Development and implementation of a GIS (geographical information system) service for the Ministry of Health and Social Welfare in Lesotho

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Introduction

The Ministry of Health and Social Welfare (MOHSW) in Lesotho has been contemplating the development of a geographical information system (GIS). This report provides recommendations on how such a service could be developed and implemented. The recommendations are the result of a consultancy study funded by the project **Support to Health Sector Reform in Lesotho -No 8.ACP.LSO.008**, as implemented by the Unit for International Development Collaboration in the National Research and Development Centre for Welfare and Health (Stakes). We visited Lesotho between the 16th and 25th of February 2005 to conduct the study, which also draws upon findings during an earlier study in April 2003.

A GIS is a computerized system which stores and analyzes geographical information to enable the user to generate maps and to link statistical data to mapped objects. For purposes of the health sector, the main applications of a GIS are to produce maps that show the provision and demand for health services, to relate these to information on the public in catchment areas being served by health services, and to analyse the prevalence and incidence of various health conditions.

The process of developing a GIS for the MOHSW can usefully be divided into two components: creating the supply or ingredients of the system, and then creating a demand for its products. Most efforts at GIS development concentrate on the former, especially on such aspects as software, hardware and data, but we urge that an equal effort be made to promote the need for GIS products.

Creating the supply

Data components

A GIS for the MOHSW would make use of four major sets of data. The first set consists of information on health facilities. The geographical data would be made up of locations of each health facility under the control of the MOHSW. These are sets of co-ordinates, each of which uniquely indicates the position of a facility. Each facility is additionally given its official name and a unique code number in the data set. A total of 198 facilities were functional and open during 2004 and the co-ordinates of these have been recorded (see Appendix 1).

The second set of data is the Ministry's HMIS (Health Management Information System) data. These data record numbers of patients treated for different diseases at each health

facility. Each data record also contains the unique code that identifies each facility, thus allowing information on diseases (and other information collected at each facility) to be linked to the first set of geographic information. Typically, analyses would show the number of cases of each disease recorded at a facility each year, but additional analyses could explore prevalence trends from month to month or year to year, for example.

A third set of data could provide information on the catchment population. This would usually consist of data on the positions of villages and number of people (ideally in different age groups, and by gender) living in each village. Such information can be obtained from population censuses or from surveys, as was the case in the MCDI rationalization study in 2002. Avery useful proxy to estimate catchment populations has recently been assembled by the Ministry of Local Government (Land Use Planning). This is a database of about 9,000 villages, which contains the number of registered votes in each village.

As with the HMIS data, the catchment information can be linked to each health facility. Analyses of these data in relation to information on treatment records would allow for the estimation of disease incidence (number of new cases divided by the catchment population) and indices of access to and effectiveness of health care.

The fourth and final set of data consists of contextual information to show such features as the presence of other social services (schools, postal services, electricity etc), roads that provide access, barriers to access (major rivers or mountain ranges), and commercial centres or growth points. As part of this study, maps of all health facilities in each of the 10 administrative districts were prepared to show many of these contextual features.

Hardware

The GIS service should be placed in the Planning and Statistics Unit of the MOHSW. This Unit is equipped with many computers suited to GIS applications. In addition, most of the computers are linked on a dedicated network which is managed by staff in the Unit. There is thus no immediate need for additional computers to develop a GIS service. However, one or more colour printers are needed for the printing of maps, and it is recommended that an A3 and/or A2-size colour printer be purchased. The printer should be of high quality, of a reputable brand to ensure that ink, paper and service is readily available.

Software

GIS software will be needed, and we recommend that ArcView and/or ArcGis be used. These are the most-widely used GIS packages, both in Lesotho and elsewhere in southern Africa. Both programmes are produced by ESRI, and information regarding these programmes can be found at its website (www.esri.com). The widespread usage of these programmes means that the GIS service can easily exchange and import from other users maps, data, symbology, map layers, geo-processing models, custom tools and interfaces, reports and metadata.

