Report on work to assess GIS (geographical information system) data for the Okavango Basin

GEF EPSMO Project, UNTS/RAF/010/GEF

November 2005

John Mendelsohn, RAISON, Windhoek, Namibia
&
Artur Mugindo de Oliveira, National Institute of Statistics (INE), Luanda, Angola

Summary
The report provides the results of investigation to determine the nature and availability of GIS data for the Okavango Basin, and to recommend how these data can be assembled to provide for planning needs. A substantial number of datasets have already been assembled in two databases, and most of these data have been circulated widely. Little new or other information is available for the Angolan catchment area of the Basin. It is recommended that data for the Basin be made as freely available as possible to all *bona fide* users, and the Harry Oppenheimer Okavango Research Centre be requested and commissioned to develop a single Okavango Information Service (OIS).

Contents

Introduction

This report is a product of a consultancy assignment to (a) investigate what relevant GIS information and institutional capacities are present in Angola, Namibia and Botswana, (b) analyze issues and aspects of GIS information across the three riparian countries, and (c) develop recommendations on how best to get a GIS system up and running for the GEF EPSMO Project. The terms of reference for this assignment are reproduced as Appendix 5 to the report.

Most effort during the consultancy was devoted to finding out what institutions and companies might have GIS data for the Okavango Basin, interviewing people at these organizations to gather information on relevant sets of data, asking for copies of the data, and finally soliciting suggestions on other sources of GIS data. The following aspects were covered to a greater or lesser degree during the discussions: the theme of data, when it was collected, what the major sources were, the co-ordinate systems used, aspects concerning accuracy, the format of the data, current mapping activities, and policies and practices relating to access to data. More investigations were conducted in Luanda than elsewhere because no recent attempt had been made to document the nature and sources of GIS data available in Angola. By contrast, several successful efforts had been made in recent years to assemble GIS data in Namibia and Botswana.

General observations and results

Principal databases

A considerable number of GIS data sets covering various aspects of the Okavango Basin have been assembled over the past three years. These are listed in Appendix 4. Most of the data have been compiled in two major databases. The first of these, known as the RAISON database, has been widely distributed in two versions, both of which were in English and Portuguese editions. The database was assembled in 2003 and 2004 by RAISON for the Namibian Ministry of Environment & Tourism, the Every River has its People project, and the Sharing Waters project. Approximately 200 different sets of GIS data are contained in this database (see Appendix 4).

The second database was compiled during the past year by the Harry Oppenheimer Okavango Research Centre (HOORC) as an assignment for the Okavango Delta Management Plan (ODMP). This data set is known as ODIS, short for Okavango Delta Information System, and the data it contains is restricted to Botswana. This database contains about 210 different sets of GIS data (see Appendix 4). Quite a number of the same sets of GIS data are present in both the RAISON and ODIS databases. In addition, HOORC has a substantial collection of satellite images, as listed in Appendix 3.

Although the focus of this consultancy study is on GIS data, it should be noted that the RAISON dataset also contains several large sets of statistical data sets, a bibliography and pdf files of about 200 reports, articles or books. Likewise, the HOORC has a very large library of material related to the Okavango. The Centre's research staff additionally has considerable numbers of statistical data sets and, of course, considerable experience. These other kinds of information will be of substantial relevance to the GEF project in its work to undertake Trans-boundary Diagnostic Assessments and the eventual development of a Strategic Action Plan for the Okavango Basin.

GIS information in Angola

In Angola, it is only in the last two or three years that any public service organizations have started to develop an interest in GIS. While quite a few organizations claim to have a GIS, very few actually have any true GIS data or operational systems. In many cases, people considered that the few scanned maps they have constituted a GIS. Some institutions are now developing software and hardware systems, but many have yet to acquire appropriately interested or qualified staff. In some cases there is also a lack of perspective on what functions their GIS will or could serve. Another constraint is that most mapping and surveying activities are concentrated on the more densely populated and accessible parts of the country. With the exception on CNIDAH, we encountered no organization or institution that was actually doing any mapping within the catchment of the Okavango.

GIS information in Botswana

As for Botswana, it is clear that HOORC and ODMP staff have done a very thorough job in compiling all available data on the Okavango within that country into the ODIS database. This has been done in collaboration with 12 government departments and numerous other data users and suppliers. ODIS also offers a metadatabase to access and document the data, and a viewing and printing system for custom-made maps. Numerous users in government departments and participants in the ODMP project have been trained. These people have also helped to identify inaccuracies and to supply corrected data. Interestingly, all government departments supplied their data to ODIS without any restrictions. All in all, this is an impressive product developed with the involvement of many people and organizations. In terms of identifying and sourcing relevant GIS data for Botswana, it is very likely that all potential sources have been covered. No one could suggest any other potential sources of Botswana data to us. The entire ODIS database is about 12 gb in size. We requested a copy for the GEF EPSMO project but were told that the project leader would have to formally request a copy from Mr Mushanana Nchunga, Executive Secretary, Department of Environmental Affairs, Private Bag 0068, Gaborone, Botswana. It should be noted that the HOORC library is also developing a resource for printed material to be called “Flow: information for Okavango Basin planning”.

GIS information in Namibia

Little new mapping work has been done in recent years in the Kavango region of Namibia. All the detailed GIS data assembled by the Directorate of Surveys and Mapping have already been distributed in the RAISON database. A map of the Kavango for tourists will be printed early next year. The Central Bureau of Statistics (CBS) has recently assembled sets of data on village locations, public services and the boundaries of enumeration areas to which data from the 2001 Population & Housing Census can be linked. These 2001 census data are perhaps the most important new set of data to have become available. The CBS will update their dataset for Kavango during 2006. Four conservancies have recently been registered in Kavango, while a fifth is being planned. The Namibia Nature Foundation has mapped the boundaries of these conservancies, but no other new mapped information has been collected on the conservancies.

The Department of Agriculture have a large set of data relating to soils, agro-ecological zones, climate, and agricultural services. Our enquiries suggested that all these data have been incorporated into the RAISON data set. However, efforts should be made in the

future to check on the availability of any new sets of data that might be available. The responsible unit is amongst the most dynamic of mapping units in Namibia.

The Department of Water Affairs has not done any recent mapping work in the Kavango. Of ancillary interest is their HYCOS recording station at Rundu which automatically collects data on rainfall, water levels, conductivity, turbidity, temperature, wind speed, wind direction and solar radiation. This station has been operational since November 1999, although it has not delivered a continuous set of data as a result of various technical problems. The Department continues to monitor river levels and flow at Rundu and Mukwe.

Although not part of the mapping community for Namibia, Joe Dooley is based in Windhoek and is working on a project for the FAO to compile the African Water Resource Database. This will be distributed on DVD as a massive compilation of about 75 data layers on river basins, water bodies, fish resources, topography, climate and demographics. It would be useful to check for any new data sets in this compilation once it has been released.

Recommendations

Before proceeding to specific suggestions on the establishment of a GIS service for purposes of the GEF EPSMO project, it is useful to reflect on several general principles of importance to GIS in particular, and information systems in general. First, there is a need for prudence and caution. There has been a flurry of interest in data for the Okavango River Basin over the past year. Much of the attention was bred by assumptions that little data exist, that data will yield answers and incentives to improve management of the river system, that people who play a role in the management of the Basin *need* data to improve their management practices, and that managers will *use* data to make better management decisions. Most of these assumptions are tenuous, however, and efforts to assemble and analyze data in pursuit of these assumptions are unlikely to bear fruit. A database is not an end in itself, but a means to an end, an end that first needs to be determined. Likewise, databases form part of a toolbox to be used to solve problems, but the problems need to be known before the tools are selected.

Second, is the need to recognize that databases do not yield information automatically, and they are also only as useful as the information that they can yield. Thus, in deciding where to place emphasis and resources, it is important to ensure that data can be analyzed and interpreted usefully by people who can ask the right questions, produce results and disseminate the answers intelligibly. People yield information, not data. Sadly, this aspect is largely ignored in most discussions about information systems. Having the right people to analyze and broker data is much more critical than the technical aspects of databases, and of hardware and software.

Third, much more data is already available than is generally assumed. With the exception of data on certain features of the Angolan catchment and land use impacts in Kavango, we would argue that an increase in overall data availability is unlikely to influence management perceptions or practices in the Basin.

Fourth is the idea that it would be useful to have **one** information **service** for the Okavango Basin, and that this service would serve the immediate needs of the GEF

EPSMO project and the Integrated River Basin Management (IRBM) project's need to establish an information system for OKACOM. Such a service should run as simply as possible, and be designed such that data can be used for a variety of purposes by a variety of people. While the focus in this consultancy is on GIS, we would strongly argue that GIS data should form one component of an information service that would additionally include statistical databases and literature resources. And following from what was said earlier, a body of interested and competent people would be needed to assemble, maintain, update, document, query and analyze these resources to then disseminate information usefully, frequently and sensibly. Self-evidently, the information service and its resources should be managed as sustainably as possible.

Fifth, there is a need to work hard against bureaucratic controls which limit the sharing, flow and utility of data. Interesting dichotomies arises in almost any discussion about data access in any field of endeavour. All professional and technical people who *actually use* data strongly agree that it should be shared openly and freely, whereas almost all managers and administrators that *seldom use* data argue that access to data needs to be tightly controlled. The more data people have, the more they are happy to share it. Similarly, the less people use information, the less they want other people to have access to information. Unfortunately, calls for controls are even more vehement when it comes to thoughts of sharing data between countries. To repeat the frequent hope: all efforts should be made to reduce the effects of nationalism and promote the concept of "basinism" when it comes to managing the Okavango Basin. Open, free access to all data for the Basin would contribute in at least a small way to that goal.[1]

Finally, the great majority of vector data sets for the Basin are in ArcView shape file formats. It should be easy to convert those that are not. Likewise, it should be simple to convert all data to a single geodetic coordinate system using a standard datum.

Bearing in mind that EPSMO's requirement to know what data and information already exists and its wish to see the development of a GIS database and system, we recommend the following:

1. That a separate GIS facility **not** be developed by the GEF EPSMO project in Luanda and Menongue.
2. That HOORC (Harry Oppenheimer Okavango Research Centre) in Maun be requested to expand their Okavango Delta Information System (ODIS) to cover data resources for the whole Basin. Such an expansion should be relatively simple and cheap to do. The expansion could be renamed as OIS (OIS – Okavango Information **Service**).
3. That this expanded set of data serves the needs of the GEF EPSMO project in Luanda and Menongue where copies of the databases could be used.

[1] In commenting on a draft of this report, Hartmut Krugmann reminds us that certain data may, or should not be in the public domain. Examples are data on commercially exploitable mineral resources or commercially exploitable plant genetic resources, the fear being that the rights of local residents may be jeopardized if resources are unfairly exploited. The protection of these rights is important, but it is equally important to guard against protectionism which will constrain the free flow of data that should legitimately be available to all *bona fide* users.

4. That consideration is given to extending coverage of the ODIS data compilation to include statistical data and literature.
5. That a Portuguese version of the viewing system be compiled. Again, this should be quite simple and cheap to achieve.
6. That updated sets of data be shared across the Basin using Internet access or CDs for sets of data that are too large to share by Internet.
7. That consideration is given to creating a network of **active** Okavango data users. Such a network should function rather informally and promote collegial cooperation and support.
8. That all parties interested in the Okavango and information on the Basin should jointly support HOORC as the one organization that is professionally and technically competent to assemble and share data.
9. That the GEF EPSMO and IRBM consider providing financial support to HOORC for the development of OIS, but
10. That the overall, long-term operations of OIS be run as independently of donor funding as possible.
11. That a formal decision of principle be made that access to OIS be as open as possible, and that it be based on the paradigm that all appropriate information is freely available to all *bona fide* users.
12. That these recommendations be conveyed to the IRBM project with the suggestion that OIS then serves the needs of the OKACOM Secretariat in Maun.
13. If these recommendations are adopted, OKACOM will need to convey its needs for data collection, storage and analysis to the OIS.

