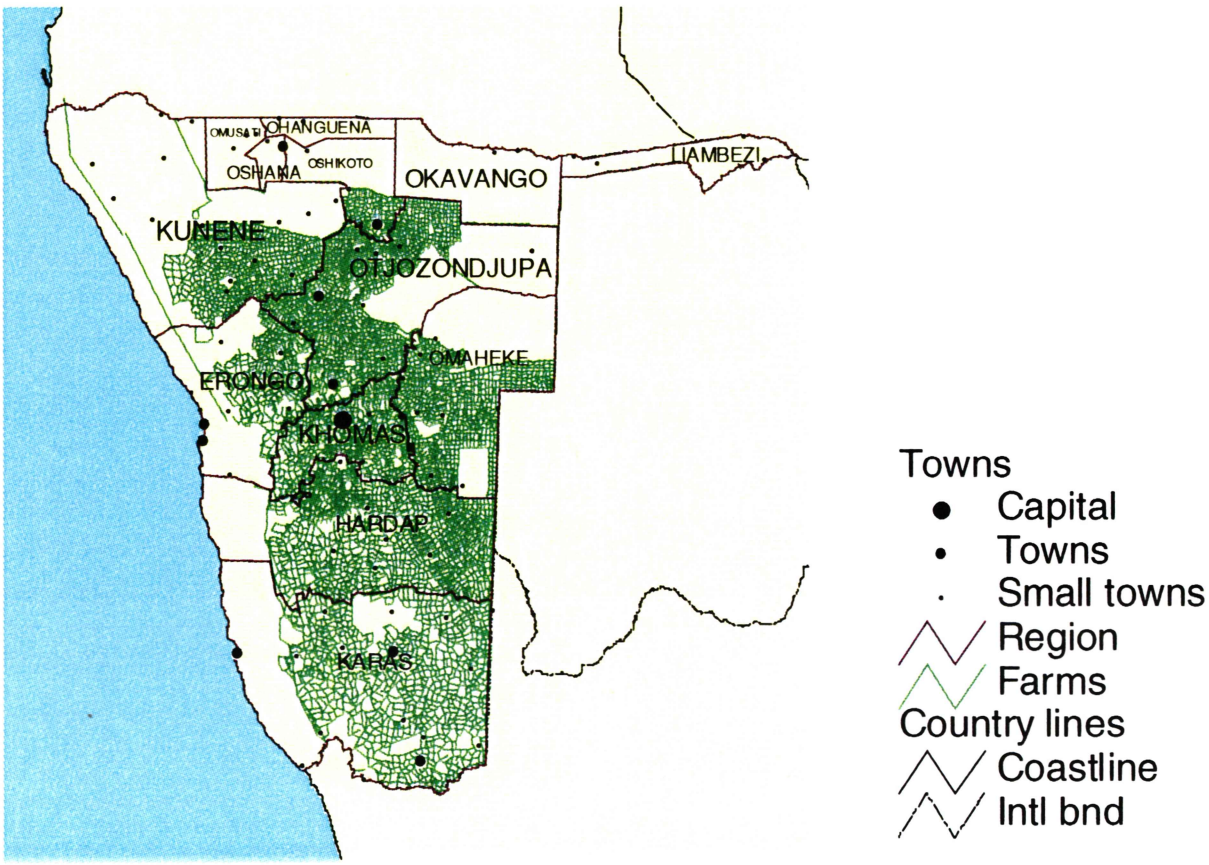
4 *Available spatial data in Namibia from other sources; Contents; Costs*

To be able to produce maps and analyses in a GIS, one needs digital data on topography and infrastructure. Meetings where held with representatives having knowledge of the sources for this kind of data. The data source for digital data are maps in different scales. The scales reflect the richness of details in the data. I have concentrated on available data on 3 major scales: 1:1.000.000, 1:250.000 and 1:50.000.

4.1 Scale 1:1.000.000 covering the whole country

Data available from Geological Survey

Themes:
- geology generalised
- rivers
- roads
- farm boundaries
- railways
- region boundaries
- towns



Example of available data in scale 1:1000.000 from Geologial survey

Data available from National Remote Sensing Centre (NRSC)
Themes: roads
vegetation
landforms using FAO classification

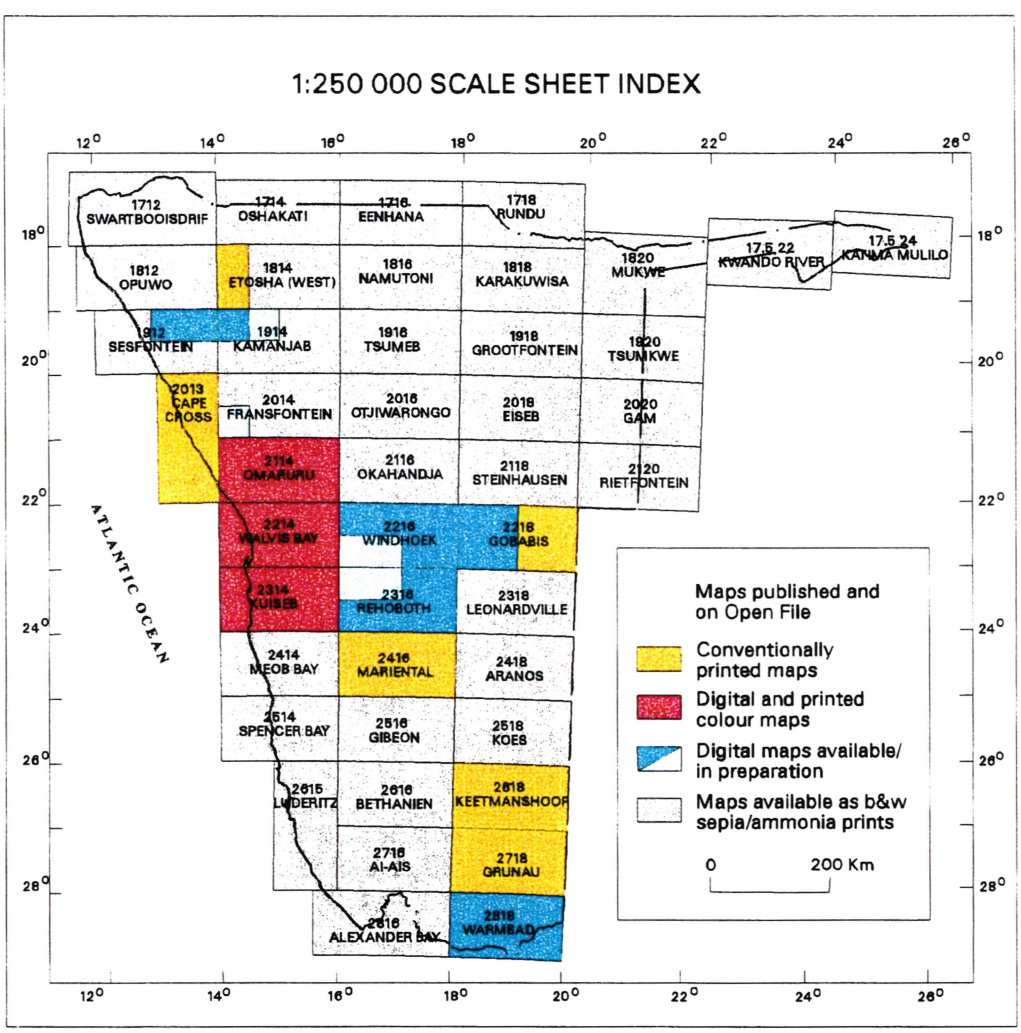
In addition both have coastline and border lines.

Data available from The office of Surveyor General
No known digital data.

4.2 Scale 1:250.000.

Data available from The office of Surveyor General
The office of Surveyor General will start capturing digital data on topography and infrastructure next year. Their goal is to have the whole country ready by year 2000.

Data available from Geological Survey
Geological Survey is working on capturing geological data in this scale. Since data on topographic and infrastructure are lacking, they collect these data at the same time. 4 out of 44 mapsheets are available at the moment. The map below shows status.

