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ENHANCING DATA MANAGEMENT FOR OKACOM

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Acronyms & Abbreviations

CTO	Cognizant Technical Officer
DNA	National Directorate of Water (Angola)
EPSMO	Environmental Protection and Sustainable Management of the Okavango River Basin Project
GABHIC	Cabinet for the Administration of the Cunene Hydrographical Basin
GEF	Global Environment Facility
GIS	geographic information system
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
HOORC	Harry Oppenheimer Okavango Research Center
HTML	Hypertext Markup Language (a Web language)
HYCOS	Hydrological Cycle Observing System
HYDATA	a database for storing hydrological data
ISO	International Standards Organization
LAN	local area network
Landsat	US Government land remote sensing system (not an acronym or abbreviation)
MARC	Machine-Readable Cataloging
NGO	non-governmental organization
NORAD	Norwegian Agency for Development Cooperation
OBSC	Okavango Basin Steering Committee
ODMP	Okavango Delta Management Plan
OKACOM	Permanent Okavango River Basin Water Commission
OKASEC	Permanent Secretariat to OKACOM
SADC	Southern African Development Community
SGML	Standard Generalized Mark-up Language (for Web-enabled storage of text and graphics files)
SOW	statement of work
USAID	United States Agency for International Development
XML	extensible Markup Language (a Web-enabled query language)

Executive Summary

As part of the USAID-funded Okavango River Basin Project, this assessment identifies data and information needs for the Permanent Okavango River Basin Water Commission (OKACOM) and other users of information on the Okavango River Basin. The primary result of this consultancy was a data and information management strategy for the proposed OKACOM Secretariat.

Methodology:

To analyze the data and information needs of the primary users, the Consultant 1) reviewed the functions of OKACOM as defined in the Agreement to Establish a Permanent Okavango River Basin Water Commission; 2) conducted informal, one-on-one interviews with OKACOM commissioners and members of the Okavango Basin Steering Committee, a technical advisory group to OKACOM; and 3) facilitated a process whereby OKACOM and Okavango Basin Steering Committee members prioritized data needs during the 16th Meeting of the Okavango Basin Steering Committee. All three activities confirmed that the most important, immediate data and information needs fall into four general categories:

- Water resources (e.g., supply, availability)
- Water demand
- Water quality
- Harmonized data collection and maintenance

The Consultant also conducted a survey of sources of data and information, focusing on these four general categories. She visited relevant government ministries and agencies, universities and research institutions, non-governmental organizations, and other donor-funded projects in each country, as well as regional ones such as the Southern African Development Community (SADC) Hydrological Cycle Observing Systems (HYCOS) at the Department of Water Affairs and Forestry in Pretoria, South Africa. The Consultant used an interview protocol to structure discussions, and ensure consistency from one interview to the next.

Key Findings:

In Angola, excellent historical data (1950s to mid-1970s) exist in the areas of hydrology, geology and hydrogeology, and soils. These data are still useful today. The hydrology data could be extrapolated to the present by correlating it to downstream and upstream data collected in neighboring countries during the intervening time. Much of these data are still paper-based, although 10 years of important surface water data have been computerized and quality-checked as part of a Norwegian-funded project. It should be noted that Angola is only a few years out of a three-decade long war, and priorities for basic infrastructure—electricity, sanitation, transportation, health care, and education—are critical for rebuilding the country. Nearly all recent data are privately held (e.g., petroleum, mineral exploration and drilling companies, and de-mining firms). The Consultant was unable to identify any water quality, groundwater or borehole data for the Okavango River Basin region in Angola. There are no plans to develop a national data sharing infrastructure. Encouragingly, with the exception of the Ministry of Petroleum, all government staff interviewed expressed willingness to share data among themselves, and with other countries in the region.