Appendix 1: REPORT ON WORK IN ANGOLA

I travelled to Luanda on the 20th of September 2005, and departed from Luanda on the 30th of September 2005 and arrived home in Windhoek on the same day. A total of nine working week days was spent in Luanda plus two weekend days. The first three days of the trip were largely spent planning what was to be done and making appointments.

Notes on meetings and interviews

ENDIAMA, Friday 23 September 16h00 and Wednesday 28 September 09h00

This is the parastatal responsible for the diamond industry in Angola. Their main interest is in the north-eastern provinces of Lunda Norte and Lunda Sul where most diamonds are now found. The only data they claimed to have for the Okavango Basin were scanned maps, which they agreed to copy for us. In response to questions concerning data on possible kimberlites and deposits of alluvial diamonds in the Okavango Basin, they responded by saying that ENDIAMA had no information since this area was being explored by De Beers. We were promised that they would provide copies of their scanned maps and that Artur de Oliveira could fetch them at a later date.

Eli Porat, Saturday, 24 September, 19h00

Mr Porat is a local businessman working in conjunction with various interests based in Israel. Much of his work focuses on the production of aerial photographs for urban areas and for purposes of cadastral delimitation. He considers himself well versed in all aspects of GIS data and organizations in Angola, and thought that it very unlikely that we would find much, if any, useful GIS data for the Okavango catchment.

Development Workshop (DW), Monday 26 September, 09h15 and Tuesday 27 September 14h00

This organization concentrates on socio-economic research, and has accumulated considerable experience in the north-western parts of the Okavango Basin in the province of Huambo. At the moment much of their work is focused on areas around Luanda and in selected neighbourhoods of the city of Huambo and the nearby town of Caala. They do not have any specific GIS data for the Okavango Basin, but they do have black and white scans of the 1:100,000 maps. They also do not have any recent aerial photography of the Basin area, and neither do they know of anyone who has produced recent aerial photography. Mrs Katu Paulina is the person in charge of the GIS section of DW. Mr Beat Webber is her supervisor and responsible for Research and Evaluation.

Some useful secondary pieces of information were gathered. First, was the fact that Angola uses the Camacupa spheroid for its maps. Second, the DW recently completed a study of land use in areas around Huambo town, the results of which should be published and available in about two weeks.

The DW (and ADRA, another research NGO that concentrates on rural development and has an office in Huambo) have much to offer in terms of helping to understand patterns, processes, opportunities and constraints concerning land uses and socio-economic conditions in the Angolan part of the Okavango Basin.

Instituto Geodesia e Cartografia de Angola (IGCA), Monday, 26 September, 11h00

IGCA is part of the Ministry of Environment & Tourism. The meeting was with the Director of the IGCA, Eng. Benjamin. The focus of the IGCA is on cadastral limits, and

their GIS work is now confined to areas around Luanda. They have no GIS data for the Okavango Basin other than scans the 1:100,000 maps. We were told that it would be possible to obtain copies of these and that we should contact the Technical Director of the relevant section. In response to queries about aerial photography, we were informed that IGCA does not have any recent aerial photographs of the Basin, but that we should contact ABSAT. This is a Brazilian company with offices here in Luanda. The IGCA promised to provide copies of their scanned maps, which could be collected at a later stage.

Subsequently, Edlira Kollozaj at FAO in Luanda informed us that IGCA have aerial photographs of the Basin. These might have been taken in 1980, but it is also possible that they were taken in 1953 – 1957. She further informs us that she should a copy of all the 1953-1957 aerial photographs at the agriculture university in Tchianga, Huambo.

Faculty of Science, Universidade Angostinho Neto Monday 26 September 15h00
Meeting with Dr Joaquim Sucure who reported that his Department of Geography had no GIS information, and remarked that GIS is a very new enterprise in Angola as a whole. He provided the names and telephone numbers of several other people we could consult.

Artur de Oliveira later met with Prof. Igor Gramiz of the Geography Department who informed him that they have scanned maps of geology, demography, and some natural resources information, but that these maps have yet to be geo-referenced.

Ministerio da Geologia e Minas (Ministry of Geology and Mines), Tuesday 27 September 09h00
Meeting with Luzia Alexandre who explained that the most important sets of data they have are scanned maps at a variety of scales and information on mineral deposits and exploration and mining concessions. Their whole computer system is now out of commission and will only function again once they get a new server. She promised to provide copies of the scanned maps and would ask her supervisor for permission to supply copies of the data on mineral deposits and concessions. Subsequent discussions between Luzia Alexandre and Artur de Oliveira indicated that it will take some time for the sever to be fixed and for the data to become available.

CNIDAH, Tuesday 27 September 11h00
This is a parastatal organization responsible for planning and monitoring the clearing of landmines in Angola. Our meeting was with Mohamed Qasim who is responsible for maintaining the database. This is an impressive operation involving the systematic mapping and assessment of landmine threats throughout the country. The assessments are currently limited to areas of immediate impact to people, namely areas around villages and along roads. A database of some 19,000 villages has been compiled, and this includes the name and co-ordinates of each village and an assessment of whether landmines are a problem in surrounding areas. In addition, a wide variety of socio-economic data has been collected for about 1,400 of these villages where landmines are a threat. These data include information on numbers of people, the availability of social services, and farming and other economic activities.

Roads have been digitzed off old 1:100,000 maps, and then checked for their current status and classified for risk associated with landmines. The mapping and assessments of

all roads in the Okavango Basin provinces of Kuando Kubango, Bié and Huambo should be complete by the end of this year. Likewise, village mapping and assessments for Kuando Kubango will be complete at the end of 2005.

CNIDAH's policy is that all data should be freely accessible. This policy and the rich set of new data being compiled means that CNIDAH will be an important source of new GIS data for the Okavango Basin in Angola.

Biodiversity Programme, National Directorate of Environment, Wednesday 28 September, 11h00
Meeting with the coordinator of the biodiversity programme (Vladimir Russo), who reported two new programmes that may provide useful information in the future. The first is that the IGCA intends to establish a remote sensing centre, while the second is the establishment of a "State of Environment" programme by the Ministry of Environment. His biodiversity programme had commissioned several thematic studies, the results of which would soon be published. He suggested several other organizations and people who might have or know of GIS data.

ABSAT, Wednesday 28 September, 12h00
Meeting with João Ferreira who is the local representative of this Brazilian company which is mainly a provider of satellite imagery. Their prices for QuickBird images, which have a high pixel resolution of about 0.7 metres seemed very reasonable.

SINFIC, Wednesday 28 September 15h00 and Thursday 29 September, 17h00
Met João Canaria who explained that SINFIC is a private company that concentrates on urban planning in southern Angola, mainly in the provinces of Namibe, Huila and Huambo. Most of their staff are based in southern Angola. They do not have any GIS data of direct relevance to the Okavango Basin.

Angola Alliance, Thursday, 29 September, 11h00
Meeting with Nelus de Waal and Japie Krynauw who described the services that this grouping of private South African-based companies offers. Of particular interest were their projects to do land cover, land use, farming and conservation potential mapping in Namibe, Cunene, Huila, Huambo and Cuanza Sul provinces. Parts of Huambo and Huila fall within the Okavango Basin.

In essence they have used LandSat imagery, detailed elevation data and ground surveys to assemble sets of data on land cover, land uses, climatic factors, soil types, and vegetation types, and then used these to model potentials for different kinds of farming and for conservation. It might be useful to commission this organization to extend their approach and methodology to produce similar land cover and land use maps for the remaining parts of the Okavango Basin.

Direcção Nacional de Aguas (National Water Directorate), Thursday, 29 September, 14h00
Meeting with Francisco Quipuco who has a small GIS setup with a few layers of data (topography, river basin limits, some towns and villages, and major river lines). He claims that he can do no more to use or expand the work in the absence of an Internet

connection. This assumption is incorrect because his GIS software runs independently of any Internet services and he should be able to add and manipulate any sets of data.

World Food Programme (PAM)
Ms Filomena Andrade emailed to us various GIS files that she had. These covered provincial, municipal and communa borders, some river lines, and towns. She also provided the following web-sites as sources of data:

http://data.geocomm.com/catalog/AO/datalist.html
http://www.fao.org/geonetwork/srv/en/main.search
http://ortelius.maproom.psu.edu/dcw/
http://igskmncnwb015.cr.usgs.gov/adds/

Subsequent information obtained
After the September visit to Luanda, several other pieces of relevant information became available. The National Institute of Statistics (INE) will be conducting a household income and expenditure survey in January 2006. The survey will cover the whole of Angola. A demographic survey for each province was done by INE in 2000. The INE further have sets of GIS data for the provinces of Bie, Huila, Benguela, Luanda, Cabinda and Cuanza Sul on roads and tracks, communa boundaries, rivers, and the limits of urban areas (bairro). Finally, the INE have data for each municipality on the number of men, women and children, and levels of education from a survey done three years ago in Kuando Kubango, Lunda Sul, Cabinda and Zaire provinces.

Artur de Oliveira also met Dr Maria Luiza who works in the Geology Department and has knowledge about the Engineering Laboratory. This Engineering Laboratory, however, has no GIS data and concentrates its activities on civil engineering projects.

Artur de Oliveira later met with Prof. Igor Grimize of the Geography Department who informed him that they have scanned maps of geology, demography, and some natural resources information, but these maps have yet to be geo-referenced.

Subsequent discussions between Luzia Alexandre and Artur de Oliveira indicated that it will take some time for their sever to be fixed and for the data to become available. Artur de Oliveira also met Eng. Gigi of the Ministerio das Obras Publicas. He stated that they have no data for the catchment provinces, but have some data for the cities of Luanda and Benguela, and scanned 1:100,000 maps. This Ministry concentrates its activities on urban areas.

The following sets of digital data were collected by Artur de Oliveira:

- Base of data of the main rivers of the Okavango Basin.
- Base of data on the population in the Angolan area of the Basin namely, communes of the province of Huambo, Bié and Kuando Kubango.
  Base data on infrastructure for the Angolan area of the Basin.
- ArcView shapefiles on administrative limits (provinces, municípios and comunas), highways, nature reserves and airports.
- Soil, geological, lithological and vegetation maps of agriculture areas for the Basin in Angola.