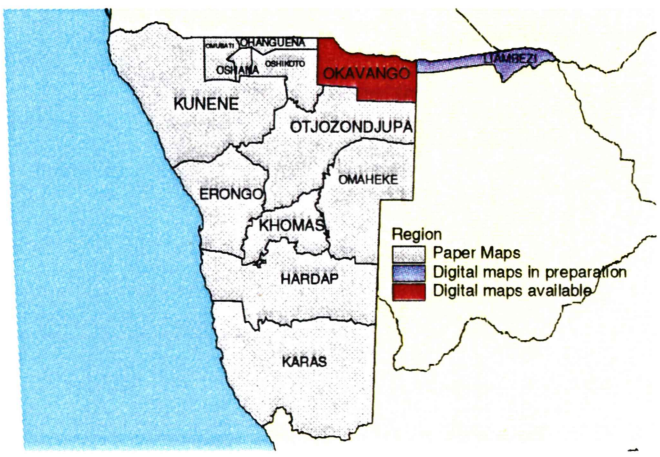


4.3 Scale 1:50.000.

Data available from The office of Surveyor General

Topographic data Okawango region (77 sheets).
Including contour lines with equidistance 10 and 20 meter.
The households (can contain 1-5,6 houses) are mapped.
Administrative borders for counties and municipalities.

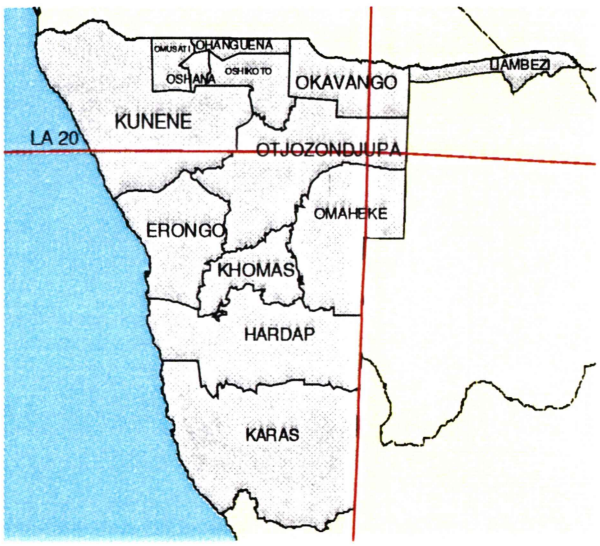
On going projects:
One more region (Caprivi) will be ready by the end of 1998.



Total number of sheets in scale 1:50.0000 is about 1500.

Data available from National Remote Sensing Centre (NRSC)

Forest cover map of the north (above Latitude 20) established.



Inventory is going on. Will be done in about two year's time.
Included in this mapping are rivers, roads and villages. 4 villages are mapped thoroughly in the study.

A Project called Environmental profile is starting now and will be finished in the end of 1998.

Central Bureau of Statistics

We have not been in contact with Central Bureau of Statistics, but it is possible that they have some useful census data. The data needed are population, age and sex distribution in each town or village.

4.4 Cost.

Use of GIS requires base map data from one or more of these sources. The policy for pricing digital data varies from country to country. In Norway digital data are expensive and they are a major factor in the budget.

The Ministry of Lands, Resettlement and Rehabilitation is working on policy document of distribution and pricing. No data has yet been distributed. The office of Surveyor General will wait till the document is ready. Our contact said that governmental agencies would not be charged.

Geological Survey will not charge any cost for their data to MME since MME is in the same ministry. NRSC works on project basis. They do not own the data themselves and can not give MME the data directly. MME can contact the source institutes and they will probably give NRSC permission to export data to the ministry.

4.5 Conclusion

As an overview map scale 1:1000.000 is appropriate. This scale can be used to make maps in A1 and down to A4. In the beginning of using GIS it is enough to have that scale map.

The scale 1:250.000 can not be used when working with the whole country at the same time. Only when studying parts of the country this scale is used. It will take some years before data in this scale is available for the whole country. Some parts are ready and can be used to test the suitability of the data for a specific task.

Scale 1:50.000 contains a lot of data. I my opinion topographic data in this scale will not be of interest for MME in the near future. Special dataset for specific tasks will be (ex. Forest cover) of interest. When one need to combine forest cover with other data sets, these can be fetched from other scales.

5 *Data needed in addition*

MME's specific projects have different requirements for data. Most of base map data are relevant for all projects and the same will be the case for MME's own data. All data must be available for all GIS users at MME. This requires a common storing and classification of data.

A complete list of all data relevant for use of GIS will need a thorough mapping of tasks and data needed for each task. In this report I will only deal with the data needed as far as I found out during my stay.

Digital data can be points, lines, polygons and raster which all have a location.

Geological survey produced in 1994 a map called: "Electricity supply map in the republic of Namibia" in scale 1:2.500.000. The data from this map are digital and available to MME.

Apart from the transmission lines, the rest of MME's data are point data:

- power stations of different types
- monitoring stations
- wells or oil installations
- petrol stations

To find the location, identify and classify each of these data types are not a major task except for the petrol stations. In Mr. von Jeney's opinion the digital data about the petrol stations are available from the oil companies, so to get them should not be a problem. MME's task will be to add additional attributes such as owner, year of construction and so on to each data set. When collecting data the content and form must be decided on before starting or else the risk of having to collect the same data again is large.

Before starting it is extremely important that you plan and specify the content and structure of the data you want. To make data easily accessible for many users I strongly recommend that data have a standard content and form and include documentation.

At present data on renewable resources are lacking. For the resource maps I see possibilities of analysing when monitoring data are available.

The questionnaire done by Mr. Hamutme is very suitable for GIS analyses and presentation. Each questionnaire is connected to a town or village who will be the location. I recommend that the results are stored in a spreadsheet or other table-format that enables them to be presented on a map.

6 *Data capture methods*

Location and attributes to point data can be collected from ASCII-files, spreadsheets or other table-formats. The location must be written in a specific projection with co-ordinates for both east and south.

To capture the exact location of lines and borders of polygons a digitising table is needed. Points and lines are measured up using a sensor and their analogue values converted into digital sets of co-ordinates. These co-ordinates are then fed into a host computer. The location of each vertex can also be written in a file and transferred to the computer. This method is fit for use on straight lines.

New data can also be added in a GIS from the screen. The degree of accuracy depends upon the background map that is used.

The GIS software has edit tools so changes can be made on screen.

7 *Software requirements and costs*

The GIS technology has moved from large mainframes to desktop computers making the use of spatial technology more widespread and accessible. GIS has traditionally been software for large corporations or public institutions due to complex user interface, large files and data set size. The PC of today has storage capacity that no longer makes hardware a limitation.

As it seems the most used GIS tools in Namibia by ministries is ESRI software. That means ArcView for desktop users and Arc/Info as strong GIS software for UNIX and NT. Both NSRC and Geological Survey use this software, and the Director of Mines use ArcView in an application for managing titles.

The distributor for this software is located in Johannesburg and is named GIMS. In addition they serve as consultants in training and application development.

Preliminary prices from GIMS are as follows: Prices are exclusive of all Government Taxes and VAT

PC ArcView3.0 for Windows 95/NT	R 6,660.00
ArcView Spatial Analysis Module	R 13,950.00
Network Analysis for ArcView	R 8,640.00
3D Analyst for ArcView	R 13,950.00
ArcPress for ArcView	R 2,160.00

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Training per person	Cost US$	Cost ca. N$
Three days course in ArcView.	410	4400
Three days course in Spatial Analyst	548	5754
Two days course in ArcView Power-User	366	3970

GIMS offer course held at the client-site. These courses can be held for minimum of four and maximum of eight persons (two students per computer). The cost are US$1000 per day (N$ 10850). This requires four computers with software available at the client-site. The

Geological Survey has arranged this kind of course and has probably the necessary schoolroom.

Handling MME, Energy Directorate task will require basic PC ArcView with extensions for spatial analyses in the field of renewable resources.

8 Hardware requirements and costs

The PC of today is fast and has storage capacity that enables them to store large data sets. Therefor PC can be sole hardware for GIS data and software.

ArcView is used on PC. It requires a strong PC (suggest 32 MB RAM) and storage capacity. Most important is the screen. To handle digital data and composite maps you need a large screen. I recommend screen size from 17-20 inches.