In Botswana, data are plentiful and most have been computerized; borehole data are currently being entered into a database from historical and current paper records at the Department of

Geological Survey in Lobatse. However, data are inconsistently collected in time and content. Important surface water data could be improved so as to distinguish between zero (no flow) and null (no data), and to distinguish between collected data and interpolated data. Important data compilations exist, including the Okavango Delta Information System at the Harry Oppenheimer Okavango Research Centre (HOORC) in Maun, and the National Integrated Geophysical Information System of the Ministry of Minerals, Energy and Water Affairs. There is also a fledgling National Spatial Data (sharing) Infrastructure for Botswana. Like Angola, all government staff interviewed in Botswana expressed willingness to share data among themselves, and with other countries in the region. Data users (NGOs, researchers) expressed mixed results in acquiring data in a timely fashion, but all said they eventually got what they needed.

In Namibia, data are plentiful, and of generally high quality. Quality exceptions are noted, and data are reviewed prior to finalizing their entry into databases. There is good availability of surface water data. Borehole data up to 1995 has been digitized. Atypically, data on water quality monitoring are still entirely paper-based. There is hope that the new Water Resources Management Act ("Water Law") of 2004 will renew efforts to computerize these important data. The Namibia National Spatial Data (sharing) Infrastructure has been operational for several years, and contains more than 500 records from 15 agencies—demonstrating not only a willingness to share data, but also a commitment for doing so. Data are well-used for national and regional planning. However, there are too few staff to fully analyze and utilize all of the data.

Recommendations:
The first step to implementing a data sharing mechanism for OKACOM is simply to inventory available data. The most widely accepted way for doing that is through the use of "metadata." Pending OKACOM approval, the Consultant recommends hiring a technical consultant to develop the link between the OKACOM Web site ("internet hub") being developed by the Every River Has Its People Project, and a Web-based metadata search engine ("database link") to metadata records exported from MetaLite, a free, simple, "open source" software tool. As this technical work progresses, the Interim Secretariat staff could begin filling in metadata records using the priority list of data resources (water resources, water demand, and water quality) established by OKACOM and the Okavango Basin Steering Committee. Many of these records are already available from the Botswana and Namibia National Spatial Data (sharing) Infrastructures, and can be copied. The Interim Secretariat should work with data providers to develop a plan or strategy for keeping the metadata up-to-date. Ideally, data providers should maintain their own metadata, providing updates to the Secretariat as they become available. In some cases, it may be necessary to provide training, so that data originators may develop and maintain their own metadata. (EIS-Africa provides metadata training in the SADC region.) When approved by OKACOM, this metadata strategy should be incorporated into the general OKACOM Secretariat's Information Management Strategy.

Eventually, simply knowing where data are will not be sufficient for rapid, informed decision making. In those cases where data are already available on line, a simple "hot link" can connect the users to actual data identified as being of interest from the metadata. In other cases, data that are commonly used can be housed at the Secretariat, obviating the need to acquire it time and again from its source. Collecting such data should be on a "demand driven," as needed basis—data should not be collected simply for the sake of collecting it.

Two excellent data compilations already exist. A data set for the entire basin, including the recommended meta-data system, should build upon these compilations. The first is the

Okavango Delta Information System. Less than a year into its development it has already proven to be a well-used resource by staff from 13 different government agencies who have been trained in its use. Although ODIS presently covers only the Botswana portion of the basin, it would not be technically difficult to expand it to include the entire basin. The second compilation is the Africa Water Resource Database. Four years in development, this geographic information system covers the entire continent of Africa and includes layers for water surface bodies, administrative boundaries, population densities, soils, satellite imagery, and multiple watershed models. The data layers are fully integrated and harmonized, so that polygons match at national boundaries and from one layer to the next. The Okavango River Basin portion of this database would be an excellent base in which to insert additional data, such as that from the Okavango Delta Information System, to provide detail when and where it is needed.