Names and telephone numbers of organizations and people who have an interest in GIS data in Luanda, Angola (names in **bold** are those of people personally consulted in September 2005)

GOVERNMENT AND PARASTATALS

Ministerio da Geologia e Minas
- **Sra Luzia Alexandre – 915-11580 or 324864**

CNIDAH (NGO for landmine clearing)
- **Mohamed Qasim** – 923 526054 or 372 218
- Pedro Ribero

Development Workshop (NGO) - 448 366 or 448 371
- **Allan Cain** – 912 807 253 allan.dwang@angonet.org
- **Beat Webber 923 710 150 beat.dwang@angonet.org**
- **Katu Paulina** 912 519 534 gis.dwang@angonet.org

ENDIAMA (parastatal for diamond exploration)
- Eng. Tamos – 923 729 300 or 912 200 149 –
- Eng. Adriano
- **Domingos Miguel Cristoves – 923 496705**

Universidade Angostinho Neto
- **Dr Joaquim Sucure, Associate Professor of Geography – 923-610 201 sucure@engineer.com**
- Prof. João Silva in the Faculty of Sciences (tel. 923 400 575)
- Prof. Igor Grimize in the Faculty of Sciences (tel. 390 397 (h)) – known as the father of GIS in Angola
- Prof. Emilio Silva in the Faculty of Engineering (tel. 912 505 560) – has an interest in remote sensing
- Decano e Mata 372 850
- Dr Maria Luiza (tel. 350 526) and Dr Morais (912 502 443 or 350 551), Department of Geology and Engineering Laboratory of Angola

World Food Programme (PAM)
- **Filomena Andrade – 923 606381** filomena.andrade@wfp.org

Instituto Geodesia e Cartografia de Angola (IGCA)
- **Eng. Benjamin** – 923 610 847

Ministry of Environment and Urbanisation (National Directorate of Environment)
- **Vladimir Russo** – 912 321 918
- Eng. Soki – 923 319 465
- Nascimento Antonio – 912 527 053

National Water Directorate (*Direcção Nacional de Aguas*)
- **Francisco Quipuco 923 600150**

PRIVATE COMPANIES

ABSAT
- **João Ferreira tel: 370276 or 370303**

SINFIC
- **João Canaria – 923 526 720**

Eli Porat

ANGOLA ALLIANCE
- **Nelus de Waal and Japie Krynauw (320 969)**

Hennie van der Berg (+27182976287 or +27828781760, hennievdb@softhome.net

OTHERS TO BE FOLLOWED UP AT SOME FUTURE STAGE

1. Edlira Kollozaj – she is a FAO consultant and advisor in Luanda who concentrates on the evaluation of natural resources in Angola, ekollozaj@yahoo.com
2. UNHCR – Mr Mulegeta 923 367 980/1
3. ADRA – this is a large NGO with offices in Huambo and some other provinces. The organization concentrates on research concerned with rural development.
4. SONANGOL – the state-owned parastatal concerned with oil exploration and production, Carlos Andrade – 912 509881 and Hamilton Cicero

PEOPLE/ORGANIZATIONS WHICH HAD NO GIS DATA

1. Domingos de Souze (tel: 912 242245), private enterprise but does not do GIS.
2. Policia Civil - Eng. Nelson Coluna – Police do not have a GIS.
3. Ministerio das Obras Publicas - Eng. Gigi

Appendix 2: REPORT ON WORK IN BOTSWANA AND NAMIBIA

Artur de Oliveira arrived at 17h30 on Sunday the 23rd of October. After fetching him from the airport and leaving him at his hotel, John Mendelsohn was involved in a slight car accident which damaged the car in which we were to travel to Botswana. As a result, we used John Mendelsohn's private Toyota Hilux double-cab vehicle for the trip.

Our departure on Monday the 24th was delayed by the need to first apply for a Botswana visa for Mr de Oliveira. We eventually left Windhoek at about 11h30 and reached Maun at about 21h00 on Monday evening. The total distance of our journey from Windhoek to Botswana and back to Windhoek covered 1,934 kilometres. We drove back to Windhoek on Thursday the 27th of October.

Most of our time was spent at the Harry Oppenheimer Okavango Research Centre in Maun, where we discussed data issues with Sue Ringrose, Connie Masalila, Tebogo Namushi, Cornelis vander Post, Hannelore Bendsen, Kita Mosepole, Thoralf Meyer and Monica Morrison (Librarian). In addition, we met with Pete Hancock (Birdlife Botswana and an independent environmental consultant), Lovemore Sola (in charge of operations of Conservation International in Botswana), and Portia Segomelo (Project Co-ordinator for the Okavango Delta Management Plan).

In Windhoek, we consulted the following people and organizations in Windhoek at various stages to assess the availability of any new GIS data: Simon Mayes (Namibia Nature Foundation) and responsible for mapping of conservancies in Kavango; Uzo Okafor (Directorate of Surveys and Mapping), Marina Coetzee (Department of Agriculture) and responsible for mapping of soils, agro-ecological zones and agricultural services; Antje Eggers (Department of Water Affairs) and responsible for hydrological monitoring of the rivers; Pius Manetti (Central Bureau of Statistics) where he is a team member of the unit responsible for mapping of population survey and census data; and Jo Dooley (freelance consultant trading as Spatial Data Services and Mapping) and a team member responsible for building of the African Water Resource Database for FAO.

Appendix 3: LIST OF AERIAL PHOTOGRAPHS AND SATELLITE IMAGES

1. Aerial photographs documented or available at HOORC

YEAR	AREA	Scale	At HOORC
1949	Savuti Channel		Yes
1951	Panhandle/Northern Delta		Yes
1961	Western Ngamiland		Yes
1969	Northern Delta		Yes
1971	Maun	1:15,000	No
1973	Delta		Yes
1974	Delta		Yes
1974	Okavango Block	1:70,000	Yes
1975	Lake Ngami area (contract 151)		No
1977	Northern Rivers	1:50,000	No
1977	Savuti to Okavango (contract 165)		No
1977	Maun	1:15,000	No
1977	Linyanti		Yes
1978	Lake Ngami	1:50,000	No
1978	Maun	1:15,000	No
1978	North-east ofMaun (contract 171)	1:70,000	Yes
1978	Lake Ngami		Yes
1980	Ngamiland-west	1:40,000 and 1:70,000	Yes
1980	Ngamiland-west	1:50,000	No
1983	Okavango Delta	1:50,000	Yes
1983	Maun	1:15,000	Yes
1983	Roadstrip	1:10,000	No
1983	Ngamiland	1:50,000	Yes
1983	Naoga		Yes
1983	DeltaBlock Lake Ngami (Digital)	1:50,000	Yes
1985	Molapo Dev area	1:7500	Yes
1986	Etsha	1:15,000	Yes
1986	Gumare	1:50,000	Yes
1986	Nhabe river	1:10,000	Yes
1986	Nokaneng	1:15,000	Yes
1986	Maun	1:15,000	Yes
1987	Botswana Northern Rivers	1:50,000	Yes
1987	Thamalakane river	1:7500	Yes
1987	Botletle river	1:7500	Yes
1989	Nokaneng Flats	1:10,000/42,000,15,000	Yes
2000	Panhandle Digital		Yes
2002	Digital Orthophotos		Yes

2. Satellite images available at HOORC

IMAGE ID: LANDSAT	SCENE_NUMBER	IMAGE TYPE	DATE	DESCRIPTION
170-0-075Q3	170-0-075Q3	Landsat5Rangedeg	?	
171-0-074Q3	171-0-074Q3	Landsat5Rangedeg	?	
171-0-75	171-0-075	Landsat5Rangedeg	13/9/1994	Selebi-Phikwe
171-0-76	171-0-076	Landsat5Rangedeg	13/9/1994	
171-0-77	171-0-077	Landsat5Rangedeg	12/02/1994	
172-0-74	172-0-074	Landsat5Rangedeg	26/1/1995	Nata
172-0-75	172-0-075	Landsat5Rangedeg	26/1/1995	Serowe
172-0-76	172-0-076	Landsat5Rangedeg	26/1/1995	
172-0-77	172-0-077	Landsat5Rangedeg	26/1/1995	
172-0-77	172-0-077	Landsat5 TM	25/10/1995	
172-0-78	172-0-078q1	Landsat5Rangedeg	26/1/1995	
173-0-72	173-0-072	Landsat5 TM	06/12/1996	Sedudu
173-0-73	173-0-073	Landsat7 ETM	12/04/2000	Mpandamatenga
L71173074_07420000412	173-0-074	Landsat7 ETM	04/12/2000	Makgadikgadi
L71173074_07420001005	173-0-074	Landsat7 ETM	10/05/2000	Makgadikgadi
173-0-75	173-0-075	Landsat5Rangedeg	17/1/1995	Orapa
L71173075_07520000327	173-0-075	Landsat7 ETM	27/3/2000	Orapa
L71173075_07520001005	173-0-075	Landsat7 ETM	10/05/2000	Orapa
173-0-76	173-0-076	Landsat5Rangedeg	01/01/1995	
173-0-77	173-0-077	Landsat5Rangedeg	01/01/1995	Jwaneng
173-0-78Q1Q2Q4	173-0-78Q1Q2Q4	Landsat5Rangedeg	01/01/1995	
174-0-073	174-0-073	Landsat5 TM b	09/04/1989	Savuti
174-0-073	174-0-073	Landsat5 TM b	08/01/1994	Savuti
L71174073_07320010828	174-0-073	Landsat7 ETM b	28/08/2001	Savuti
174-0-73	174-0-073	?	31/08/1999	Savuti
174-0-73	174-0-073	Landsat7 ETM	04/03/2000	Savuti
174-0-73	174-0-073	Landsat7 ETM	3/4//2000	Savuti
174-0-73	174-0-073	Landsat5Rangedeg	24/1/1995	Savuti
174-0-074	174-0-074	Landsat5 TM b	09/04/1989	Maun
174-0-074	174-0-074	Landsat5 TM b	08/01/1994	Maun
174-0-74	174-0-074	Landsat5Rangedeg	24/01/95	Maun
174-0-74Q?	174-0-074Q?	Landsat5 TM	24/7/1997	
174-0-74Q?	174-0-074Q?	Landsat5 TM	08/09/1997	
174-0-74Q?	174-0-074Q?	Landsat5 TM	26/9/1997	
174-0-74	174-0-074	Landsat	?/1/1998	Maun
174-0-74[Georectification]	174-0-074	Landsat7 ETM	04/03/2000	Maun
174-074	174-0-074	Landsat7 ETM	04/03/2000	Maun
174-0-74	174-0-074	Landsat7 ETM	04/03/2000	Maun
174-0-74	174-0-074 (ENVI)	Landsat7 ETM	04/03/2000	Maun
174-0-74[Georectification]	174-0-074	Landsat7 ETM	08/09/2000	Maun
174-0-74	174-0-074	Landsat7 ETM	09/10/2000	Maun

174-0-74	174-0-074	Landsat7 ETM	09/10/2000	Maun
174-0-74?	174-0-074 (ENVI)	Landsat7 ETM	9/10/2000?	Maun
174-0-74?	174-0-074 (ENVI)	Landsat7 ETM	17/2/2001	Maun
174-0-74?	174-0-074 (ENVI)	Landsat7 ETM	08/12/2001	Maun
L71174074_07420010913	174-0-074	Landsat7 ETM b	13/09/2001	Maun
174-0-74	174-0-074 (ENVI)	Landsat7 ETM	13/09/2001	Maun
174-0-74	174-0-074	?	31/08/1999	Maun
174-0-74	174-0-074	Landsat7 ETM	04/09/2002	Maun
174-0-74	174-0-074	Landsat7 ETM	31/08/2002	Maun
174-0-74	174-0-074	Landsat7 ETM	10/02/2002	Maun
174-0-75	174-0-075	Landsat5Rangedeg	24/01/95	Deception Pan
174-0-76	174-0-076	Landsat5Rangedeg	09/02/1994	
174-0-77	174-0-077	Landsat5Rangedeg	2/9//1994	
174-0-78	174-0-078	Landsat5Rangedeg	02/09/1995	Tsabong
175-0-72	175-0-072Q4	Landsat5Rangedeg	1994?	
175-0-073	175-0-073	Landsat5 TM b	08/10/1989	Okavango
175-0-073	175-0-073	Landsat5 TM b	24/08/94	Okavango
175-0-73	175-0-073	Landsat5Rangedeg	14/12/1994	Okavango
175-0-73	175-0-073	Landsat	?/1/1998	Okavango
175-0-73	175-0-073	Landsat7 ETM	04/10/2000	Okavango
175-0-73	175-0-073 (ENVI)	Landsat7 ETM	04/10/2000	Okavango
175-073	175-0-073	Landsat7 ETM	20/11/2000	Okavango
L71175073_07320010328	175-0-073	Landsat7 ETM b	28/03/2001	Okavango
L71175073_07320011006	175-0-073	Landsat7 ETM	10/06/2001	Okavango
175-0-73	175-0-073	Landsat7 ETM	08/06/2002	Okavango
175-073	175-0-073	Landsat7 ETM	22/8/2002	Okavango
175-073	175-0-073	Landsat7 ETM	23/9/2002	Okavango
175-0-074	175-0-074	Landsat5 TM b	08/10/1989	Tsao
175-0-074	175-0-074	Landsat5 TM b	24/08/1994	Tsao
175-0-74	175-0-074	Landsat5Rangedeg	14/12/1994	Tsao
175-074	175-0-074	Landsat7 ETM	04/10/2000	Tsao
175-0-74	175-0-074 (ENVI)	Landsat7 ETM	04/10/2000	Tsao
L71175074-07420010328	175-0-074	Landsat7 ETM	28/03/2001	Tsao
L71175074_07420011006	175-0-074	Landsat7 ETM b	10/06/2001	Tsao
175-0-75	175-0-075	Landsat5Rangedeg	10/11/1994	Gantsi
175-0-76	175-0-076	Landsat5Rangedeg	15/01/1995	
175-0-76	175-0-076	Landsat7 ETM	02/06/2000	
175-0-77	175-0-77/0	Landsat5Rangedeg	15/01/1995	
175-0-77	175-0-077	Landsat7 ETM	04/10/2000	
175-0-78	175-0-078	Landsat5Rangedeg	15/01/1995	
176-0-072	176-0-072	Landsat5 TM b	09/02/1989	
176-0-072	176-0-072	Landsat5 TM b	18/10/1994	
L71176072_17220011013	176-0-072	Landsat7 ETM b	13/10/2001	