You also need possibility to make printout in colour. The format can vary from a part of an A4 page in a WORD-document to a map in format A0. Geological Survey has plotting facilities. MME may be able to use these facilities for special large plots. The bulk of plots are A4 or less.

Digital data should be available for more than one user. This requires a network, a server and common facilities for printing and personnel with knowledge of and responsibility for hardware and standard software.

I strongly recommend that the equipment bought be of high quality because they are more stable and reliable.

9 Personnel; responsibility, application development and training

Desktop GIS as ArcView are Windows based and uses the same buttons/icons as other windows based software. The functionality of these icons is therefor familiar to many persons already. Additional buttons are well documented and the help functions are extensive. Nevertheless a basic course are needed to learn how to operate the system. The same applies for each new extension.

A GIS use digital data to solve spatial questions. The persons with knowledge of the data and with the questions are nearest to define the data content and set up the spatial queries. The best solution is to train the end-users in using the system.

All the GIS users will use most of the digital data. This requires a common storage of data. To set up standards for content, identification, classification and documentation of digital data one person must have responsibility based on definition by a group. The system and data handling will also need internal support and help which the responsible must take care of.

Most desktop systems include a programming language. This language can be used to change the user interface or add new functionality to the system. ArcView is written in a script language called Avenue. The scripts are available for the users to change or edit. For some tasks done by a number of persons (as for example making standard maps), development of

an application where Avenue is used to modify the standard user interface can make the use easier and more effective. This ensures that the task is always done in the same. Complex tasks which includes more than one operation will be easier to execute when put on a button or in a menu. It also secures the quality of the product produced by the button.

10 Examples of use for MME

During my stay in Namibia I learned about MME's tasks. Some of them will in my opinion have great help in using GIS. In this chapter I will focus on some tasks and illustrate with listing some questions that a GIS can answer.

10.1 The resource maps

Making resource maps are only possible by using GIS tools. A simple ArcView will not solve this analysing problem, but the software to do it is available. The analyses are depended on combining information from different sources.

Bio mass resources
The objective is to map the energy efficiency throughout the country for wood fuel. A classification must be made based on forest distribution, vegetation and other factors. These data must be combined as defined in the classification.

Spatial questions a GIS can answer:
What is the energy content of biomass in different part of the country and totally.
Show the different contents on a map using a classification.

To be able to answer the questions, relevant data is required and certain definition must be defined:

The energy content based on knowledge of species and vegetation.
The units for calculation.
A classification of different energy content.

A resource map can show mean or total energy efficiency for each object.

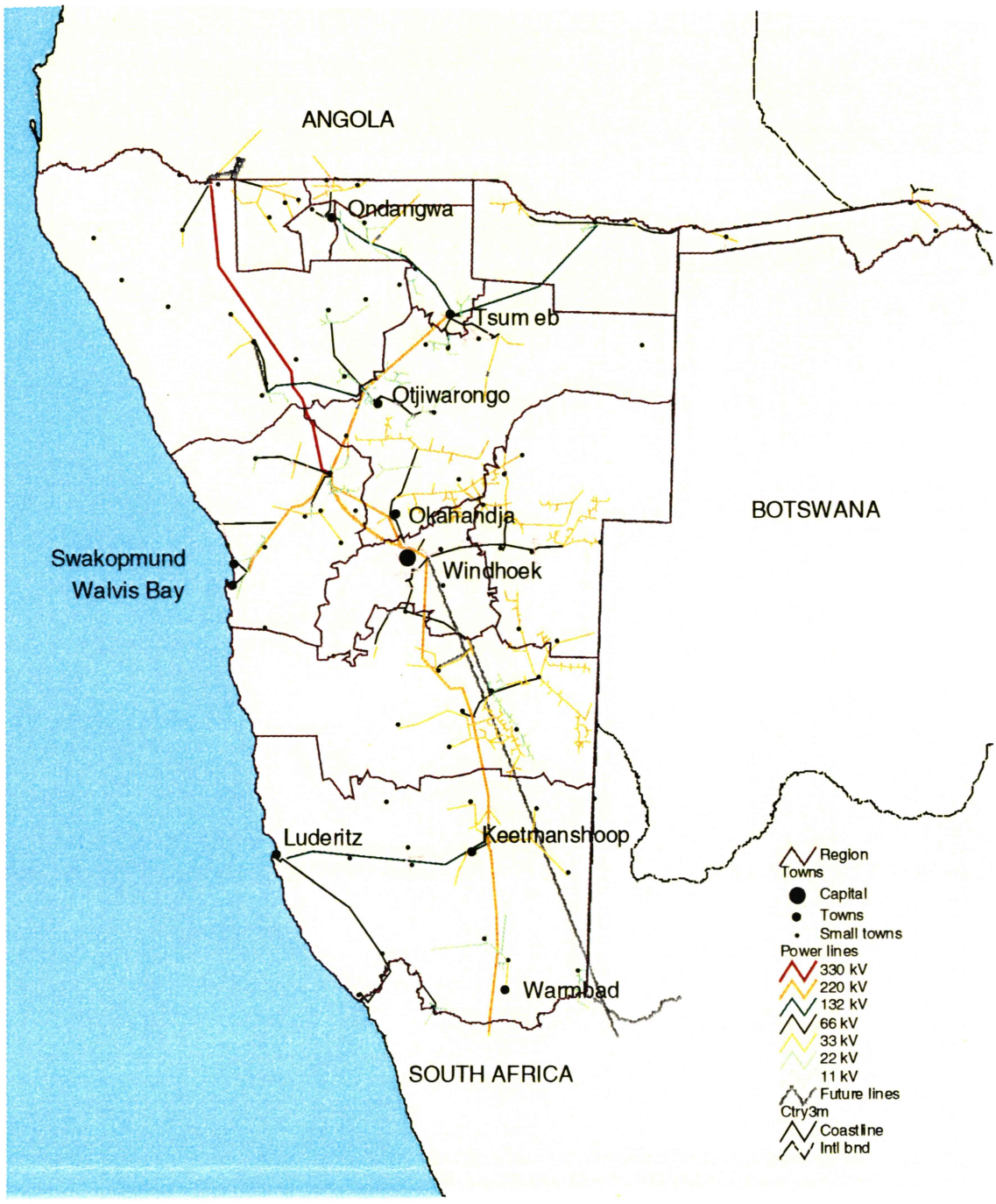
Solar, wind and wave resources
These maps are dependent on survey results. A grid can be made from monitoring results using for instance landscape and elevation as basis. These analysing possibilities are not in standard ArcView, but in an extension called Spatial analyst. To program the solutions it might be necessary to use a consultant.

10.2 Electricity master plan

The transmission lines are digital and available. Large parts of Namibia are without electricity. This data will verify where there is no electricity. Combined with ex. Census data to calculate the population growth, planning can be done for years ahead.

Combined with the resource maps GIS can be a planning tool to find where electricity is needed and to choose the best energy source for the area.

ELECTRICY SUPPLY IN THE REPUBLIC OF NAMIBIA



10.3 Managing petrol stations

The petrol stations location is also an easy and obvious task. When data are available GIS will provide an overview of where the petrol stations are, who own them, when are they build, how much they earn and so on. The possibilities are numerous and only depending of available data and how you want to use it.

10.4 Oil and petroleum projects.

I have had communication with the Norwegian Petroleum Directorate to find out what use they have of maps and GIS. Minutes from this communication are in appendix B.

Based on this information I can see the following use of GIS.