1. Background

This report summarizes findings and recommendations from a five-week review and assessment of data and information needs for OKACOM and other users of information on the Okavango River Basin. The study was carried out by a Senior Data Management Specialist as part of the USAID/OKACOM Okavango River Basin Project task order of the indefinite quantity contract "Integrated Water and Coastal Resources Management" (USAID Contract No. LAG-1-811-99-00018-00).

Water scarcity in Southern Africa is a growing concern. Population growth and associated demands for domestic, agricultural and industrial use are increasing stress on limited water resources. The majority of the region's watersheds are shared between two or more countries. What happens in the upper reaches of rivers and watersheds affects people, wildlife and ecosystems downstream. Regional responses and coordination are required to ensure equitable allocation and use of water resources within river basins.

Angola, Botswana, and Namibia agreed in 1994 to establish the Permanent Okavango River Basin Water Commission (OKACOM) to promote coordinated, regional water resources development objectives for the Okavango river basin, while addressing the legitimate social and economic needs of these three riparian states. A coherent approach to managing the basin's resources, based upon equitable allocation, sound environmental management, and sustainable utilization is a key objective of OKACOM's efforts.

USAID/Southern Africa, recognizing the commitment of OKACOM, has agreed to support the commission's institutional development through the Okavango River Basin Project (USAID/OKACOM Project), a four year initiative. OKACOM and its technical advisory body, the Okavango Basin Steering Committee (OBSC), guide the implementation of the USAID/OKACOM Project in collaboration with government ministries, active non-governmental organizations in the basin, communities, regional academic and research institutions, businesses and local governments that use and manage the resources in the Okavango River Basin.

The USAID/OKACOM Project combines efforts with other basin-wide initiatives, such as the Environmental Protection and Sustainable Management of the Okavango River Basin Project (EPSMO), financed by the United Nations Development Program-Global Environment Facility and the Every River Has Its People project , supported by the Swedish International Development Cooperation Agency. The USAID/OKACOM Project also liaises and coordinates with numerous national initiatives and programs.

Three components make up the USAID/OKACOM Project: organizations' ability to manage river basin resources enhanced; information systems for biodiversity and natural resource management improved, and; community management and local governance of natural resources improved. These three distinct but interrelated components combine synergistically to strengthen regional capacity for improved management of selected river basins. Incorporated with these three components are three cross-cutting themes—providing linkages to HIV/AIDS information and services, ensuring the participation of women and disadvantaged groups, and promoting the participation of the private-sector, through the development of public private partnerships.

This consultancy assignment focuses on Component 2 of the Project, which is focused on providing OKACOM with access to reliable and accurate information in order to prepare appropriate recommendations concerning the equitable allocation, conservation and sustainable utilization of water and other natural resources within the basin. (See Annex A for detailed statement of work.) Importantly, this does *not* mean creating a new database or data set, since many excellent data sources already exist. It is recognized that due to constantly changing socioeconomic and environmental conditions within the Okavango River Basin, it is important that decision-makers can continually access and analyze data. Thus, a portion of Component 2 aims to improve information management by enhancing access to databases.

The consultancy therefore focused on (i) identifying key data and information needs, (ii) identifying key data and information resources, and (iii) recommending ways to provide access to those data and information resources.

2. Approach & Methodology

The Consultant gathered information on data needs, as well as on available information in the region, primarily by conducting interviews with key information users and providers. A complete list of individuals interviewed can be found in Annex B. OKACOM commissioners and OBSC members met with include the following individuals:

OBSC Members

Mr. Carlos Andrade (Angola)
Mr. Paulo Emilio (Angola)
Ms. Portia Segomelo's Staff (Botswana)
Mr. Kalaote Kalaote (Botswana)
Dr. Stefan deWet (Namibia)
Ms. Laura Namene (Nambia)

OKACOM Commissioners

Eng. Armindo Gomes Da Silva (Angola)
Dr. Akolang Tombale (Botswana)
Mr. Piet Heyns (Namibia)

The interviews on data and information needs were semi-structured, with questions paraphrased from the following:

- How does decision-making occur within OKACOM?
- What kinds of decisions do you/will you make as an OKACOM/OBSC member?
- How do you/will you go about making these decisions?
- What data and information do you need to order to make these decisions?