LE7176072000308450	176-0-072	Landsat7 ETM b	25/03/2003	
176-0-073	176-0-073	Landsat5 TM b	09/02/1989	Nxaunxau
176-0-073	176-0-073	Landsat5 TM b	18/10/1994	Nxaunxau
176-0-73	176-0-073Q2&Q4	Landsat5Rangedeg	6/1//1995	Nxaunxau
L71176073_07320011013	176-0-073	Landsat7 ETM b	13/10/2001	Nxaunxau
LE7176073000308450	176-0-073	Landsat7 ETM b	25/03/2003	Nxaunxau
176-0-74	176-0-074Q2&Q4	Landsat5Rangedeg	01/06/1995	Aha hills
176-0-75	176-0-075Q4	Landsat5Rangedeg	01/06/1995	Xanagas
176-0-76	176-0-076Q2&Q4	Landsat5Rangedeg	01/06/1995	
176-0-77	176-0-077Q2&Q4	Landsat5Rangedeg	01/06/1995	
177-0-072	177-0-072	Landsat5 TM b	25/09/1989	Okav Basin
177-0-072	177-0-072	Landsat5 TM b	10/09/1994	Okav Basin
L71177072_07220011004	177-0-072	Landsat7 ETM b	10/04/2001	Okav Basin
178-0-071	178-0-071	Landsat5 TM b	19/11/1989	Okav Basin
178-0-071	178-0-071	Landsat5 TM b	30/09/1994	Okav Basin
LE7178071000125250	178-0-071	Landsat7 ETM b	09/09/2001	Okav Basin
178-0-072	178-0-072	Landsat5 TM b	19/11/1989	Okav Basin
178-0-072	178-0-072	Landsat5 TM b	30/09/1994	Okav Basin
LE7178072000122050	178-0-072	Landsat7 ETM b	08/08/2001	Okav Basin
179-0-070	179-0-070	Landsat5 TM b	09/07/1989	Okav Basin
179-0-070	179-0-070	Landsat5 TM b	21/09/1994	Okav Basin
L71179070_07020011002	179-0-070	Landsat7 ETM b	10/02/2001	Okav Basin
179-0-071	179-0-071	Landsat5 TM b	09/07/1989	Okav Basin
179-0-071	179-0-071	Landsat5 TM b	21/09/1994	Okav Basin
L71179071_07120011002	179-0-071	Landsat7 ETM b	10/02/2001	Okav Basin
LE 7179069000312150	179-0-069	Landsat7 ETM	01/05/2003	Okav Basin
LE7179070000312150	179-0-070	Landsat7 ETM	01/05/2003	Okav Basin
LE7179071000312150	179-0-071	Landsat7 ETM	01/05/2003	Okav Basin
LE7178071000311450	178-0-071	Landsat7 ETM	24/04/2003	Okav Basin
LE7178072000311450	178-0-072	Landsat7 ETM	24/04/2003	Okav Basin
LE7177072000313950	177-0-072	Landsat7 ETM	19/05/2003	Okav Basin
175-0-073	175-0-073	Landsat7 ETM	02/05/2002	
074-0-073	074-0-073Q4	Landsat7 ETM	11/05/2002	
074-0-074	074-0-074	Landsat7 ETM	11/05/2002	
176-0-074	176-0-074Q2	Landsat7 ETM	02/05/2002	
177-0-072	177-0-072	Landsat S.E	25/02/2002	Angola
178-0-069	178-0-069	Landsat S.E	07/05/2002	Angola
178-0-070	178-0-070	Landsat S.E	20/07/2000	Angola
178-0-071	178-0-071	Landsat S.E	04/07/2000	Angola
178-0-072	178-0-072	Landsat S.E	08/08/2001	Angola
179-0-069	179-0-069	Landsat S.E	11/05/2001	Angola
177-0-070	177-0-070	Landsat S.E	30/04/2002	Angola
177-0-071	177-0-071	Landsat S.E	30/04/2002	Angola

179-0-070	179-0-070	Landsat S.E	12/06/2000	Angola
179-0-071	179-0-071	Landsat S.E	11/05/2001	Angola
180-0-069	180-0-069	Landsat S.E	31/05/2000	Angola
180-0-070	180-0-070	Landsat S.E	28/12/2001	Angola
175-0-075	175-0-075	Landsat	16/08/2000	Angola
175-0-074	175-0-074	Landsat	30/08/1999	Angola
175-0-073	175-0-073	Landsat	30/08/1999	Angola
175-0-074	175-0-074	Landsat	01/09/2000	Angola
174-0-074	175-0-074	Landsat	25/08/2000	Angola
174-0-074	174-0-074Q1	Landsat7 ETM	16/04/1996	
174-0-074	174-0-074Q1	Landsat7 ETM	26/12/1995	
174-0-074	174-0-074Q1	Landsat7 ETM	08/11/1995	
174-0-074	174-0-074Q1	Landsat7 ETM	21/09/1995	
174-0-074	174-0-074Q1	Landsat7 ETM	20/08/1995	
174-0-074	174-0-074Q1	Landsat7 ETM	19/07/1995	
174-0-074	174-0-074Q1	Landsat7 ETM	01/06/1995	
174-0-074	174-0-074Q1	Landsat7 ETM	14/04/1995	
174-0-074	174-0-074Q1	Landsat7 ETM	13/03/1995	
174-0-074	174-0-074Q1	Landsat7 ETM	07/12/1994	
174-0-074	174-0-074Q1	Landsat7 ETM	27/003/2003	
174-0-074	174-0-074Q1	Landsat5 TM	04/10/1994	
174-0-074	174-0-074Q1	Landsat5 TM	16/06/1989	
174-0-074	174-0-074Q1	Landsat5 TM	29/04/1989	
174-0-074	174-0-074Q1	Landsat5 TM	18/07/1989	
174-0-074	174-0-074Q1	Landsat5 TM	27/02/1990	
174-0-074	174-0-074Q1	Landsat5 TM	16/04/1990	
174-0-074	174-0-074Q1	Landsat5 TM	03/06/1990	
174-0-073/074	174-0-074Q1	Landsat5 TM	21/07/1990	
174-0-074	174-0-074Q1	Landsat5 TM	22/08/1990	
174-0-074	174-0-074Q1	Landsat5 TM	23/09/1990	
174-0-074	174-0-074Q1	Landsat5 TM	30/08/1995	
174-0-074	174-0-074Q1	Landsat7 ETM	05/03/1998	
174-0-074	174-0-074Q1	Landsat7 ETM	15/12/1997	
174-0-074	174-0-074Q1	Landsat7 ETM	12/10/1997	
174-0-074	174-0-074Q1	Landsat7 ETM	06/06/1997	
174-0-074	174-0-074Q1	Landsat7 ETM	21/05/1997	
174-0-074	174-0-074Q1	Landsat7 ETM	12/12/1996	
174-0-074	174-0-074Q1	Landsat7 ETM	23/09/1996	
174-0-074	174-0-074Q1	Landsat7 ETM	22/08/1996	
174-0-074	174-0-074Q1	Landsat7 ETM	05/07/1996	
174-0-074	174-0-074Q1	Landsat7 ETM	19/06/1996	
174-0-074	174-0-074Q1	Landsat7 ETM	05/11/2000	
174-0-074	174-0-074Q1	Landsat7 ETM	14/06/2000	

174-0-074	174-0-074Q1	Landsat7 ETM	29/05/2000
174-0-074	174-0-074Q1	Landsat7 ETM	11/05/1999
174-0-074	174-0-074Q1	Landsat7 ETM	09/04/1999
174-0-074	174-0-074Q1	Landsat7 ETM	19/01/1999
174-0-074	174-0-074Q1	Landsat7 ETM	13/09/1998
174-0-074	174-0-074Q1	Landsat7 ETM	27/07/1998
174-0-074	174-0-074Q1	Landsat7 ETM	12/06/1999
174-0-074	174-0-074Q1	Landsat7 ETM	25/06/1998
174-0-074	174-0-074Q1	Landsat5 TM	13/05/1994
174-0-074	174-0-074Q1	Landsat5 TM	09/08/1997
174-0-074	174-0-074Q1	Landsat5 TM	14/10/1992
174-0-074	174-0-074Q1	Landsat5 TM	24/01/1995
174-0-074	174-0-074Q1	Landsat5 TM	24/07/1997
174-0-074	174-0-074Q1	Landsat5 TM	20/12/1993
174-0-074	174-0-074Q1	Landsat5 TM	26/03/1994
174-0-074	174-0-074Q1	Landsat5 TM	02/09/1994
174-0-074	174-0-074Q1	Landsat5 TM	20/10/1994
174-0-074	174-0-074Q1	Landsat5 TM	09/08/1991
174-0-074	174-0-074	Landsat7 ETM	10/10/1999
174-0-074	174-0-074	Landsat7 ETM	30/01/2000
174-0-074	174-0-074Q1	Landsat7 ETM	03/01/2002
174-0-074	174-0-074Q1	Landsat7 ETM	24/03/2002
174-0-074	174-0-074Q1	Landsat7 ETM	11/05/2002
174-0-074	174-0-074Q1	Landsat7 ETM	14/07/2002
174-0-074	174-0-074Q1	Landsat7 ETM	15/10/2001
174-0-074	174-0-074Q1	Landsat7 ETM	08/01/2001
174-0-074	174-0-074Q1	Landsat7 ETM	16/05/2001
174-0-074	174-0-074Q1	Landsat7 ETM	17/06/2001
174-0-074	174-0-074Q1	Landsat7 ETM	19/07/2001
174-0-074	174-0-074Q1	Landsat5 TM	26/09/1997
174-0-074	174-0-074Q1	Landsat5 TM	22/06/1991
174-0-074	174-0-074Q1	Landsat5 TM	05/05/1991
174-0-074	174-0-074Q1	Landsat5 TM	03/04/1991
174-0-074	174-0-074Q1	Landsat5 TM	02/03/1991
174-0-074	174-0-074Q1	Landsat5 TM	12/12/1990
174-0-074	174-0-074Q1	Landsat5 TM	05/11/1994
174-0-074	174-0-074Q1	Landsat5 TM	29/11/1991
174-0-074	174-0-074Q1	Landsat5 TM	21/11/1991
174-0-074	174-0-074Q1	Landsat5 TM	21/04/1992
174-0-074	174-0-074Q1	Landsat5 TM	08/06/1992
174-0-074	174-0-074	Landsat5 TM	23/10/1995
174-0-074	174-0-074Q1	Landsat5 TM	29/07/1993
174-0-074	174-0-074Q1	Landsat5 TM	11/06/1993

174-0-074	174-0-074Q1	Landsat5 TM	07/03/1993
174-0-074	174-0-074Q1	Landsat5 TM	18/01/1993
174-0-074	174-0-074Q1	Landsat5 TM	15/11/1992
174-0-074	174-0-074Q1	Landsat5 TM	12/09/1992
174-0-074	174-0-074Q1	Landsat5 TM	12/09/1992
174-0-074	174-0-074Q1	Landsat5 TM	11/08/1992
174-0-074	174-0-074	Landsat5 MSS	15/09/1993