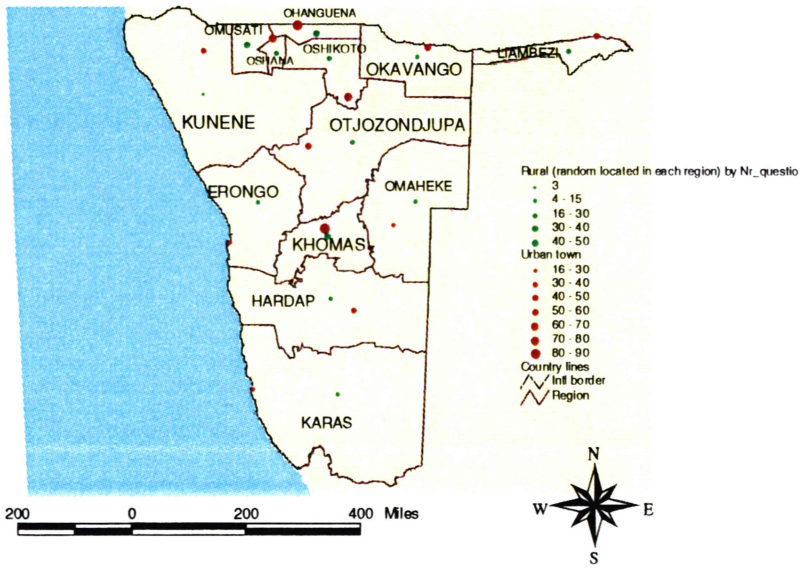
The directorate needs to know what activities are going on at all times by whom and where. A GIS can make this data easily accessible and possible to present on maps if the data have location and relevant information structured in a common way. This will include data from monitoring seismology and drilling. A collection of all data from the different oil companies should be stored in the directorate to make them available for later use independent of oil finding at this time.

The history of licence for each field is also a part where GIS can be of use.

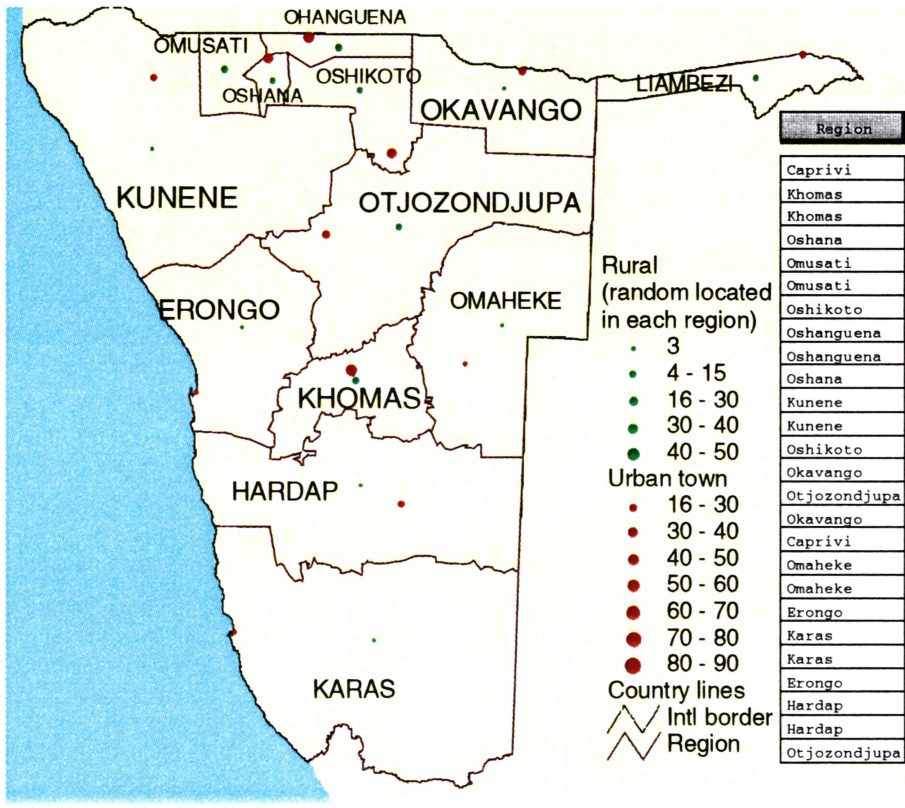
10.5 Energy efficiency and conservation project.

A random number of persons in one rural village and one town in each region have answered the same questionnaire. The results from this survey are suitable to present on maps and by a GIS because the location of persons questioned is relevant.

Location of the towns and rural villages studied in the survey



GIS tasks:
Make a map showing the location of the towns questioned without or with the rest of towns at the same map. The map can contain scaled symbol for each town by the number of questionnaires.



Region	Nr. of questionna	Town type
Caprivi	44	U
Khomas	36	R
Khomas	83	U
Oshana	28	R
Omusati	96	U
Omusati	40	R
Oshikoto	27	R
Oshanguena	89	U
Oshanguena	39	R
Oshana	67	U
Kunene	32	U
Kunene	3	R
Oshikoto	64	U
Okavango	58	U
Otjozondjupa	27	R
Okavango	11	R
Caprivi	20	R
Omaheke	11	R
Omaheke	26	U
Erongo	27	U
Karas	30	U
Karas	13	R
Erongo	12	R
Hardap	12	R
Hardap	33	U
Otjozondjupa	51	U

Questions
Where are most people using wood fuel for heating, lighting and cooking? Show the distribution on a map. Show forest distribution on the same map.
Where are most people using electricity? Show the transmission lines on the same map.
Present the result of the analysis in the map. Use this to understand the survey results better.

10.6 General terms

Maps can be drawn to fit into reports, as insight on the computer or as different maps.
In planning GIS can give access to relevant information which must be considered in the planning process. This includes location of villages, population density, roads and so on.

11 Suggestions for the course toward a functional GIS

As far as I see MME has the main basis for having advantage of GIS use. They have tasks where GIS can be a tool to help in the decision making process in the MME, and the data needed are either available or easy to collect for a number of objectives. Some tasks need data that takes time and resources to collect (e.g. The resource maps), but these tasks are impossible to do without a GIS. The software needed is windows based and does not need a lot of training to be useful.

My proposal is that MME introduces GIS in a small scale and opens for a wider use in the future. It is imperative however that you from the start have a plan for wider use and what it will require.

There are at least three alternative ways of introducing GIS.

Alt. 1. Make specifications for an application that shall handle one specific task. Getting a consultant to program it. The system will do what you want, but your own personnel will not know the system and will be dependent of the consultant.

Alt. 2. Buy an easy program; put one enthusiastic user as responsible. Train a group of personnel in use of the system. Start with a specific task. Start small. Buy new equipment as time goes on and you feel confident in extended use of the system. Use consultants to solve specific problems and learn by that.

Alt. 3. I have looked into the possibility of using software owned by the Geological Survey. Mr. Hill said this of course is a possibility, but it has to be decided by the ministry. Geological Survey has purchased the software and hardware they need themselves, and it is hard to get permission to buy more. The software packages are stored on individual machines used by specific personnel. They are therefore not available in a computer room where different personnel can use it when needed. I will not recommend this solution. If this is the only option, I do not think it will be widely used.

As I see MME Energy Directorate's situation so far, I would suggest alt. 2. Mining has chosen alt. 1 and that might be because they have one very specific task and are able to describe it thoroughly.

In any case MME needs one person with responsibility for introducing GIS. That person will need a group of people who can discuss the projects and together propose what to do next.

11.1 Schedule for introduction of GIS

1. Designate one person for implementing the tool.
2. Specify for what projects GIS shall be used.
3. Set up all the tasks you want the GIS to solve.
4. Write specifications to GIMS and ask for an offer of software and suggestion for the equipment you will need, necessary training and consultant price.
5. Set a plan for installation, training and results for a period of time.
6. Install necessary equipment
7. Train personnel who will use it in the near future.

8. Specify the content and structure of the data you want. Decide on a standard content, form and documentation.
9. Collect and store data.
10. Use GIS for one task and present the results.

11.2 Possible assistance from NVE

NVE started looking for a GIS tool in 1989. The software was installed in October 1991. The decision process included mapping of relevant tasks in NVE and specification of requirements. Since 1991 a lot of time has been used in collecting and structuring data and making applications and products useful for NVEs tasks.

NVE can assist with the following:

1. Specifications of requirements
2. Mapping of relevant tasks and data.
3. Make an enquiry to GIMS and get estimates for a number of services
4. Data modelling including suggestions for standard content, identification, classification and documentation of each data set.
5. Suggest how and where data should be stored.

MME should themselves specify objectives and data content and collect data.

11.3 Draft specification to GIMS on software, hardware, training and support.

This is a list of questions and services Ministry of Mines and Energy, Energy Directorate will need to inquiry after and get an offer for from GIMS.

Enclose the results of the preliminary mapping of tasks where GIS can be of use. (Ch.10 in the report.)