Staffing

It is generally easy to assemble data, hardware and software for GIS applications, but it is very much harder to find appropriate people to do the work. While GIS is a tool, it only becomes really useful when applied in an enquiring and analytical context. Personnel with initiative and enthusiasm are thus required, people who can ask questions and explore different options for answering them. The staff should receive some basic training to introduce them to the main concepts and processes. Thereafter, they should train themselves as they gain experience. ESRI provides extensive documentation and on-line help that can be consulted, and the staff should maintain close collaboration with other GIS users in Maseru who can provide advice and assistance. Many GIS processes can be accomplished in several different ways, and it is up to the GIS technician to consider the alternatives. The ability to do this cannot easily be acquired through training, but is more the result of interest and confidence. The same is true for innovative applications and analyses, and the ethic of ensuring that all databases are backed-up for safe keeping and that the data are as up-to-date, error-free and comprehensive as possible.

Data policies and sources

The GIS service will use and depend on data generated by the MOHSW itself (geographical locations of health facilities and the HMIS database) and other sources. A large set of data from such other sources was collected during this and the earlier April 2003 study, and copies of all these have been provided to the Planning and Statistics Unit (see Appendix 1). What is important is that the Unit continues to seek, obtain and update additional sets of data whenever these become available. To this end, the Unit should maintain good links with all other GIS users and developers in Lesotho, freely exchanging and swapping all data. There is a tendency in many governments to attempt to control and co-ordinate databases. Usually, these attempts aim to set standards or specifications for data systems, to avoid duplication of effort and to attempt cost recovery. All this sounds admirable, but these attempts usually get bogged down in bureaucratic processes and restrictive controls that dampen enthusiasm and limit the availability of information.

In addition to exchanging and obtaining GIS data, the Unit should constantly attempt to update and check its own databases. It will be comparatively easy to maintain and update data on the geographical locations of health facilities, but this will be much harder for the HMIS databases. Every effort should be made to obtain the HMIS data as rapidly as possible, to check and clean these data, and to ensure that all facilities submit completed questionnaires every month. In short, having a complete and clean set of HMIS data will be of great value in allowing the Unit to perform reliable, comprehensive and informative analyses.

Information obtained during this and the April 2003 study suggests that the best source of GIS data in Maseru is the Land Use Planning Unit of the Ministry of Local Government. This Unit has assembled very large and useful sets of data. Its policy is also to make these readily available to other users. By contrast, the official mapping agency of the Lesotho Government (the Directorate of Land Survey and Physical Planning) has little data to offer and intends to make these available only under restrictive conditions.

Placement of the GIS service
From our investigations in Lesotho, it seems generally agreed that the GIS service would be placed in the Planning and Statistics Unit of the MOHS. This seems entirely appropriate and correct. However, there was also the thought that local GIS units could be developed in each of the districts. Our view is that this would be premature, and it would be advisable to concentrate on developing a fully functional and mature GIS service in the Planning and Statistics Unit at head office over the next two or three years. A centrally placed unit should also be able to provide GIS services for the districts, and consideration could be given at a later stage to providing additional services in the districts.

Creating a demand for a GIS service
GIS services usually start off with a great flourish. People are enchanted with the new tool, the data it can store, and the maps and analyses it can produce. However, without a sustained demand for the data and products, the service will probably quietly die after several years. Moreover, staff who become experienced and proficient GIS users often move to other occupations. This all sounds pessimistic, but it is better to be warned, and averting these probabilities requires several activities.

Identify advocates of the service
It is likely that certain senior staff members of the MOHSW will be more interested in the GIS products than other management people. They will make greater use of the maps and analyses, and will thus inadvertently promote the service. The personnel responsible for the GIS service will themselves be motivated to produce more and better products. A key recommendation, therefore, is to try to identify managers who are really interested in the GIS, and then to actively serve their needs and interests.

Print and distribute large quantities of maps
People generally like maps, especially attractive ones. The maps are often hung on office walls or in other prominent places. This might seem like decoration, but maps hung in public places serve to disseminate much useful information, even when they are only viewed casually. It would therefore serve everybody's interests to produce lots of different maps and to distribute as many copies as possible. A first step would be to do copy and distribute the 10 district maps and the national map of health facilities produced as part of this consultancy. Several copies of the district maps should be sent to each district. All senior managers in MOHSW should receive copies as well.