Satellite imagery and aerial photography documented in the RAISON metadatabase

1. Orthophotos of the Kavango Region taken in 1996. Available from the Harry Oppenheimer Okavango Research Centre (HOORC), Private Bag 285, Maun, Botswana, tel. +267 6861833, fax. +267 6861835 or the Namibia Nature Foundation (NNF), PO Box 245, Windhoek, Namibia, tel: + 264 61 248345, fax: + 264 61 248344. Also obtainable from the Directorate of Surveys and Mapping, Windhoek. Projection parameters: Lamberts Conformal, Bessel Spheroid, Central Meridian: 17.75E, Origin parallel: 19.5S, Standard and 1st parallel: 17S, 2nd parallel: 19S
2. LandSat images in MrSid format mosaics, each image covering 5 x 5 degrees. Images taken in the early 1990s. Available from the Harry Oppenheimer Okavango Research Centre (HOORC), Private Bag 285, Maun, Botswana, tel. +267 6861833, fax. +267 6861835 or the Namibia Nature Foundation (NNF), PO Box 245, Windhoek, Namibia, tel: + 264 61 248345, fax: + 264 61 248344. Projection parameters: UTM. Select the zone according to the file or image number, e.g. S34 is Zone 34, S35 is Zone 35.
3. Georeferenced LandSat TM7 images of the Angolan and Namibian sections of the Okavango Basin, from 2000, 2001 or 2002. Projection parameters: UTM. Experiment and select Zone 33, 34 or 35.
4. Georeferenced LandSat TM7 images of the whole Okavango Basin (indeed most of Africa) can be obtained from Directorate of Environmental Affairs, Ministry of Environment and Tourism, Private Bag 13306, Windhoek, Namibia, tel + 264 61 249015, fax: + 264 61 240339, Contact Jo Tagg, e-mail: jotagg@iafrica.com.na. Projection parameters: UTM. Experiment and appropriate Zone.
5. Georeferenced colour aerial photographs of the entire river from Katwitwi to Mohembo taken in October 1999 and April 2000 by Yves Baudot of Lux Development for the Ministry of Agriculture, Water and Rural Development, Windhoek. Contact Guido van Langenhove, e-mail: LangenhoveG@mawrd.gov.na. Projection parameters not known.
6. Mosaic of whole Okavango Basin made from MrSid images for RAISON. Two images of different resolutions: 114 metres and 250 metres per pixel. Projection parameters: Albers Equal Area, Bessel Spheroid, Central Meridian: 20E, Origin parallel: 20S, Standard and 1st parallel: 20S, 2nd parallel: 14S.
7. Decadal NDVI (Normalized Differential Vegetation Index) data from NOAA images for the Okavango Basin from 1985 to 2003 obtained for RAISON. Geodetic co-ordinates. Available from the Harry Oppenheimer Okavango Research Centre (HOORC), Private Bag 285, Maun, Botswana, tel. +267 6861833, fax. +267 6861835 or the Namibia Nature Foundation (NNF), PO Box 245, Windhoek, Namibia, tel: + 264 61 248345, fax: + 264 61 248344.

Appendix 4: LIST OF KNOWN GIS DATA SETS

1. Data sets in the ODIS database at HOORC

Category name	Title	Description	Source
Boundary	agric_district_area_botswana	Agricultural district boundaries	Department of Crop Production
Boundary	agric_ext_border_botswana	Agricultural extension areas	Department of Crop Production
Boundary	contr_hunting_area_2004_ngamiland	Controlled Hunting areas boundary map produced in 2004	Department of Wildlife and National Parks
Boundary	contr_hunting_area_botswana	Controlled Hunting areas (CHAs) boundaries for the whole country (Botswana)	Department of Wildlife and National Parks
Boundary	contr_hunting_area_ngamiland	Controlled Hunting Areas (CHAs) boundaries in Ngamiland District	Department of Wildlife and National Parks
Boundary	contr_hunting_point_2004_ngamiland	Controlled Hunting areas point map produced in 2004	Department of Wildlife and National Parks
Boundary	country_area_botswana	Botswana's international boundary	Department of Surveys and Mapping
Boundary	country_border_botswana	Botswana international boundary	Department of Surveys and Mapping
Boundary	country_border_ngamiland	International boundary	Department of Surveys and Mapping
Boundary	district_area_botswana	District administration boundaries for the whole country (Botswana)	Department of Surveys and Mapping
Boundary	district_area_ngamiland	Ngamiland Admin district	Department of Surveys and Mapping
Boundary	district_border_ngamiland	Ngamiland Admin district	Department of Surveys and Mapping
Boundary	orthophoto_index	Digital Orthophoto Index	Harry Oppenheimer Okavango Research Center
Boundary	parks_reserves_botswana	Wildlife National Parks and Game Reserves in Botswana	Department of Wildlife and National Parks
Boundary	plan_zone_area_ngamiland	Planning zones in Ngamiland District	Department of Town and Regional Planning
Boundary	ramsar_site_area	Proposed ODMP site covering Ramsar Site and Tsodilo Hills. Different from the original boundary	Okavango Delta Management Plan
Boundary	ramsar_site_area_orig	Original boundary defining ODMP area, this covers Ramsar site and Tsodilo Hills area	Okavango Delta Management Plan
Boundary	sub_district_area_ngamiland	Ngamiland Sub-District boundaries	Department of Town and Regional Planning
Boundary	sub_landboard_area_ngamiland	Tawana Sub-Land Board boundaries	Tawana Land Board
Boundary	tsodilowhs_buffer_area	Tsodilo Hills World Heritage site buffer zone	National Museum and Art Gallery
Boundary	tsodilowhs_buffer_point	Tsodilo Hills World Heritage site buffer zone	National Museum and Art Gallery
Boundary	tsodilowhs_core_area	Tsodilo Hills World Heritage site buffer zone	National Museum and Art Gallery

Boundary	tsodilowhs_core_point	Tsodilo Hills World Heritage site buffer zone	National Museum and Art Gallery
Boundary	vet_disease_control_zone_botswana	Veterinary disease control zones boundaries in Botswana	Department of Animal Health and Production
Boundary	vet_disease_control_zone_ngamiland	Veterinary disease control zones boundaries in Ngamiland	Department of Animal Health and Production
Boundary	vet_district_area_botswana	Veterinary district boundaries in Botswana	Department of Animal Health and Production
Boundary	vet_district_area_ngamiland	Veterinary district boundaries in Ngamiland	Department of Animal Health and Production
Boundary	vet_ext_area_botswana	Veterinary extension area boundaries in Botswana	Department of Animal Health and Production
Boundary	vet_ext_area_ngamiland	Ngamiland Veterinary extension area boundaries	Department of Animal Health and Production
Climate	climate_station_delta	Location of Department of Metereological gauging stations in the Okavango Delta	Department of Metereological Services
Climate	climate_station_ngamiland	Location of rainfall stations (rain gauges) used for rainfall data collection	Department of Metereological Services
Climate	climate_station_proposed	Proposed site for additional gauging stations in the Okavango Delta	Department of Water Affairs
Climate	raingauge_delta	Location of rain gauges in the Okavango Delta used by DWA in the development of the Hydrologic Model	Department of Metereological Services
Climate	wind_station_botswana	Location of wind stations in Botswana	Department of Metereological Services
Cultural	archaeological_site_ngamiland	Some of archaeological sites in Ngamiland	Harry Oppenheimer Okavango Research Center
Demographics	camps_lodges_ngamiland	Hotels, Camps and Lodges in Ngamiland	Harry Oppenheimer Okavango Research Center
Demographics	census_area_botswana_1991	1991 Population census enumeration areas	Central Statistics Office
Demographics	census_area_ngamiland_2001	2001 Population census enumeration areas	Central Statistics Office
Demographics	construction_material_village_2001	Number of households by material of wall construction - 2001 Population Census	Central Statistics Office
Demographics	crops_by_household_2001	Number of Households that Planted One or More Type of Crop(Agricultural Season Before the Census) 2001 Population Census	Central Statistics Office
Demographics	durables_by_household_2001	Number of Households by Ownership of Durables - 2001 Population Census	Central Statistics Office
Demographics	hotspots_issues	Hotspots issues raised during the 2003/04 kgotla meetings	Okavango Delta Management Plan
Demographics	languages	Languages spoken in and around the Okavango Basin	RAISON
Demographics	livestock_by_household_2001	Number of Households Owning One or More Type of Livestock	Central Statistics Office

		2001 Population Census	
Demographics	major_village_ngamiland_point	Main villages and settlements in Ngamiland	Harry Oppenheimer Okavango Research Center
Demographics	pop_by_settlement_ngamiland	1981, 1991 and 2001 population census data for Ngamiland	Central Statistics Office
Demographics	population_density_botswana_1991	Density of people in the country based on 1991 population figures	Department of Town and Regional Planning
Demographics	settlements_ngamiland_point	Villages, settlements and localities in Ngamiland	Harry Oppenheimer Okavango Research Center
Demographics	type_house_household_2001	Number of Households by Type of Housing Unit They Occupy 2001 Population Census	Central Statistics Office
Demographics	village_energy_ngamiland_2001	Number of househols by type of cooking energy used - 2001 Population Census	Central Statistics Office
Demographics	water_supply_household_2001	Number of Households by Source of water 2001 Population Census	Central Statistics Office
Ecology	aquarap_sampling_sites	Georeference points sampled during the AquaRAP expedition to the Okavango Delta, Botswana, June 5-20, 2000	RAP Bulletin of Biological Assessment - AquaRAP
Ecology	carrying_capacity_area_ngamiland	Carrying capacity map of Ngamiland	Department of Crop Production
Ecology	Ecological_Zoning_Map	Ecological_Zoning_Map of the Okavango Delta, 1989. Produced by SMEC for the Ministry of Local Government	Ministry of Local Government
Environmental_hazards	fire_occurence_ngamiland_2004	2004 bush fire occurrence in Ngamiland	Web Fire Mapper
Environmental_hazards	fire_occurence_regional_2004	2004 bush fire occurrence in Ngamiland and surrrounding areas	Web Fire Mapper
Environmental_hazards	refuse_disposal_village_2001	Number of households by method of refuse disposal - 2001 Population Census	Central Statistics Office
Environmental_hazards	waste_management_inventory	Inventoy of North West District Council Environmenta Health in Ngamiland	Department of Sanitation and Waste Management
Fauna	2001_buffalo	Buffalo distribution in 2001	Department of Wildlife and National Parks
Fauna	2001_cattle	Cattle distribution in 2001	Department of Wildlife and National Parks
Fauna	2001_elephant	Elephant distribution in 2001	Department of Wildlife and National Parks
Fauna	2001_hippo	Hippo distribution in 2001	Department of Wildlife and National Parks
Fauna	2002_buffalo	Buffalo distribution in 2002	Department of Wildlife and National Parks
Fauna	2002_cattle	Cattle distribution in 2002	Department of Wildlife and National Parks