Software.
Can GIMS confirm that ESRI software can solve the tasks described above? The software current of interest is ArcView with extensions.

Which part of the software are needed to solve the tasks?

Get an offer of price for the software in $N for single user and for up to 10 users for ArcView and three for the needed extensions. What is the price of each license when software is stored on an NT server with PCs us clients?

Training
Four to eight persons will need training in use of the software and collecting data using the software. Get GIMS to suggest which courses they will need together with price for the training at the client-site, a special course for them in their schoolroom and for these people attending the regular courses? What are the requirements for the schoolroom? A description of content and length of each course should follow.

Support
What do GIMS offer as support and what is the yearly cost for this support?

Consultant service
To solve some of the tasks an application created by use of Avenue programming may be necessary. Do GIMS offer this service and what is the consultant price?

Hardware
What are the requirements for the PC where the software shall run? What do GIMS recommend of RAM, MHz, storage capacity and size of screen?

Appendix A: Term of reference

INTRODUCTION OF GEOGRAPHICAL INFORMATION SYSTEM (GIS) IN THE MINISTRY OF MINES AND ENERGY.
TOR FOR A FACT- FINDING MISSION ORGANISED BY NVE

INTRODUCTION

GIS

Geographical Information System (GIS), which is a computer -based tool for mapping and analysing features and events that happen on earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualisation and geographical analysis offered by maps.

A standard GIS system has the capacity of storing, retrieving, analysing, manipulating, displaying and integrating environmental, economic and social data in a single system.

The need for monitoring MME's different activities and the energy resource base in Namibia, resulted in a proposal to consider GIS as a future tool to enhance the background for decisions in the MME. This proposal is a result of general comments in the Draft White Paper on the Energy Policy of Namibia, and is included in the planning matrix for work in the Energy Department for 1998.

As a first step, a fact-finding mission shall be carried out by NVE. Their representative will be Mrs. Astrid Voksø.

OBJECTIVE

That MME shall learn what GIS is and tasks it can handle. MME shall get a basis that enables them to chart a course to a functional GIS.

SCOPE OF WORK

Friday 6th of February

- Work with Mrs. Amaambo, learn her projects
- Visit institutions using GIS together with Mrs Amaambo

Saturday 7th of February

- Participate in the EPUPA hearing

Monday 9th of February

- Give a presentation on GIS, what is it? What can it give? Presentation with examples demonstrated on a laptop or with use of overhead. What require GIS of

data, software, and hardware. What require GIS of personnel and what kind of know-how do they need?

- Visit institutions using GIS together with Mrs Amaambo
- Work with Mr. Siepker and Mr. Hamutwe, learn their projects

Tuesday 10th of February

- Work with Mr. Vahekeni, Mr. Clarke, Mr. Matali, learn their projects
- Work with Mr. von Jeney, Mr Appolus, learn their projects
- Work with Mr. L Möller, Mr. Nangolo, learn their projects

Wednesday 11th of February

- Prepare a draft report
- Any other meetings, for example NamPower if they use GIS

Thursday 12th of February

- Prepare draft report
- Discuss the draft report with relevant personnel in the MME

Friday 13th of February

- Present the draft report and discuss possible co-operation on:
- The need for a policy for GIS in the MME
- NVE's assistance to Training of personnel
- NVE's assistance with specifications and purchase of equipment

The final report with state of the art and recommendations shall be completed within 1st of March 1998.

Appendix B: Minutes from meeting

Memos by Astrid Voksø

Friday 06.02.98 at MME Namibia.

9 a.m. meeting with Mrs. Amaambo

Project name: Study of need of alternative fuels in to villages as case study

Responsible: Mrs. Amaambo

Objective: Villages especially in the north do not have alternative fuel to wood fuel. They have long distance to go to collect fuel or have no forest at all. A market study will be done in two villages in the Karas region. The study intends to find out what they need of fuel and what they can afford. A planning workshop is scheduled before the end of March to decide from the market study what alternatives the ministry shall suggest and how they shall put it into action.

Suggestions for GIS use

Spatial questions:
How far is the to villages from forests or available wood. How far are the villages from electricity, roads or other relevant objects?
Are the to villages representative for other villages?
How far are other villages from the same sources?
Can the information collected in the market study be extrapolated to similar villages so to be able to calculate total cost for all villages with the same problem?

Data need.
Location of all villages, forest and woods, electricity lines roads.
Population in the villages.
Spices in the forests?

Data capture in market study.
The data about each village should be collected and identified by the village's name or other unique identification and saved in a database. The centre of the villages should be located in a co-ordinate system.

Project name: Bio mass resource map.

Responsible: Mrs. Amaambo

Objective: Investigate if it possible to produce a bio mass resource map.

Suggestions for GIS use

Spatial questions:
What is the energy content of biomass in different part of the country and totally.
Show the different content on a map using a classification.

Data need.
Forest cover.
The different spices in the forests.
Vegetation maps.

Data capture needed by MME
Define the energy content based on knowledge of spices and vegetation.
Define a unit for calculation.
Define a classification of different energy content.

10 a.m. meeting with Mr. D. Hill in the Geological Survey.

Mr. D Hill is responsible for the computer systems at the survey. He is not a GIS expert but responsible for all standard software and hardware.

Objective: To produce geological and geophysical maps and make data about geology and geophysics available for extensive use.

GIS software and hardware:
Arc/Info for UNIX HP9000 (4 licenses) from ESRI, USA.
Users have good x-terminals connected in a network
ArcCad (Minicad for Mac).
ArcView (14 licences) from ESRI, USA
4 digitise tables (2 A0, 2 A1)
4 PC Arc/Info from ESRI, USA. (Rarely in use will soon be outdated). Used for data capturing and digitising.

Erdas Image 8.3 (1 licence) used for satellite images.
Plotters for A1 and A0.

No printing capabilities. Use printing in Finland or Sweden.

Personnel:
Staff shortage. Geologist GIS-expert: Dr. Ute Shreiber.

GIS support and training:
GIMS is the ESRI distributor for Namibia. They are located in Johannesburg, South Africa. Used for training and support. They are professional, but expensive. Contact: Patrick McGivegan.

Geological data:
Geological mapsheets in scale 1:250.000.
Digital from 1993.
Total in Namibia about 44 sheets. 4 digital area printed, 4 old ones are conventionally printed maps and 4 digital mapsheets are in preparation.

Digital Geological map of Namibia in scale 1:1.000.000.

Satellite images.
Used to map areas with ground geology in areas where you can't go. They map with reasonable accuracy.

Data capture methods and plans.
Geologists capture geological data from area photos and field studies. A reliability index for each map shows how the separate data sets are captured.

The new digital maps are produced in districts with economical interests and lack of data.

Base map data.
The old maps are stored as separate covers. Some of these have been scanned (in Turkey) to achieve a digital cover of ex. rivers and roads. Other base map data needed to produce the 1:250.000 map sheets have been digitised.

Digital elevation model (DTM) exists for a small area in 1:50.000.

Projection:
LO-coordinate system was used before. They have now decided to use UTM zone 33 with datum Gauss Bezel.

Cost. No cost for other ministries.

Note: Geological survey produced in 1994 a map called: "Electricity supply map in the republic of Namibia" in scale 1:2.500.000. The data from this map are digital and available to MME.

Directory of Mines.

Objective: Namibian state owns all mineral titles. The ministry gives titles for companies. To establish a title management supplies system based on GIS.

GAF-Germany has written an ArcView application for managing titles.
A pamphlet of the system is produced.

Suggestion from Dr. D. Hill:
Hardware: Buy good stuff with quality. (Cheap stuff breaks more easily down).
Use GIMS, they are good.
Train Namibians to handle the data and system.

11.30 a.m. meeting with Mr. H. Kisting from National Remote Sensing Centre (NRSC).

Objective: The centre work on project basis.

GIS software and hardware:
ArcView (2 licenses)

Data capture methods:
Area photos and field work
Satellite image (Landsat 30* 30 meter, SPOT XS 20*20 meter)
Difficult to use for vegetation mapping because inside a pixel there can be ex. 10 spices, but it can only be presented with one signature.