Publish the results
It is recommended that the Planning and Statistics Unit consider producing a book or booklet that provides an overview of health services, challenges and issues in Lesotho. The production and publication of many maps would make such a publication both attractive and interesting. Maps would show, for example, the provision of services, areas in which an expansion of services is needed, demographic features, trends in rural development and urbanization, and the incidence and prevalence of the most important

health problems in the country. The book would also serve to greatly improve public knowledge on Lesotho's health system, and it would set a useful goal for the GIS and other staff in the Unit to produce such a publication. We would further suggest that the book "Health in Namibia: progress and challenges" be used as a template for the publication.

Other publications could be considered, for example, brochures, posters and newsletters. All of these would provide an additional benefit in showing that information and statistics collected by and through the HMIS is indeed useful. This would also provide feedback to staff in the health facilities and districts to show how the information they submit can be used.

Engage the districts
The GIS unit must maintain close links with staff in the districts, both to engage them in the process of collecting and verifying information, and to serve their mapping needs. All of this engagement will enhance the degree to which district staff enjoys ownership of the data, the maps and the health services they provide.

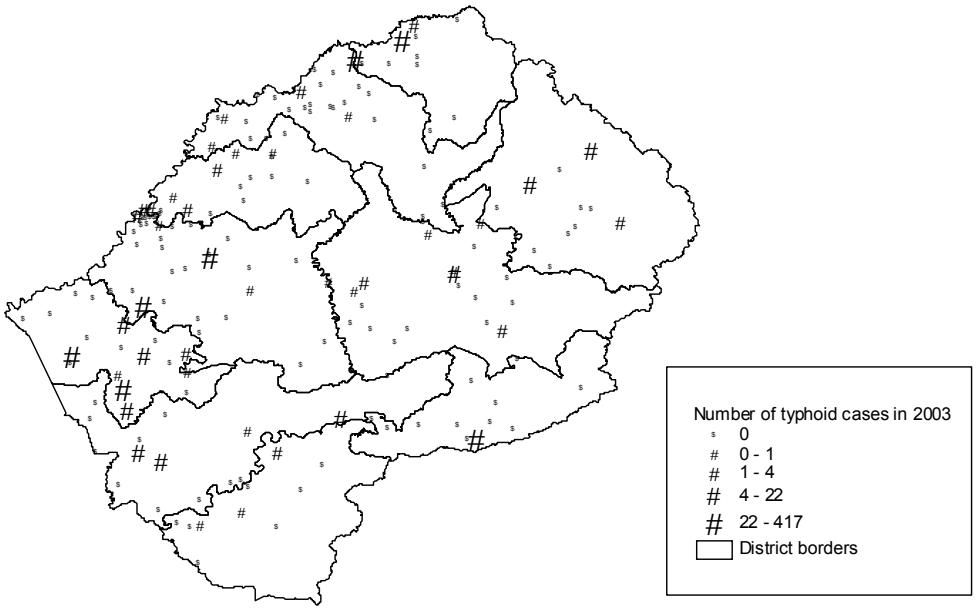
These are a few ideas on how demands can be generated for a GIS service. There are doubtless other ways, as well. The most important point is that the staff realize that demands and interest need to be created, and that every effort to do so should be recognized and then seized.

Applications of a GIS
There are several different applications and uses of a GIS for the MOHSW. These are listed below, but we also predict that other benefits will be found once the service is up and running.

Decentralization
The MOHSW is now facing the prospect of shifting its regional administration of health services from 18 health service areas to 10 district zones. There is no geographical correspondence between the health service areas and districts. As a first and easy step, the GIS data will be used to determine what facilities fall in each district. A second, more difficult step is to estimate and agree upon what villages (and hence catchment areas and populations) are to be served by each facility and thus district. This will be simple for facilities falling well within the boundaries of a district, but those near the borders are known to often serve people living nearby in adjoining districts. The major utility of a GIS will be plot out all this information on large maps, which show the facilities, villages and perhaps estimates of the number of residents per village. Once assembled, the maps can be used as a basis for discussion between health administrators at head office and the relevant districts to determine and agree upon what villages and populations should be taken as being in the catchments of each facility. The importance of maps for this purpose lies in the fact that everyone will be debating the issues around a common set of information. Reaching agreement on the catchments and budget allocations will therefore be quicker and less contentious.