Fauna	2002_crocodile	Crocodile distribution in 2002	Department of Wildlife and National Parks
Fauna	2002_elephant	Elephant distribution in 2002	Department of Wildlife and National Parks
Fauna	2002_hippo	Hippo distribution in 2002	Department of Wildlife and National Parks
Fauna	2002_lion	Lion distribution in 2002	Department of Wildlife and National Parks
Fauna	aquarap_fish_sampling_sites	Description of the 2000 aquaRAP fish sampling sites	RAP Bulletin of Biological Assessment - AquaRAP
Fauna	bird_roost_okav_delta	Bird roosting sites in the Okavango Delta	Bird Life Botswana
Fauna	bird_survey_2001	2001 Bird survey in the Okavango Delta by BirdLife Botswana	Bird Life Botswana
Fauna	bird_survey_2002	2002 Bird survey in the Okavango Delta by BirdLife Botswana	Bird Life Botswana
Fauna	bird_survey_2003	2003 Bird survey in the Okavango Delta by BirdLife Botswana	Bird Life Botswana
Fauna	buffalo	Buffalo distribution mapped within the Okavango river basin	RAISON
Fauna	cattle_density	Cattle density in and around the Okavango Basin	RAISON
Fauna	crocodile	Distribution of crocodile within the Okavango Delta	RAISON
Fauna	crocodile_data_point	Sites where crocodile we located in 2001, 2002 and 2003 along the Okavango delta panhandle	Harry Oppenheimer Okavango Research Center
Fauna	elephant	Species distribution mapped within the Okavango river basin	RAISON
Fauna	elephant_1990_dry	Elephant distribution during dry season of 1990	Department of Wildlife and National Parks
Fauna	elephant_1990_wet	Elephant distribution during wet season of 1990	Department of Wildlife and National Parks
Fauna	fish_sampling_sites	Fish data from Aquarap report	RAP Bulletin of Biological Assessment - AquaRAP
Fauna	fish_species_aquarap_2000	Fish species list from Aquarap 2000 survey	RAP Bulletin of Biological Assessment - AquaRAP
Fauna	fishing_grids_proposed	Proposed fishing grids to be used by fishermen to shwo where they catch their fish	Okavango Delta Management Plan
Fauna	fishing_stations_okav_delta	Villages where fishermen recording catch data forms for Fisheries Division are located	Okavango Delta Management Plan
Fauna	giraffe	Species distribution mapped within the Okavango river basin	RAISON
Fauna	hippo	Species distribution mapped within the Okavango river basin	RAISON
Fauna	impala	Species distribution mapped within the Okavango river basin	RAISON

Fauna	lechwe	Species distribution mapped within the Okavango river basin	RAISON
Fauna	reedbuck	Species distribution mapped within the Okavango river basin	RAISON
Fauna	tsessebe	Species distribution mapped within the Okavango river basin	RAISON
Fauna	waterbuck	Species distribution mapped within the Okavango river basin	RAISON
Fauna	wattled_crane_1993	1993 Wattled Crane survey by Birdlife Botswana	Bird Life Botswana
Fauna	wildlife_census_botswana_1994	Department of Wildlife and National Parks 1994 wildlife census for the whole country. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_botswana_1996	Department of Wildlife and National Parks 1996 wildlife census for the whole country. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_botswana_2001_dry	Department of Wildlife and National Parks 2002 dry season wildlife census for the whole country. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_botswana_2002_dry	Department of Wildlife and National Parks 2002 dry season wildlife census for the whole country. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_1989_dry	Department of Wildlife and National Parks 1989 dry season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_1990_dry	Department of Wildlife and National Parks 1990 dry season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_1990_wet	Department of Wildlife and National Parks 1990 wet season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_1991_dry	Department of Wildlife and National Parks 1991 dry season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_1992_dry	Department of Wildlife and National Parks 1992 dry season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_1992_wet	Department of Wildlife and National Parks 1992 wet season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_1993_wet	Department of Wildlife and National Parks 1993 wet season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_1994_dry	Department of Wildlife and National Parks 1994 dry season wildlife census for Ngamiland	Department of Wildlife and National Parks

		District. Aerial census	
Fauna	wildlife_census_ngamiland_1994_wet	Department of Wildlife and National Parks 1994 wet season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_1995_dry	Department of Wildlife and National Parks 1995 dry season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_1995_wet	Department of Wildlife and National Parks 1995 wet season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_1996_dry	Department of Wildlife and National Parks 1996 dry season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_1999_dry	Department of Wildlife and National Parks 1999 dry season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_1999_wet	Department of Wildlife and National Parks 1999 wet season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_2001_dry	Department of Wildlife and National Parks 2001 dry season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Fauna	wildlife_census_ngamiland_2002_dry	Department of Wildlife and National Parks 2002 dry season wildlife census for Ngamiland District. Aerial census	Department of Wildlife and National Parks
Flora	aquarap_vegetation_sampling_sites	Locality descriptions of plots sampled for vegetation during the 2000 AquaRAP survey	RAP Bulletin of Biological Assessment - AquaRAP
Flora	okavango_vegetation_gtruth_sites	Sites with vegetation descriptions, species list used in production of vegetation map	Harry Oppenheimer Okavango Research Center
Flora	okavango_vegetation_map_45cls	45 class vegetation map of the Okavango region produced using remote sensing	Harry Oppenheimer Okavango Research Center
Flora	Okavango_vegetation_map_generalised	Vegetation map produced from classied landsat image. Map generalised to ten (10) classes	Harry Oppenheimer Okavango Research Center
Geodetic	trig_station_point_ngamiland	Trigonometric stations in Ngamiland	Department of Surveys and Mapping
Geology	dolerite_dykes	Dolerite dykes in Ngamiland	Department of Geological Services
Geology	faults	Geology faults in Ngamiland	Department of Geological Services
Geology	ngamiland_geology	Geology map of Ngamiland	Department of Geological Services
Hydrography	aquarap_water_sampling_sites	AquaRAP 2000 water quality sampling sites	RAP Bulletin of Biological Assessment -

			AquaRAP
Hydrography	borehole_point_ngamiland	Boreholes in Ngamiland	Department of Water Affairs
Hydrography	data_collection_platform_delta	Locations of Data Collection Platforms (DCP'S) in the Okavango Delta	Department of Water Affairs
Hydrography	delta_discharge_stations	Discharge stations located in the Okavango Delta	Department of Water Affairs
Hydrography	depth_max_92	Overland maximum water depth in five year period 1992 -1997. Dry years used to develop the topo model	Department of Water Affairs
Hydrography	depth_min_92	Overland minimum water depth in five year period 1992 -1997. Dry years used to develop the topo model	Department of Water Affairs
Hydrography	discharge_station_delta	Discharge stations located in the Okavango Delta	Department of Water Affairs
Hydrography	flood_max_92	Maximum flood envelop, where water occurred in the five year period, 1992-1997. Where water was more than 20cm over the five ye	Department of Water Affairs
Hydrography	flood_min_92	Minimum flood envelop, where water occurred in the five year period, 1992-1997. Where water was more than 20cm over the five ye	Department of Water Affairs
Hydrography	high_flood_delta	Extent of water in the delta in high flood years	Harry Oppenheimer Okavango Research Center
Hydrography	hydrometric_station_delta	Location of hydrometric stations in the Okavango Delta. Used by the DWA in the development of Topomodel	Department of Water Affairs
Hydrography	hydrometric_station_proposed	Proposed locations of hydrometric stations in the Okavango Delta, by DWA.	Department of Water Affairs
Hydrography	lagoon	Lagoons in the Okavango Delta and Linyanti	Harry Oppenheimer Okavango Research Center
Hydrography	lake_Ngami	Extent of Lake Ngami	Harry Oppenheimer Okavango Research Center
Hydrography	low_flood_delta	Extent of water in the delta in low flood years	Harry Oppenheimer Okavango Research Center
Hydrography	okavango_delta_outline	Outline of Okagango Delta	Harry Oppenheimer Okavango Research Center
Hydrography	pan	Pans in Ngamiland	Harry Oppenheimer Okavango Research Center
Hydrography	river_ngamiland	Rivers in Ngamiland derived from satellite imagery	Harry Oppenheimer Okavango Research Center

Hydrography	river_ngamiland_2005_inprogress	Ngamiland rivers digitised from 2002 digital orthophotos	Department of Water Affairs
Hydrography	surface_water_abstraction_point	Surface water abstraction points	Department of Water Affairs
Hydrography	szl_min_92	Saturated zone level, groundwater elevation over the five year period, 1992-97. Dry years used to develop the topo model	Department of Water Affairs
Hydrography	uzdef_max_92	Unsaturated zone, moisture deficit in the root zone over the five year period 1992-97. Dry years used to develop the topo model	Department of Water Affairs
Hydrography	water_quality_2000	Water quality data collected in 2000 by DWA and Aquarap	RAP Bulletin of Biological Assessment - AquaRAP
Hydrography	water_quality_aquarap_2000	Water quality data collected in 2000 by Aquarap	RAP Bulletin of Biological Assessment - AquaRAP
Improvements	cutline_line_ngamiland	Debushed area used either for exploration purposes, for demarcating landuse area, as fire breakx	Harry Oppenheimer Okavango Research Center
Improvements	drift_fence_ngamiland	Agricultural fences used to fence off arable fields from grazing areas	Department of Crop Production
Improvements	firebreak_line_ngamiland	Fire breaks in Ngamiland District	Agricultural Resources Board
Improvements	gates	Gates along fences in Ngamiland	Harry Oppenheimer Okavango Research Center
Improvements	vet_cattlecrush_ngamiland	Cattle crush locations	Department of Animal Health and Production
Improvements	vet_fence_ngamiland	Veterinary fences in Ngamiland District	Department of Animal Health and Production
Land_status	animal_graveyard_site	Sites where cattle were buried during eradication of cattle lung disease outbreak	National Conservation Strategy Agency
Land_status	arable_fields_ngamiland	Extent of arable fields around the delta	Harry Oppenheimer Okavango Research Center
Land_status	cbnrm_ngamiland	CBNRM in Ngamiland District	Harry Oppenheimer Okavango Research Center
Land_status	cbnrm_ngamiland_point	CBNRM in Ngamiland District	Harry Oppenheimer Okavango Research Center
Land_status	chiefs_island_landmarks	Facilities at Chief's Island in the Okavango delta	Harry Oppenheimer Okavango Research Center
Land_status	Chobe_national_park	Chobe National Park boundary	Department of Wildlife and National Parks
Land_status	landuse_area_botswana	Land use map of Botswana based on Controlled Hunting Area boundaries	Lands Department

Land_status	landuse_area_ngamiland	Land use map of Ngamiland District based on Controlled Hunting Area boundaries	Lands Department
Land_status	makgadikgadi_national_park	Makgadikgadi Natiaonal Park boundary	Department of Wildlife and National Parks
Land_status	maun_game_sanctuary	Maun game sanctuary boundary	Harry Oppenheimer Okavango Research Center
Land_status	moremi_game_reserve	Moremi game reserve boundary	Department of Wildlife and National Parks
Land_status	moremi_infrastructure	Facilities in Moremi Game Reserve	Department of Wildlife and National Parks
Land_status	nxai_pan_national_park	Nxai Pan National Park boundary	Department of Wildlife and National Parks
Land_status	ranch_area_ngamiland	farms derived from 2002 othorphotos	Harry Oppenheimer Okavango Research Center
Land_status	wildlife_management_area	Wildlife management areas in Ngamiland District	Department of Wildlife and National Parks
Landform	contours	Contours in Ngamiland District (meters above sea level, m.a.s.l) used in the development of the Okavango Delta topographic mode	Department of Water Affairs
Landform	hill_area_ngamiland	Hills in Ngamiland District	Harry Oppenheimer Okavango Research Center
Landform	hill_point_ngamiland	Hills in Ngamiland District	Harry Oppenheimer Okavango Research Center
Landform	landmarks	Land marks in Ngamiland District	RAISON
Landform	spot_elevation_point	Trigonometric stations/beacons in Ngamiland	Department of Surveys and Mapping
Landform	topomodel	Topographic model developed for the Okavango Delta Management Plan in 2004	Department of Water Affairs
Satellite Image	deltageowgs84	Landsat TM image of the Okavango Delta	Harry Oppenheimer Okavango Research Center
Soil	soil_fertility	Soil fertility in the Ramsar Site area	Department of Crop Production
Soil	soil_map_unit_gumare	Coded soil units of the area.1:250000 Gumare soil map sheet	Department of Crop Production
Soil	soil_map_unit_linyanti	Coded soil units of the area.1:250000 Linyanti soil map sheet	Department of Crop Production
Soil	soil_map_unit_maun	Coded soil units of the area.1:250000 Maun soil map sheet	Department of Crop Production
Soil	soil_map_unit_shakawe	Coded soil units of the area.1:250000 Shakawe soil map sheet	Department of Crop Production
Soil	soil_map_unit_toteng	Coded soil units of the area.1:250000 Toteng soil map sheet	Department of Crop Production