Project Forest inventories.
Data:
Phase 1: Forest cover map of the north (above LA 20) in 1:50.000 established.
Phase 2: Inventory is going on. Will be done in about two-year time.
Included in this mapping are rivers, roads and villages. 4 villages are mapped thoroughly in the study.

Project Environmental profile. Starting now and available in the end of 1998.

Project Landform and vegetation map data.
Scale 1:1.000.000
Roads
vegetation
Landforms using FAO classification.

Costs.
Take contact with the source institutes and they give permission for the centre to export data to the ministry. Costs for export only.

Suggestion from Mr. Kisting:

If not GIS, MME will be left behind. MME have got a lot of spatial data and need a data management system. You will only need ArcView (Namibian $70000 a piece).

Define your purpose and find how GIS can give your answers.
Relevant spatial questions: Distribution of energy.
Sources of demand.

15 p.m. meeting with Mr. L. Moller, MME and Dr. Roger Swart at NAMCOR.

Objective: Help and advise the MME. Map the protensial for mining in particular areas.

GIS software:
IRMAPPER. Cheap with some GIS capability and good output possibilities.

Map small areas. Monitor for advisory
Offshore database for well information.
They map seismic data (6-7 wells).
Plot geographic exploration system together with cultural data.

16.15 p.m. meeting with Mr. U.G.O Okafor at the Ministry of Lands, Resettlement and Rehabilitation.

He is the chief Surveyor: Mapping & GIS unit.

Objective: To produce topographic maps for Namibia. At the time they are working on the maps in scale 1:50.000.

GIS software:
REGIS for digitising
Autodesk World 1.

Personnel:
At the time there are 4 formally trained personnel. Next year he hopes they will have 6-8 operator fully trained. That will be OK.

Data capture methods:
Aerial photographs for the whole country in scale 1:80000 are finished.
Orthophoto made by Swiss firm. Each photo covers an area of 27*27 km.
Digitise themes from orthophoto (ex. roads, villages, rivers and so on)
Roads are identified and classified by standard set by the Directorate of roads and transportation. The directorate captures road-data by using GPS. The accuracy is +- 100 meter. That is not good enough for the ministry, so they digitise the roads from orthophotos and put the identification and classification on each road.

Projection: Gauss Bezel. There are no problems with export or import of any format.

Digital data ready:

Topographic data for one region (Okawango) in scale 1:50.000 (77 sheets).
Including isolines for elevation (10 and 20 meter ekv.)
The households (can contain 1-5,6 houses) are mapped.
It also includes administrative borders for county and municipalities.

Plans for data capture in the future.
One more region (Caprivi) will be ready by the end of 1998.
Total amount of sheets in scale 1:50.0000 is about 1500.

They plan to start capturing data for data in scale 1:250.000 from 1999 (44 sheets). There are no plans for how they are going to capture the data yet. But he expects the data to be ready in about 18 mouths time from when they start. The goal is to have a GIS database ready for the whole country by year 2000.

Costs.
Governmental agency will not be charged.
The Ministry of Lands, Resettlement and Rehabilitation are making a policy document of distribution and pricing at the moment. No data has been distributed yet. They will wait till the document is ready.

Monday 09.02.98 at MME Namibia.

9 a.m. meeting with Mr. G. Hamutwe

Project name: Energy efficiency and conservation project

Responsible: Mr. G. Hamutwe

Objective: The goal is to get households to use energy more efficient. A questionnaire has been made and answered by one rural and one urban town/villages in each region. The questions are created to find what kind of energy households are using and why. Data from the questionnaire will be saved in a database. The database will also include general information about energy sources.

The country needs awareness about use of energy efficient and what kind of alternative there is. This has to be done by spreading information by radio, newspaper, TV or other ways.

The database will include:
Lists of what kind of energy sources for cooking, lightning, heating is available and how good they are.
List of suppliers both in the county and international.
List of organisations that deal with research on this. They have expertise and can help with ex. training

Analysing the results of the questionnaire.

All questionnaires are filled out. A consultant shall help with analysing methods and how to store the data in a database.

Suggestions for GIS use

Show location of the towns questioned on a map without or with the rest of towns at the same map.
Present the result of the analysis on the map. Use this to understand the results better.

Examples:
Map with a scaled symbol for each town by the number of questionnaire.
Map which show the distribution of source for cooking, lighting or heating as ex. Cakediagram based on the number of users.

Project: Greenhouse gas mitigation under power pooling in Southern Africa (SAPP).

Objective: Power production efficiency. What can it do to the environment? Namibia wants higher efficiency without more pollution (CO_2). Electricity plant from coal pollutes. Where do they have cleaning systems? Promote to insure that the gasses are cleaned and improved.
Have measurements with how they pollute.

Power plants in Namibia:

Windhoek	diesel	standby for use when needed
Windhoek	coal	standby for use when needed
Katima	diesel	
Cuene	hydro	

Electricity is also imported from South Africa.

Project: Promote use of alternative energy sources. Ex. solar cells. Saving energy by architectural efficiency.

Results. New buildings are induced to use solar energy to heath water and for lighting.
Enhancing building design to save energy.

10.30 a.m. meeting with Mr. B. Siepher.

Project: Energy planning.

Objective. Create energy resource maps on each renewable resource. Use this to find the best location for energy production. Derive optimal energy to be used at a particular point is good energy planning.

Solar resource: Physical radiation level throughout the country.
Wind energy resource.
Bio mass resources.
Wave power from sea currents.

Data needed.
Solar measurements throughout the year in a number of places. To stations are in operation.

Measuring wind speed where it is relevant. At 2 places MME have been measuring wind speed and direction the last 2 -2.5 years. Some measurement can be collected from meteorology, but they do not measure all parameters that are needed to derive the energy resource. A wind measurement campaign will start at MME with 5 - 10 stations in the near future.

Population density.
Traditional energy demand.
Current energy information structure. The power system is digitised by Geological survey and is available to MME.

Suggestions for GIS use.

From measurements make spatial distribution of each energy resource? This can be shown either as raster (grid cells where each cell have a value) or by contour lines indicating where the boarder between levels are.

MME, Energy directorate needs to decide what parameters are needed and find the method for combining the information to create the spatial distribution..

The raster for each resource can then be combined to find the optimal energy to be used at a particular point.

12 p.m. meeting with Dr. Ute Schreiber at Geological Survey.

The meeting was to enhance my knowledge of what data they have and in what formats.

Projections used: UTM zone 33 and zone 34. Zone 33 is used for the whole country. Datum is Gauss bezel. Some old data are in Alders equal area projection.

<u>Data available:</u>
1: 1.000.000 Themes: geology generalised
rivers
roads
farm boundaries
railways
region boundaries
towns

Data captured by digitising old maps by GIMS. Data quality varies in the country. The data is generalised to 1:2.000.000.

They are capturing data for the maps in scale 1:250.000. In this work they also capture base map data needed in their map production because is not available from other sources.

She will try and put data on the themes: region boundaries, towns, farm boundaries and energy production in geographic co-ordinates on a diskette to MME.

3.30 p.m. presentation of GIS by Astrid Voksø

Participants:
Hamutme MME-ED
T. Jensen MME-ED
L. Amaambo MME-ED
A.M. Shanyenge MME-ED
H.S. Ndume MME-ED
H. Muller MME/GTZ
M. von Jeney MME
B. Siepher MME
G. Amanyanga MME
N.E. Tjiluene MME

Tuesday 10.02.98 MME, Namibia

9 a.m. meeting Mr. M. Appolus

He is the Energy directorate economist.

He was concerned by the cost and meant that why should MME have their own GIS, when Geological survey have it already. MME do not research, just administrate. There is no coherent planning because of the resource constraint they have.

NamPower is the electricity utility in Namibia. They own the generator, transmission lines and part of the distribution network. They do the physical planning and are own by the state. They earn money by selling electricity to the municipalities.

Rural electrification is MME involved in. Consultants do the planning.

10 a.m. meeting with Mr. F Vahekeni and Mr. G. Clarke

Project: Electricity master plan.

Objective: To decide where future electricity development is going to take place. There is no long term planning.

Long distance lines.

All transmission lines are planned and build by NamPower. MME gives permission, but do no research.