Epidemiology
Although the HMIS reports information on the number of cases of different diseases treated at each facility, it is difficult to visualize geographic trends or patterns in prevalence from the figures that are normally listed in tables. It also difficult to pick out any areas where there may be an alarming number of cases, and because HMIS data are not related to estimates of catchment populations, it almost impossible to identify trends in incidence. For example, the incidence of a disease at a facility with a big catchment may be less difficult than a smaller number of cases in an area with a small catchment.

Maps produced by the GIS service will do much to solve these limitations. The HMIS data can be joined to the GIS locations of each facility, and the number of cases (as prevalence) can then be shown on a map. Likewise, estimates of incidence can be obtained by dividing the number of cases by the catchment population. An example map showing the number of typhoid cases reported at each health facility in 2003 follows.



Service planning
Health facilities are expensive to establish and, once built, they are difficult to move. However, the number and distribution of people requiring health services may change quite rapidly, especially as a result of urbanization and the development of new infrastructure. A central question therefore for health planners is to ask how the supply of facilities matches demand? A GIS can be useful in solving this problem. Maps showing the locations of facilities, actual catchment populations known to have access to the facilities, and more distant and inaccessible villages can be produced relatively easily. Geographical features which aid (usually roads) or impede access (such as mountain ranges and large rivers) can be shown on the maps, all of which should make it possible to identify populations that are poorly served by facilities. Similarly, it should be possible

to identify facilities that are perhaps under utilized by dividing attendance figures at facilities by estimates of catchment populations.

All of these analyses will help the MOHSW to improve access to health in Lesotho, and also to make its services more efficient and effective. The implementation of the results of these analyses should also result in considerable economic savings, which are likely to be several times greater than the costs of running a GIS.

Improving levels of information
One major benefit of the maps and analyses described above is that overall awareness on health services and issues is raised. Many people suddenly realize that there is a health centre in a particular village, or that there seem to be a rather large number of facilities in another place, for example. Likewise, more health practitioners become aware of the fact that certain diseases are more prevalent in certain areas or at particular times. All of this increases levels of understanding and literacy on matters concerned with health and the services provided by the MOHSW. Raising awareness amongst politicians, senior decision-makers, local leaders, development planners etc has obvious value. The point should be repeated that the more maps and publications that are produced, the greater the level of knowledge will be. The MOHSW will probably also enjoy greater support for its services, activities and plans.

Steps for going forward
The following recommendations are offered as steps to be taken in developing and implementing a GIS. A first step will be to acquire the GIS software and printer described above. From our discussions in Maseru, it seems desirable that three staff members be involved in the GIS service: an epidemiologist, a statistician and a technician from the HMIS/IT (Information & Technology Section). These people should be formally identified and sent for some basic training. Our enquiries suggest that this could be provided by the local company Quadrant. An alternative would be to receive training from the company GIMS in Johannesburg. The training should focus on the basic principles and processes to be used in a GIS. Additional training on the use of GIS in the health sector could be provided by RAISON or another company with relevant experience.

We recommend that firm goals be set for the GIS service to deliver several stipulated products at an early stage. These goals will allow the staff to have a clear idea of what is required, and they will also derive a good deal of satisfaction by being able to produce maps and analyses at an early stage. Examples of immediate products are new and revised maps for each of the districts, a book or profile on health in Lesotho, and geographical analyses of the most important diseases in Lesotho. The staff might also be set the task of incorporating survey data from sentinel and DHS (demographic and health survey) into the GIS.

We have mentioned the need to involve and engage MOHSW staff in the districts in the GIS service. This could be started now by asking the district staff to check and correct the first set of district maps produced as part of this consultancy. A second step to involve district staff would be to request their help in visiting all their health facilities to record the co-ordinates using a GPS (global positioning system). The majority of co-ordinates for the 198 facilities are approximate, and it would be useful to obtain GPS locations as soon as possible to ensure that this set of data is correct and precise.