Soil	soil_map_unit_tsau	Coded soil units of the area.1:250 000 Tsau soil map sheet	Department of Crop Production
Soil	soil_physical_data	Soil physical properties	Department of Crop Production
Soil	soil_sampling_pits	Soil pits sampled for soil classsification	Department of Crop Production
Transportation	airfield_area_ngamiland	Airstrips in the delta as polygons	Harry Oppenheimer Okavango Research Center
Transportation	airfield_area_ngamiland	Airstrips in the delta as polygons	Harry Oppenheimer Okavango Research Center
Transportation	airfield_point_ngamiland	Airstrips in the delta as points	Harry Oppenheimer Okavango Research Center
Transportation	boat_station_point	Boat stations in Ngamiland	Harry Oppenheimer Okavango Research Center
Transportation	ferry_jetty_ngamiland	Ferry jetty in Ngamiland	Harry Oppenheimer Okavango Research Center
Transportation	ferry_stop_point	Ferry stop	Harry Oppenheimer Okavango Research Center
Transportation	linethemes	Debushed area used either for exploration purposes, for demarcating landuse area, as fire breakx	Harry Oppenheimer Okavango Research Center
Transportation	river_crossing_point	River crossing without a bridge	Harry Oppenheimer Okavango Research Center
Transportation	road_bridge_point	River crossing with a bridge	Harry Oppenheimer Okavango Research Center
Transportation	roads_line_ngamiland_update	Roads in Ngamiland	Harry Oppenheimer Okavango Research Center

2. Data sets in the RAISON database

Theme	File name	File type	Region	Data source
Vegetation	Vegetation types, delta	ArcView grid	Botswana	HOORC
Boundaries	Kavango constituencies	ArcView shape	Namibia	Delimitation Commissions
Boundaries	Angolan districts	ArcView shape	Angola	Digital Atlas of Africa produced by United States Geological Survey.
Boundaries	Botswana districts	ArcView shape	Botswana	HOORC
Boundaries	Ngamiland District	ArcView shape	Botswana	HOORC
Boundaries	Okavango Basin focal area	ArcView shape	Okavango Basin	RAISON
Boundaries	Okavango Basin grid	ArcView shape	Okavango Basin	RAISON
Boundaries	Africa & southern africa	ArcView shape	Africa	Digital Chart of the World (DCW)
Boundaries	Angola provinces	ArcView shape	Angola	Digital Atlas of Africa produced by United States Geological Survey.
Boundaries	Kavango Region	ArcView shape	Namibia	Atlas of Namibia
Boundaries	Namibian Regions	ArcView shape	Namibia	Atlas of Namibia
Climate	Rainfall variance	ArcView shape	Okavango Basin	RAISON
Climate	Average rainfall zones	ArcView shape	Okavango Basin	RAISON
Climate	Rainfall histograms	ArcView shape	Okavango Basin	Various
Climate	Rainfall southern africa	ArcView shape	Southern africa	RAISON
Climate	Average rainfall per station	ArcView shape	Southern africa	Various
Demography	languages	ArcView shape	Okavango Basin	RAISON
Demography	people density-angola	ArcView shape	Angola	UNEP/GRID-Sioux falls
Demography	people density-botswana	ArcView shape	Botswana	Atlas of Botswana
Demography	people density-focal area	ArcView shape	Okavango Basin	RAISON
Demography	people density-kavango	ArcView shape	Namibia	RAISON and various
Farming	cleared land in 1943-kavango	ArcView shape	Namibia	RAISON
Farming	cleared land in 1972-kavango	ArcView shape	Namibia	DSM
Farming	cleared land in 1996-kavango	ArcView shape	Namibia	DSM

Farming	cleared land-angola	ArcView shape	Angola	RAISON
Farming	cleared land-ngamiland	ArcView shape	Botswana	HOORC
Farming	crop zones	ArcView shape	Okavango Basin	RAISON
Farming	all fences	ArcView shape	Okavango Basin	RAISON, various
Farming	cattle crushpens-ngamiland	ArcView shape	Botswana	HOORC
Farming	cattle density	ArcView shape	Okavango Basin	RAISON, and various
Farming	kavango cattle density	ArcView shape	Namibia	RAISON & Veterinary Services, MAWRD
Farming	kavango goat density	ArcView shape	Namibia	RAISON
Farming	tsetse fly range	ArcView shape	Africa	Atlas of Botswana
Farming	commercial ranch-ngamiland	ArcView shape	Botswana	HOORC
Geology	old fluvial sediments	ArcView shape	Botswana	RAISON
Geology	dunes	ArcView shape	Okavango Basin	RAISON
Geology	geological faults	ArcView shape	Botswana	RAISON
Geology	basin geology-new	ArcView shape	Okavango Basin	
Geology	kalahari basin deposits	ArcView shape	Southern africa	
Geology	african elevations	ArcView shape	Southern africa	RAISON
Geology	basin elevation	ArcView shape	Okavango Basin	RAISON
Geology	kavango relief	ArcView shape	Namibia	
Hydrology	delta rivers	ArcView shape	Botswana	HOORC
Hydrology	delta wetlands	ArcView shape	Botswana	HOORC
Hydrology	Delta monthly flood1999	ArcView shape	Botswana	RAISON
Hydrology	Delta average monthly floods	ArcView shape	Botswana	RAISON, and various
Hydrology	Delta Annual floods1995&2001	ArcView shape	Botswana	
Hydrology	Boreholes from luxdev-kavango	ArcView shape	Namibia	Lux Development
Hydrology	Borehole chemistry-kavango	ArcView shape	Namibia	MAWRD, Namibia

Hydrology	Borehole no3-kavango	ArcView shape	Namibia	BIWAC
Hydrology	Borehole pl-kavango	ArcView shape	Namibia	BIWAC
Hydrology	Borehole so4-kavango	ArcView shape	Namibia	BIWAC
Hydrology	Flow system-kavango	ArcView shape	Namibia	BIWAC
Hydrology	Groundwater tds-kavango	ArcView shape	Namibia	BIWAC
Hydrology	Groundwater yield-kavango	ArcView shape	Namibia	BIWAC
Hydrology	groundwater level-kavango	ArcView shape	Namibia	BIWAC
Hydrology	makgadikgadi	ArcView shape	Botswana	RAISON, HOORC
Hydrology	exs+prop water extraction	ArcView shape	Okavango Basin	RAISON
Hydrology	okavango catchments	ArcView shape	Okavango Basin	RAISON
Hydrology	okavango drainage	ArcView shape	Okavango Basin	RAISON
Hydrology	okavango habitats-namibia	ArcView shape	Namibia	DSM, Lux Development
Hydrology	okavango perennial rivers	ArcView shape	Okavango Basin	RAISON
Hydrology	southern african lakes and dams	ArcView shape	Southern Africa	Digital Atlas of Africa produced by United States Geological Survey.
Hydrology	southern african rivers	ArcView shape	Southern Africa	Digital Atlas of Africa produced by United States Geological Survey.
Landuse and history	historical sites	ArcView shape	Okavango Basin	Various
Landuse and history	kavango boundaries 1937-68	ArcView shape	Namibia	Atlas of Namibia
Landuse and history	kavango boundaries 1968-92	ArcView shape	Namibia	Atlas of Namibia
Landuse and history	kavango boundaries 1992-98	ArcView shape	Namibia	Atlas of Namibia
Landuse and history	landmarks	ArcView shape	Okavango Basin	RAISON
Landuse and history	kavango landuse	ArcView shape	Namibia	RAISON & various
Landuse and history	kavango pressure on resources	ArcView shape	Namibia	Various
Landuse and history	kavango tribal admin offices	ArcView shape	Namibia	CSO
Landuse and history	kavango tribal areas	ArcView shape	Namibia	RAISON
Landuse and history	ngamiland landuse-detailed	ArcView shape	Botswana	HOORC

Social services	ngamiland airstrip	ArcView shape	Botswana	HOORC
Social services	buffer of 5km from schools	ArcView shape	Namibia	RAISON & MBESC
Social services	schools in 2002	ArcView shape	Namibia	RAISON & MBESC
Social services	buffer of 10km from health facilities	ArcView shape	Namibia	RAISON & MOHSS
Social services	finalariper1000	ArcView shape	Namibia	RAISON & MOHSS
Social services	final-bldiarrper1000	ArcView shape	Namibia	RAISON & MOHSS
Social services	health facilities in Kavango	ArcView shape	Namibia	RAISON & MOHSS
Social services	teenage pregnancy	ArcView shape	Namibia	RAISON & MOHSS
Social services	bilharzia-sites	ArcView shape	Namibia	RAISON & MOHSS
Social services	malaria-namibia	ArcView shape	Namibia	RAISON & MOHSS
Social services	kavango police stations	ArcView shape	Namibia	Atlas of Namibia
Social services	kavango post offices	ArcView shape	Namibia	Atlas of Namibia
Social services	kavango powerline	ArcView shape	Namibia	DSM
Social services	ngamiland roads	ArcView shape	Botswana	HOORC
Social services	orientation roads	ArcView shape	Okavango Basin	RAISON and various
Soils	botswana soils	ArcView shape	Botswana	HOORC
Soils	kavango soils	ArcView shape	Namibia	RAISON & Interconsult
Soils	ngamiland soils	ArcView shape	Botswana	HOORC
Soils	okavango basin soils	ArcView shape	Okavango Basin	RAISON and various
Soils	south-east angola soils	ArcView shape	Angola	RAISON
Tourism	hotel, lodges, safari camps	ArcView shape	Okavango Basin	RAISON and various
Tourism	hunting concessions	ArcView shape	Namibia	RAISON & MET
Tourism	game park and reserve	ArcView shape	Okavango Basin	RAISON & various
Towns	basin main places	ArcView shape	Okavango Basin	RAISON
Towns	basin placenames	ArcView shape	Okavango Basin	RAISON

Towns	kavango placenames	ArcView shape	Namibia	RAISON & Lux-development
Vegetation	fires 1997, 2000, 2001, kavango	ArcView shape	Namibia	Simon Trigg and Johan le Roux
Vegetation	fire-years burnt, kavango	ArcView shape	Namibia	NRSC and Alex Verlinden
Vegetation	average vegbiomass, okavango basin	ArcView shape	Okavango Basin	RAISON
Vegetation	Vegbiomass 1985-2003, okavango basin	ArcView shape	Okavango Basin	RAISON
Vegetation	Vegbiomass 1985-2002, kavango	ArcView shape	Namibia	MAWRD, Namibia
Vegetation	vegetation types, kuando kubango	ArcView shape	Angola	Dos Santos, R. M
Vegetation	vegetation types, okavango basin	ArcView shape	Okavango Basin	RAISON
Vegetation	vegetation types, kavango	ArcView shape	Namibia	MET
Vegetation	vegetation types, caprivi	ArcView shape	Namibia	MET
Wildlife	game biomass	ArcView shape	Botswana & Namibia	Various
Wildlife	buffalo	ArcView shape	Botswana & Namibia	Various
Wildlife	crocodile	ArcView shape	Botswana & Namibia	Various
Wildlife	elephant	ArcView shape	Botswana & Namibia	Various
Wildlife	giraffe	ArcView shape	Botswana & Namibia	Various
Wildlife	hippo	ArcView shape	Botswana & Namibia	Various
Wildlife	impala	ArcView shape	Botswana & Namibia	Various
Wildlife	lechwe	ArcView shape	Botswana & Namibia	Various
Wildlife	reedbuck	ArcView shape	Botswana & Namibia	Various
Wildlife	sitatunga	ArcView shape	Botswana & Namibia	Various
Wildlife	tsessebe	ArcView shape	Botswana & Namibia	Various
Wildlife	waterbuck	ArcView shape	Botswana & Namibia	Various
Wildlife	wattled crane	ArcView shape	Botswana & Namibia	Peter Hancock, Maun
Boundaries	Ramsar	ArcView shape	Botswana	HOORC
Climate	Rainfall stations-Botswana	ArcView shape	Botswana	HOORC