The distribution side contains mainly short lines.

Planning of new electricity is based on information from the regions. The regions give MME their priorities in consideration of which village to get electricity next. MME get the villages

plans for electricity. Consultants make these in AutoCAD. MME accepts the plans. Below 22 kV MME sponsor (subsidise) development.

Based on information from the regions MME sets up the priority between regions and villages.

Suggestions for GIS use

The distribution lines are digitised by Geological Survey. Other base map data are also available. GIS can be a useful tool to have an overview of previous work, when and what voltage the lines have.
Maps can be drawn to fit into reports, as insight on the computer or as different maps.

In planning GIS can give access to relevant information which must be considered in the planning process. This includes location of villages, population density, roads and so on.

In long term planning a GIS can combine information about possibilities for renewable energy and plans for electricity.

14 p.m. meeting with M. von Jeney

Projects: Oil deposits.

Objective: Make sure the oil deposits follow up the standard norm for security against fire and safety against steeling, vandalism and so on.

Walwis Bay has 93% of Namibia's oil deposit. Windhoek is the next largest.

The regulation of the deposits needs to be done in a large scale. The data will not be available from other sources about the detail location of each building inside the deposit. The Oil Company might use a digital tool to obtain information and make the drawings.

I do not see the use of GIS in this project now. But I would suggest that even if there are not many oil deposits in Namibia, their location should be found and included in the database.

Projects: Petrol stations.

Objective: Give oil companies permission to set up new stations. Namibia has 5 oil companies. There are 3 outlets: service station, general detailed, and customer. Each oil companies get one outlet every 5-year. The oil companies compete for market share, not price.

In the future there can be no regulations. There will be a license system administrated by MME or a regulator.

To day there are about 230 petrol stations in Namibia. Namibia has only 1.6 mill people and is oversupplied by petrol. With the new system MME hope a competition will start on price as well as market share. Since Namibia is oversupplied, some petrol stations can be forced to close because of competition.

In urban areas more than 30 km from next petrol station there is a restrict on the last service station. The oil companies must supply the last station even if it is not earning enough money.

There is no problem with pollution from the stations. They have to attend certain standards.

Suggestions for GIS use.

A spatial database containing all petrol stations with attributes as: name, oil company, town, region, in operation from (date), types of station and so on.

This can be a useful tool in the licence procedure.

Data need
The data about each station can probably be obtained from the oil companies. A database must be build up at MME containing all relevant information.

Wednesday 11.02.98 MME, Namibia.

9 a.m. meeting with Mr. D. Hill at the Geological Survey.

Objective: To find out the possibilities for MME to use their software and hardware instead of buying their own.

Mr. Hill said that since they are in the same ministry, they have the same goal and this of cause is a possibility. But it has to be decided by the ministry. Geological survey has purchased the software and hardware they need themselves, and it is hard to get permission to buy more. The software packages are stored on individual machines used by specific personnel. They are therefor not available in a computer room where different personnel can use it when needed.

Thursday 12.02.98 MME, Namibia.

11 a.m. meeting with Mr. M.M. Nangolo, Chief Inspector: Petroleum Affairs at MME.

Project: Administration of the petroleum act.

Objective: In 1991 the first exploration for oil and gas started in Namibia. 5 companies got license (Norsk Hydro, Ranger, Chevron, Sasol (South Africa), and Shell) to start drilling offshore. Since then Sasol has drawn out. MME have a regulation function and do not participate in the physical exploration. The main task is to administrate the act and to monitor the companies' activity. They are in daily contact with the companies to follow up their activity and see that there work accordingly to what was agreed upon in the license document. There are no regulations so far. The licenses are joined agreements with a number of clauses.

The activities need verification. The companies need to verify their work and also get inspections so that MME can see that all is going as agreed. Special focus is on safety and health.

The workforce is so far mainly foreign. Namibians work on board on lower level as cleaners, in the kitchen and so on.

So far is it only one company, which have found gas. Oil is not yet discovered.

There are vulnerable areas along the coast and the ocean is used to extensive fisheries. The companies must in the process do environmental studies and look into different scenarios, that is blow out, pollution.

There is more than one ministry responsible for approval of the application from the companies. In addition to MME, there is Ministry of environment and tourism, Ministry of fishery and also Ministry of roads and transportation.

Project: Drafting regulations

Objective: The regulation act is in place. But they need some regulations as guidelines.

The areas, which shall be regulated, are ex:

Safety regulations for the working force.
Good environmental conditions.
Safety in general
Emergency response.

The companies will be expected to have internal control.

The draft includes suggestions for what kind of data the companies shall collect (data on ex. weather, wave, wind). The conditions shall include what kind of data, but not have the data shall be delivered.

Monday 02.03.98 in Norway

Telephone with Mr. O. Nevestveit at Norwegian Petroleum Directorate (NPD), mail from Mr. J. A. Eide.

Objective: Keep overview of which oil field are licensed and the history of licence for each field. Information of location of every part of the oil installations is included together with information of activities on the oil fields.

<u>Geographical data stored in NPD databases</u>
National borders
Coast lines
Geographical areas
Geological areas
Quadrants
Blocks

Production Licenses (with history)
w / area
w / licensees
w / operator

Well positions
w / logs
w / interpretation
w / deviation survey

Seismic navigation
w / ownership and statistics

Oil/Gas fields
w / statistics

Oil/Gas installations

They have ArcView and Arc/Info as GIS tools. An application for printing maps with data from petroleum databases is specially designed written in basic programming language. All geographical of the above can be displayed in maps.

ESRI software are used to digitise and capture data and for presentation. NPD is planning to use ESRI's Arc products for analytical purposes on all above topics. ESRI's Arc products are in use by IBM and us for multicompany "DISKOS" project to avail info to the Norwegian based oil industry.

The different companies send in data on wells and seismology. For every five shot location are stored in a navigation database with linkage to the depth profile with seismologic data. A firm who makes the data available for both the oil companies and the directorate handles this data.

The directorate use GIS to keep track of activities at sea and publish information about drilling activities.

Appendix C: PRESENTATION of GIS at MME, Namibia

By Astrid Voksø, NVE, Norway

Dear Director, colleges, ladies and gentlemen.

In this presentation I will **first** introduce you to GIS, what it is and to what purpose it can be used. **Then** I will take you through GIS requirements in general terms. In my final report I will enlarge this section with more details. **Finally** I will point some of the advantages GIS give in decision-making and day-to-day administration.

Why GIS?

Rapidly declining computer hardware costs have made GIS affordable to an increasingly wider audience. More importantly, we have come to realize that geography (and the data describing it) is part of our everyday world; almost every decision we make is constrained, influenced, or dictated by some fact of geography. We send fire trucks to fires by the fastest available routes, we study disease by identifying areas of prevalence and rate of spread. The demand for geographic information parallels the need for GIS, explaining its rapidly growing population.

Outline

1 What is GIS
2 What can GIS give
3 What GIS require of
    - data
    - Hardware
    - Software
    - Personnel
    - What kind of know how do they need?
4 Advantages GIS give in decision-making and day-to-day administration

1 What is GIS

GIS - Geographic Information System.
GIS is a computer-based-tool for mapping and analysing features and events that happen on the earth. GIS is used as only the software tool and the geographic information system with data and specific functions developed.

Features or events that have a position on the earth, is called spatial data In other words, GIS is a system for handling all kinds of spatial data and attributes connected to them. The spatial data are stored in a geographic database.

1.1 Spatial operations

Many computer programs, such as spreadsheets (Excel), statistics packages (e.g. SAS, Minitab), or drafting packages (e.g. AutoCAD) can handle simple geographic or spatial data. GIS it only a GIS if it permits spatial operations on the data.

Name	Latitude	Longitude	GIS population
London	51 N	0	80
Oslo	60 N	10 W	50
Windhoek	22 S	16 W	10
Buffalo	42 N	78 W	30
Santa Barbara	45 N	69 W	50

Aspatial queries: What's the average number of people working with GIS in each location?