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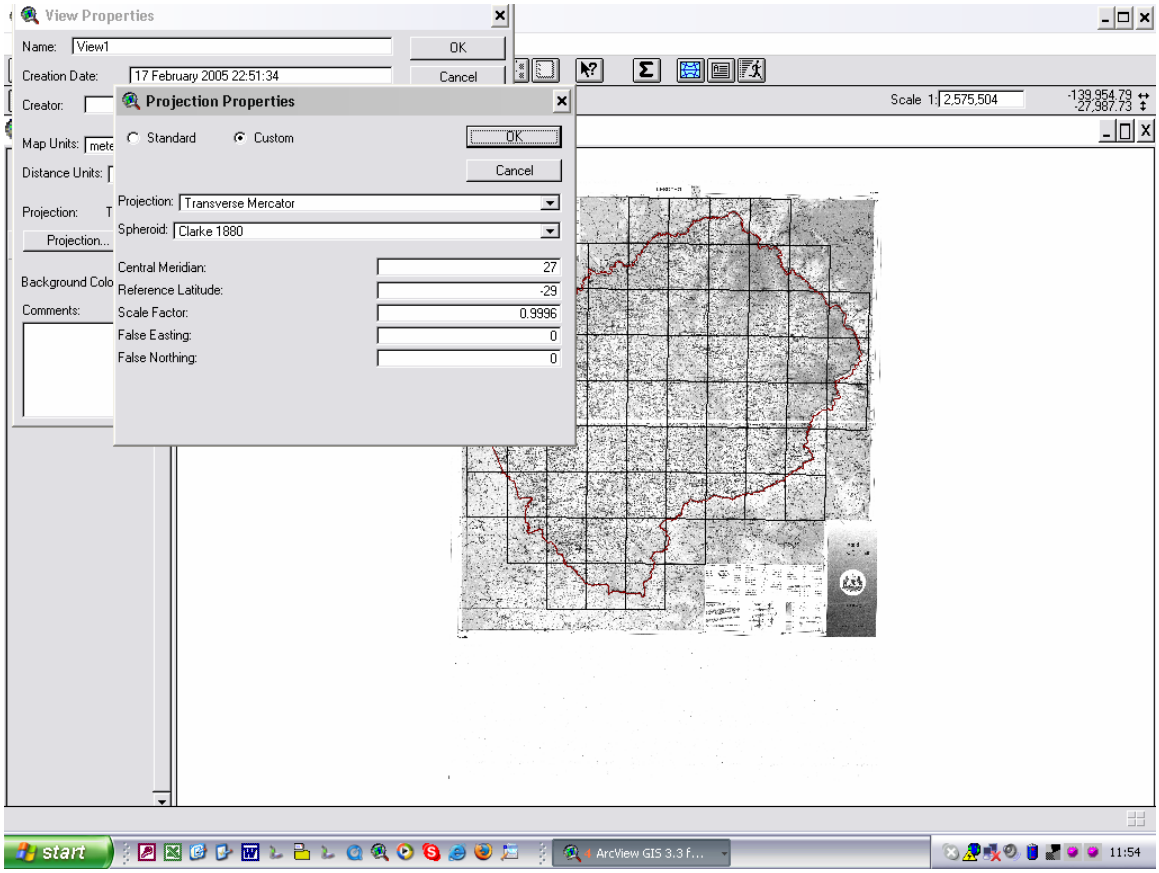
Appendix: Some notes on data left in the Planning and Statistics Unit of the MOHSW

The following sets of data were assembled by us during the first mission in April 2003, later in Namibia and now in February 2005. Copies were placed on Dr D Rumisha's computer. All these are vector data in geodetic or latitude-longitude co-ordinates.

1. Health facilities: The file of health facilities contains co-ordinates derived from several sources: points recorded during MCDI study, positions indicated to us on a map, and the positions of seven facilities that we recorded with a GPS in Maseru. The identity of those facilities mapped with a GPS is noted in a field called 'SOURCE' in the data table. It is recommended that this field be updated as and when new GPS co-ordinates are obtained so as to keep a record of what facilities have been located accurately using a GPS.
2. District borders
3. Health Service Areas borders
4. Roads
5. Rivers
6. Police Stations
7. Post Offices
8. Altitudes
9. Villages and towns
10. Community Council Areas
11. Constituencies

The following maps and satellite images were also assembled:

1. 1:250,000 map: this is a black and white version of the standard Lesotho 1:250,000 map. To view it in Arcview and overlay the vector files listed above, the View projection parameters must be set as shown in the image below.
2. 1:50,000 maps: these were left with Dr Pekka Kuosmanen in April 2003. They were stored on about four CDs. The images are in geodetic or latitude-longitude co-ordinates, and thus do not need to be specially projected.
3. A MrSid satellite image of the northern two-thirds of Lesotho. The MrSid viewer extension must be loaded before adding the image to a view. To then overlay the vector files listed above, the View projection parameters must be set as shown in the second image below.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OK
Creation Date: 17 February 2005 22:51:34
Cancel
Creator:
Map Units:
Distance Units:
Projection:
Projection...
Background Colo
Comments:
Projection Properties
Standard
Custom
OK
Cancel
Projection: Transverse Mercator
Spheroid: Clarke 1880
Central Meridian: 27
Reference Latitude: -29
Scale Factor: 0.9996
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False Northing: 0
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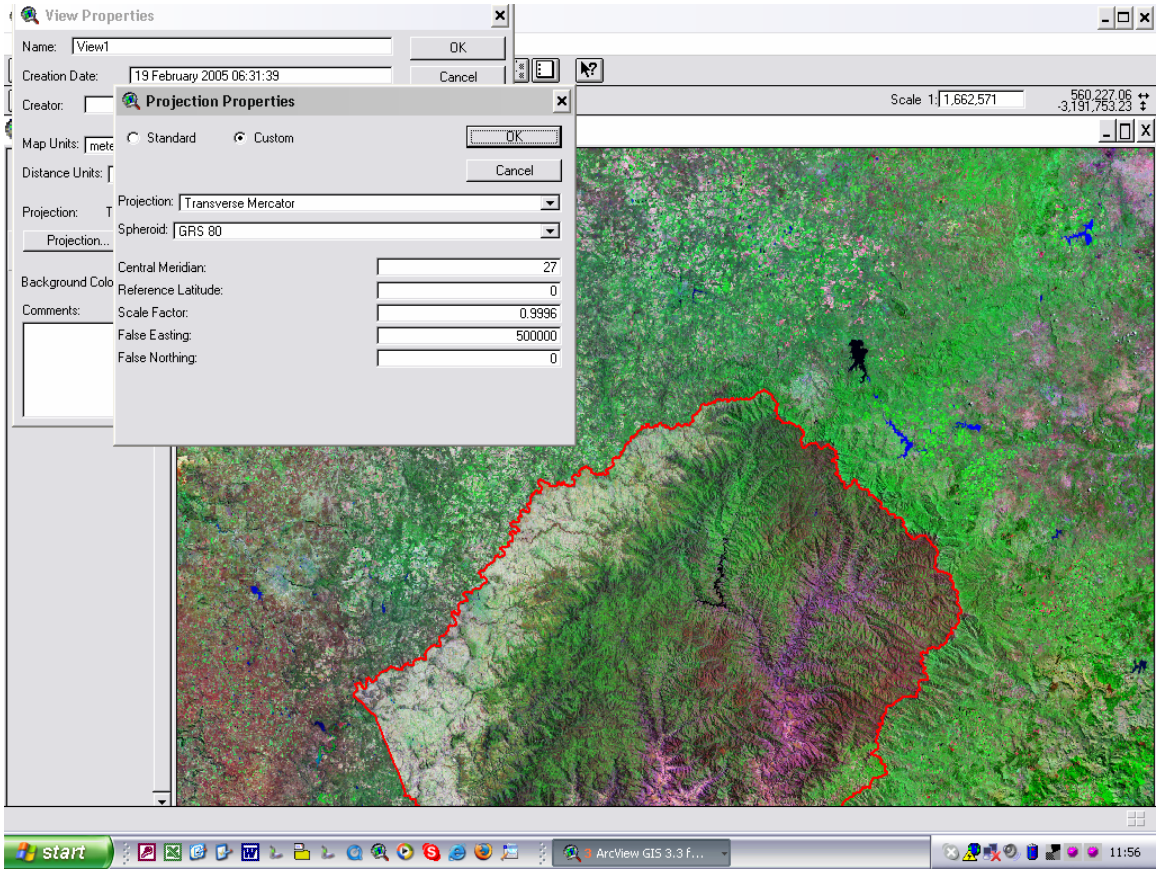
-27,987.73
start
ArcView GIS 3.3 f...
11:54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Creation Date: 19 February 2005 06:31:39
Cancel
Creator:
Map Units:
Distance Units:
Projection:
Projection...
Background Colo
Comments:
Projection Properties
Standard
Custom
OK
Cancel
Projection: Transverse Mercator
Spheroid: GRS 80
Central Meridian: 27
Reference Latitude: 0
Scale Factor: 0.9996
False Easting: 500000
False Northing: 0
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560,227.06
-3,191,753.23
start
ArcView GIS 3.3 f...
11:56