Geology	Contours-Delta	ArcView shape	Botswana	HOORC
Geology	Geology map-Delta	ArcView shape	Botswana	HOORC
Hydrology	Boreholes Ngamiland	ArcView shape	Botswana	HOORC
Livelihood	Ngamiland fishing stations	ArcView shape	Botswana	HOORC
Social services	Schools in Ngamiland	ArcView shape	Botswana	HOORC
Social services	Ngamiland villages	ArcView shape	Botswana	HOORC
Social services	Ngamiland settlement	ArcView shape	Botswana	HOORC
Social services	Ngamiland settlement over500	ArcView shape	Botswana	HOORC
Vegetation	Vegetation types, Botswana	ArcView shape	Botswana	HOORC
Climate	Rainfall and discharge per catchment	Excel	Okavango Basin	RAISON
Climate	Evaporation per month	Excel	Okavango Basin	Various
Climate	Rainfall daily data	Excel	Namibia	Namibia Meteorological Services
Climate	Rainfall monthly totals	Excel	Okavango Basin	Various
Climate	Rainfall seasonal totals	Excel	Botswana & Namibia	Various
Climate	Temperatures	Excel	Botswana & Namibia	Namibia and Botswana Meteorological Services
Climate	Windspeed,Rundu	Excel	Namibia	Namibia Meteorological Services
Demography	Age pyramids 1960-1999,Kavango	Excel	Namibia	CSO
Demography	Age pyramids 1991,Ngamiland	Excel	Botswana	HOORC
Demography	Population census 2001,Kavango	Excel	Namibia	CSO
Demography	Demography from SIAPAC,Ngamiland	Excel	Botswana	SIAPAC
Demography	Household sizes,3countries	Excel	Okavango Basin	Various
Demography	Demographic indicators, kavango	Excel	Namibia	CSO, Namibia
Demography	Demographic rates, kavango	Excel	Namibia	CSO, MOHSS
Demography	Populatioin census 1981,1991,2001-Ngamiland	Excel	Botswana	CSO, Botswana
Demography	Population data from IUCN,Angola	Excel	Angola	IUCN
Demography	Population data,Kavango & Ngamiland	Excel	Okavango Basin	Various

Demography	Population estimates,Angola part of Okavango basin	Excel	Okavango Basin	RAISON
Demography	Population per locality,Ngamiland	Excel	Botswana	CSO, Botswana
Demography	People per constituency2001, kavango	Excel	Namibia	CSO, Namibia
Farming	Agricultural Statistics 1968-98,Ngamiland	Excel	Botswana	Ministry of Agriculture
Farming	Food consumption,Kavango	Excel	Namibia	CSO, Namibia
Farming	HH planting different crops per zone,Kavango	Excel	Namibia	Lux Development
Farming	Mahangu seed types,Kavango	Excel	Namibia	CSO, Namibia
Farming	Note on cattle density in Basin area	Excel	Okavango Basin	RAISON
Farming	Cattle and field sizes,Ngamiland	Excel	Botswana	Ministry of Agriculture
Farming	Cattle bought by Meatco92-02,Kavango	Excel	Namibia	MEATCO
Farming	Cattle-people ratio,Kavango	Excel	Namibia	Various
Farming	HH having different no of cattle+goats	Excel	Okavango Basin	Various
Farming	Livestock diseases from Schneider	Excel	Namibia	H. Schneider
Farming	Livestock numbers1955-2002, Ngamiland	Excel	Botswana	Ministry of Agriculture, Botswana
Farming	Livestock numbers1980-2001, Kavango	Excel	Namibia	MAWRD, Namibia
Farming	Livestock ownership,Kavango	Excel	Namibia	Lux Development
Hydrology	Water annual volume for all stations	Excel	Okavango Basin	Namibia, MAWRD. Angola, OKAKOM. Botswana, HOORC
Hydrology	Water discharge at Maun1968-2001	Excel	Botswana	HOORC
Hydrology	Water monthly flow at Mohembo1933-2002	Excel	Botswana	HOORC
Hydrology	monthly river volumes for all stations	Excel	Okavango Basin	Namibia, MAWRD. Angola, OKAKOM. Botswana, HOORC
Hydrology	Okavango water consumption	Excel	Namibia	MAWRD, Namibia
Hydrology	River profiles	Excel	Okavango Basin	RAISON
Hydrology	water volume at mukwe	Excel	Namibia	MAWRD, Namibia
Hydrology	Water volume at rundu	Excel	Namibia	MAWRD, Namibia
Hydrology	Water volume-Angola	Excel	Angola	OKAKOM

Landuse and history	Kavango landuse areas	Excel	Namibia	RAISON
Livelihood	Craft survey,kavango	Excel	Namibia	RAISON
Livelihood	Employment data from LuxDev surveys,kavango	Excel	Namibia	Lux Development
Livelihood	Income sources from CBPP survey,Ngamiland	Excel	Botswana	Ministry of Agriculture, Botswana
Social services	Enrolments per year and grade, kavango	Excel	Namibia	RAISON & MBESC
Social services	Kids per zone and grade, kavango	Excel	Namibia	RAISON & MBESC
Social services	Adult levels of education in Kavango	Excel	Namibia	CSO
Demography	HIV infection rates,Kavango & Ngamiland	Excel	Botswana & Namibia	Ministry of Health in Namibia & Botswana
Social services	Rainfal and malaria, Kavango	Excel	Namibia	RAISON & MOHSS
Tourism	Accomodation facilities, Kavango	Excel	Namibia	RAISON
Tourism	Accomodation facilities, Ngamiland	Excel	Botswana	HOORC
Tourism	Visitors to Mahango+khaudum	Excel	Namibia	MET
Tourism	Visitors to Moremi	Excel	Botswana	HOORC
Tourism	Visitors to Popa falls	Excel	Namibia	MET
Vegetation	kav-areas burnt each year and plant production	Excel	Namibia	NRSC and Alex Verlinden
Wildlife	Delta wildlife populations	Excel	Botswana	Botswana Department of Wildlife and National Parks
Climate	Rainfall monthly, Maun1921-95	Excel	Botswana	HOORC
Climate	Windspeed,Maun1980-90	Excel	Botswana	HOORC
Climate	Rainfall monthly, Ngamiland1900-2000	Excel	Botswana	HOORC
Climate	Evaporation monthly,Ngamiland	Excel	Botswana	SMEC
Climate	Rainfall monthly,Shakawe1932-95	Excel	Botswana	HOORC
Demography	Population by age group,Ngamiland	Excel	Botswana	HOORC
Hydrology	Biological monitoring of water quality data	Excel	Namibia	MAWRD, Namibia
Hydrology	Piezodata	Excel	Botswana	HOORC
Hydrology	waterquality	Excel	Botswana	HOORC

Appendix 5: TERMS OF REFERENCE

1. for John Mendelsohn, RAISON (Research and Information Services of Namibia), Windhoek, Namibia

General arrangements

Under the supervision of the FAO technical (AGLW) and operational units concerned, the international consultant will provide consultancy services to prepare the ground for the development of a GIS base for the GEF EPSMO Project, under the project UNTS/RAF/010/GEF, henceforth referred to as the Project.

Specific duties

As the leader of a two-person team (including Mr Artur Mugindo de Oliveira of Luanda, Angola, as the other team member – see separate contract), the international consultant is expected to:

a) Travel from his home base (Windhoek, Namibia) to Luanda, Angola for a total of 10 days, and subsequently from his home base to Gaborone, Botswana and Maun, Botswana, for a total of 5 days, to meet with a range of institutions in these two countries, together with the other consultant (Mr Artur Mugindo de Oliveira), in order to determine what relevant GIS information, relevant electronic data and institutional capacities exist within these two countries and what access the project could have to these data and capabilities;
b) During a period of 3 days, meet with a range of institutions in Namibia, together with the other consultant (Mr Artur Mugindo de Oliveira), in order to determine what relevant GIS information, electronic data, and institutional capacities exist within Namibia and what access the Project could have to these data and capabilities;
c) On the basis of the results of the visits and meetings under a) and b), analyze issues and aspects of consistency (contents and format) of GIS information across the three riparian countries (1 day);
d) Develop recommendations on how best to get a Project GIS base (software and hardware) up and running and set up an operating framework for the project database, building on existing GIS information, data, and capabilities in the three riparian countries (Angola, Botswana, and Namibia) (1 day).
e) Coordinate the preparation of a report presenting the results of the visits and meetings under a) and b), the analysis under c), and the recommendations under d) (5 days).

Outputs

- ✓ Compilation of relevant GIS information, hardcopy and electronic data (as available and accessible) in CD ROM or DVD format for presentation to the project
- ✓ A detailed report including relevant annexes and graphical material presenting results, analysis, findings and recommendations for the specification of a GIS system for the project.

Duration

Total of 25 days within the period of 18 September – 31 October 2005 (by agreement, the final date was later extended to 20 November 2005).

Duty stations (chronologically)

Luanda, Angola	10 days
Gaborone and Maun, Botswana	5 days
Windhoek, Namibia (home/ regular work base)	10 days
Total	25 days

Supervision and reporting
Overall Supervision from Chief AGLW and technical supervision from Project Manager and Senior Water Policy Officer, AGLW.

---

2. for Artur Mugindo de Oliveira, National Institute of Statistics (INE), Luanda, Angola

General arrangements
Under the supervision of the FAO technical (AGLW) and operational units concerned, the international consultant will provide consultancy services to prepare the ground for the development of a GIS base for the GEF EPSMO Project, under the project UNTS/RAF/010/GEF, henceforth referred to as the Project.

Specific duties
As a member of a two-person team (including Dr John Mendelsohn of Namibia as the team leader -- see separate contract), the consultant is expected to:

f) During a period a of 10 days, meet with a range of institutions in Angola, together with the other consultant (Dr John Mendelsohn), in order to determine what relevant GIS information, relevant electronic data, and institutional capacities exist within Namibia and what access the Project could have to these data and capabilities;
g) Travel from his home base (Luanda, Angola) to Gaborone, Botswana for a total of 5 days, and subsequently to Windhoek, Namibia, for a total of 3 days, to meet with a range of institutions in these two countries, together with the other consultant (Dr Mendelsohn), in order to determine what relevant GIS information, electronic data, and institutional capacities exist within these two countries and what access the project could have to these data and capabilities;
h) On the basis of the results of the visits and meetings under a) and b), contribute to the analysis of issues and aspects of consistency (contents and format) of GIS information across the three riparian countries (1 day);
i) Assist in the development of recommendations on how best to get a Project GIS base (software and hardware) up and running and set up an operating framework for the project database, building on existing GIS information, data, and capabilities in the three riparian countries (Angola, Botswana, and Namibia) (1 day).
j) Provide inputs into the preparation of a report presenting the results of the visits and meetings under a) and b), the analysis under c), and the recommendations under d) (2 days).

Outputs
- ✓ Collection of relevant GIS information and electronic data in various formats, where available and accessible.
- ✓ Report presenting results, analysis, findings and recommendations of the work.

Duration
Total of 25 days within the period of 18 September – 31 October 2005.

Duty stations (chronologically)

Luanda, Angola (home/ regular work base)		10 days
Gaborone and Maun, Botswana		5 days
Windhoek, Namibia		3 days
Windhoek, Namibia (home/ regular work base)		4 days
	Total	22 days

Supervision and reporting
Overall Supervision from Chief AGLW, and technical supervision from Project Manager and Senior Water Policy Officer, AGLW. The work is undertaken under the direction of team leader Dr John Mendelsohn.