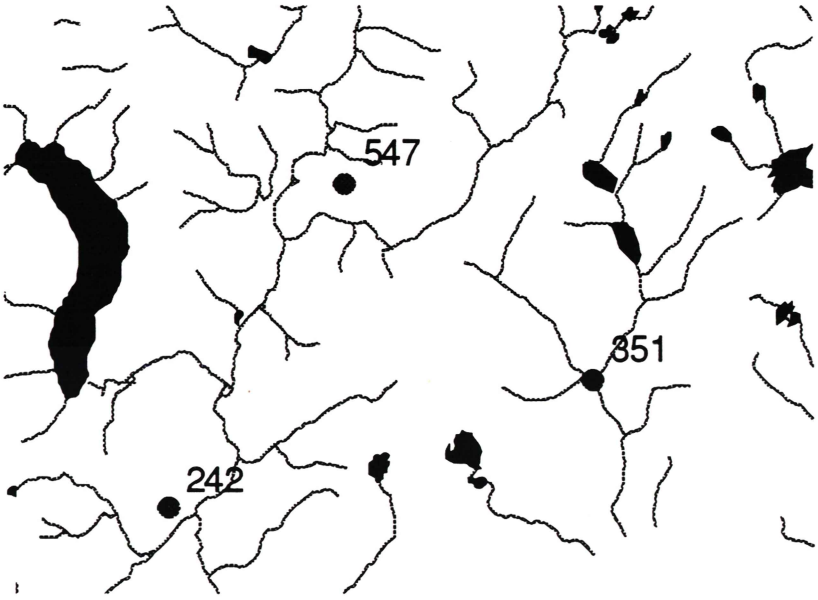
Spatial queries: How many people work with GIS within 1000 km from London?
Which centers lie within 1000 km of each other?
What's the shortest route passing through all these centers?

Spatial queries can only be answered using latitude and longitude data and other information.

1.2 Data linkage

A GIS typically links data from different sets.

Water power plants are identified with a number.



Data about each plant are stored in a database. The linkage is the number.

Number	Name	Production	Energy	Capacity flow	Run-off	Installation
242	LEIRDØLA	458.3	1.068	26.01	441.80	100
351	SAGE	15.7	0.694	0.6	91.8	1.5
547	JOSTEDAL	866.5	2.759	29.0	320.2	288

To answer the question of what is the max installation in each county you need to combine the two files.

1.2 Spatial linkage

Spatial data like soil types and crop productivity may not have the same boundaries. The layers can be joined creating a new layer containing the characteristics of both.

A GIS can perform all this operation and similar, because it uses geography, or space, as the common key between the data sets. Information is linked only if it relates to the same geographic area.

2 What can GIS give?

2.1 Capturing and storing spatial data

Spatial data have been stored on paper maps, in achieves or reports or in the heads of personnel. To make them available to a wider range of people in the organisation, they need to be collected and structured and saved in a database. GIS has the ability to store all kinds of spatial data in one common database. One common database means data stored in the same software, using the same position system. GIS integrates common database operations such as query and statistical analysis with the unique visualisation and geographical analysis offered by maps.

Data can be captured in different ways depending of the kind of data.
I will come back to this in my report when I learn what kind of data is relevant for you.

2.2 Handling spatial data

The data captured must be looked after to maintain or enhance the qualities establish when the data was captured. When data is stored in one common database used by all personnel, updating can be done one place and it is visible for all.

With GIS you can:
Editing (changes position, values, and delete or ads features).

To find errors you can:
Querying both spatially and by attributes. Errors are easier to see when shown on a map.

2.3 Present spatial data on maps

To be able to make useful maps you will in addition to your own data need digital base map data. That includes digital coastline, borderlines, rivers, built up areas and so on.

The possibilities in GIS to make maps are numerous.

You have got flexibility in format, content and how each of the objects shall be presented with different colours or in black and white. What one choice depends on the possibilities one have in plotting the map on paper and how the map shall be used.

I will show you some examples.

2.4 Connecting and accessing data

Data from different sources can be combined in different ways.

Spatial data with different attributes from other databases.

The goal here is to store the data to make them available and easy to access by the users.

2.5 Analysing

For any application there are five generic questions that a sophisticated GIS can answer.

What is at ...?

What exist at a particular location. A Location can be described in many ways using, for example, a place name, a postcode or a geographic reference, such as latitude and longitude.

Where is it?

This question requires spatial analysis to answer. You want to find a location where certain conditions are satisfied (e.g., an unforested section of land at least 2000 km2 in size, within 100 meter of a road).

What has change since...?

The third question might involve both of the first two and seeks to find the differences within an area over time.

What spatial pattern exists?

This question is asked to determine whether cancer is a major cause of death among residents near power lines.

What if ..?

This question is posed to determine what happens, for example, if a new reservoir is built. What land and people is effected? Answering this type of question requires geographic as well as other information.

I will show you with some examples.

2.6 Decision-making

Some of these functions can be put together in a user-friendly system to be used in operation and/or in decision-making.

I will point out some points, which is important in decision making

The information must be:

easy accessible
objective
Correct

The information system must be:

Easy to access information
You must be able to combine different information
The information must be able to exchange

A GIS can effectively update your data continuously so they are correct and content facts only. If they are structured and classified they can be easily accessible.

Examples of decision-making:

3 What GIS require of

3.1 Data

Spatial data must have a position referred to by a known co-ordinate system.

Positioning

Geographic co-ordinates, latitude and longitude,
eks Windhoek ca 16 grader Longitude West and 22 Latitude south.
Reference to a co-ordinate system (lazimuthal equal area projection)

Attributes

Each object/feature need in addition data about the object. Most data will also require a unique identification and a type of classification.

3.2 Software

GIS systems

Arc/Info
ArcWiew 3.0 GIS
Integragh
MapInfo

3.3 Hardware

PC to access data and software
Workstation for storing data (or on PC)
Plotter/printer

3.4 Personnel

You need personnel to handle these tasks:

Data capturing
Data modelling
Building databases for your own data and for base map data from other sources.

Build GIS applications. Applications developed in a GIS software to make data available.

This takes time. It is important to have personnel to do some of this in the organisation. Typically, it is your own personnel who know how the data should be classified and which attributes are relevant. Consultant can do the modelling and application, but they need personnel with knowledge of the datacontaint to tell them what results you need and how you want the applications to look like.

What kind of know how do they need? At present and for years to come general-purpose GIS will rely on users to know what they are doing pressing a button is not enough.

If a decision to use GIS technology is taken, it is more important with personnel than software and hardware resources in the beginning. You do not need a lot of software and hardware before the data are available. Only tools used in capturing data, editing and presenting.

Cost

Data capturing

60-80 % of the costs
Period of relevance 15 -20 years

Software and hardware

10 -20 % of the costs
Length of service 2 - 6 years

4 Advantages GIS give in decision-making and day-to-day administration

Digital updating of maps makes the production more effective. It makes the data more accessible and easier to find by everyone.

A lot if time is used to collect data that is why they are valuable.

Known savings in working methods, factors important for success and the timeelement.

Resources:
Less number of workoperations
Less manuell inspection

Qualified personnel can get time to do useful tasks instead of
- Collect information, which has been collected before
- Search in poor archives
- Travel on surveys
- Make manual illustrations

Product and services
Quicker production
New products and services

Promptly accessible information
Lesser time to consider
Possibility to sell data/products

Correct information at the right time

Efficiency which one can not quantify

Better basis for decisions
Higher quality of the products
Better understanding of the problems
Better decisions
Better planes
Less rutinwork, more interesting job

Negative sideeffects

Increase vulnerability

Increase need for personnel with know how, can exclude personnel without the knowledge or possibilities to learn it.

Conditions for efficiency

Enough time and money to give personnel qualifications
Start with a small area both in space and subject

Give datacapturing high priority

Make GIS visible through early products

Work by a plan

Have specific economic boundaries

Be prepared for adjustments in the organisation

Work multidisciplinary

Make external co-operation

Use personnel with enthuasasme and ability to solve problems

Conclusion

A GIS is not simply a computer system for making maps, although it can create maps at different scales, in different projections, and with different colours. A GIS is an analytical tool. The major advantage of a GIS is that it allows you to identify the spatial relationships between map features.

A GIS does not store a map in any conventional sense; nor does it store particular image or view of a geographic area. Instead, a GIS stores the data from which you can draw a desired view to suit a particular purpose.