Trip Report: Consultancy on the development of a GIS service and the compilation of maps for the Ministry of Health and Social Welfare in Lesotho

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As a result of the contract between RAISON and the Unit for International Development Collaboration in the National Research and Development Centre for Welfare and Health **(**Stakes) for the project **Support to Health Sector Reform in Lesotho -No 8.ACP.LSO.008**, we visited Lesotho between the 16th and 25th of February 2005. A further two days of work were completed in Windhoek to finalise aspects of the work. The programme of activities during the consultancy were as follows:

Date		**Activity**
16-Feb	Wednesday	Travel from Windhoek and arrive in Maseru at 17h00
17-Feb	Thursday	Planning of work programme with Davis Rumisha and John Nkonyana. Begin checking and compilation of list and locations of all health facilities. Introductory meeting with Director of Planning and Statistics Unit, Ms M. Makhakhe
18-Feb	Friday	Continue checking and compiling locations of all health facilities. The approximate positions of about 45 health centres and hospitals were added to the GIS database of health facilities. Consultation with the Director of Primary Health Care, Ms Momuruti Teheli to discuss use of GIS in helping to plan the decentralization of health administration.
19-Feb	Saturday	Compile maps of health facilities in 10 districts. Map the co-ordinates of seven health facilities in Maseru with a GPS.
20-Feb	Sunday	
21-Feb	Monday	Discussions with Shane Molale on HMIS data. Obtain copy of HMIS data and start to plan analyses of relevant example diseases. Consultations with Ms Agnes Lephoto of CHAL on possible GIS work being pursued by CHAL. Meeting with Mr Selebalo (Director of LSSP (Land Survey & Physical Planning)) and his staff on GIS issues in Lesotho.
22-Feb	Tuesday	Continuation of compilation of maps of all districts. Meeting with staff of Planning and Statistics Unit to discuss perceptions, expectations and planning for GIS work in their Unit. Analyses of selected diseases per health facility and health service area (HSA).
23-Feb	Wednesday	All day visit to Thaba Tseka and discussions with district and Paray Hospital staff: Ms Keneuoe Fobo and Mr Max Thomae.

24-Feb	Thursday	Complete compilation and printing of district and national maps, compile final sets of data, and debriefing with Director of Planning and Statistics and her staff. Obtain copies of constituency, community council areas, and districts from Mr Matthias Wiegand at the department of Land Use Planning. Copy all data on to Dr Rumisha's computer.
25-Feb	Friday	Travel from Maseru to Windhoek
26-Feb	Saturday	
27-Feb	Sunday	
28-Feb	Monday	Further checking and corrections to 10 district maps, national map, and drafting of report on strategic planning and implementation of GIS in MOHSW.
01-Mar	Tuesday	Completion and printing of 10 district maps, and report on strategic planning and implementation of GIS in MOHSW.

All aspects of the work stipulated in the contract were completed. The main products of the consultancy are:

1. Maps of all health facilities, towns, roads, rivers, elevations and selected villages in the 10 districts. These were printed in A3 paper and laminated, and sent by courier to Dr D Rumisha;
2. An overall map of all health facilities in Lesotho (this was not a contractual requirement). This was printed as A1 size and laminated, and sent by courier to Dr D Rumisha;
3. A large set of assorted GIS data, scanned maps and a satellite image; and
4. Report recommending the development and implementation of GIS in the Ministry of Health and Social Welfare.

We are grateful to everyone in Lesotho for making our visit and work a pleasure.

John Mendelsohn and Selma el Obeid
2 March 2005