The consultant also interviewed a wide variety of secondary and others users about data and information needs. These included representatives from government agencies in each country, scientific researchers, and NGOs, including NGOs representing local communities that are most effected by decisions made a regional and national levels (see Annex B.) Data and information needs for these users naturally follow their areas of responsibility—from land use planning to tourism to wildlife conservation. Adding secondary and other users to the mix immediately and drastically expands the landscape of data and information needs. For this reason, it was decided during the initial briefing at USAID that the Consultant would focus on the most critical needs of the primary users, as described above.

To identify sources of data and information, the Consultant developed an interview protocol prior to her arrival in Gaborone. This protocol was refined (see Annex D) during the course of the interview. Using an interview protocol helped to structure the interviews, and ensured consistency from one to the next. The Consultant visited relevant government ministries and agencies, universities and research institutions, parastatal organizations, non-governmental organizations (NGOs), and other donor-funded projects in each country, as well as regional ones such as the Southern African Development Community (SADC) Hydrological Cycle Observing Systems (HYCOS) at the Department of Water Affairs and Forestry in Pretoria, South Africa.

The consultant culminated this work in a two-part "validation" exercise carried out with OKACOM Commissioners and OBSC members during the November 2005 conference"16th Meeting of the Okavango Basin Steering Committee" held in Windhoek, Namibia. Specifically, OKACOM commissioners and OBSC members used colored stickers to select from a long list of data and information they felt were "most needed for informed decision making." Through this exercise, the Consultant was able to validate findings of the earlier one-on-one interviews with OKACOM commissioners and OBSC members on data and information needs.

3. Findings: Data and Information Needs

Increasing population, climate change, and economic development in the Okavango River Basin will challenge OKACOM decision-making in the future. Post-war mine clearing in southern Angola is already underway, and population pressures in the country are pushing people back into the upper Kubango catchment, straining all natural resources in the region, including water. At the same time, water is scarce in Namibia, which faced a near crisis in 1994-1996. At that time, the planned solution was to complete the Rundu to Grootfontein link of an existing Eastern National Water Carrier by diverting water from the Okavango River. The second largest source of income to the country of Botswana is from tourism, and the Okavango Delta's ecosystem supports a major fraction of Botswana's tourism revenue. Reductions in quality or quantity of water from the river—due to increased human activity in Angola or withdraw of water into Namibia—should be considered a serious threat to the ecosystems, and therefore to the tourism, in the region.

At the same time, there is a widespread perception that the water in the Okavango Delta is "pristine" and that the minefields in southern Angola will guard against development in the upstream region, so that it will remain "pristine" indefinitely. This perception is misleading and risky. During the Consultant's visit to Rundu, she witnessed deforestation on both sides (Angolan and Namibian) of the Okavango River, crops growing on the river banks with no riparian buffer, and garbage in the river upstream from the town of Rundu. (See pictures below.) Anecdotal evidence from others who have traveled extensively in the southern part of Angola and northern Namibia indicate that subsistence agriculture, as well as deforestation, including both clear cutting and cutting of trees for charcoal, are increasing. The Namibians interviewed were very concerned about the cumulative effects of such practices, since Namibia's primary need for water from the Okavango River is for human consumption.

Deforestation along Okavango River

Crops Growing on Bank of Okavango River near Rundu

Garbage Floating in Okavango River Upstream from Rundu

In the interviews, stakeholders expressed concerns about fellow riparian countries' future use of the river basin resources, including: concern about Namibia reviving plans to divert water from the river, concern about possible mineral exploration in the Angolan Kubango catchment, and concern that Botswana and Namibia may try to restrict economic growth in Angolan portion of the basin. All expressed a need for better information regarding what is *really* going on in the region, and what is *really* being planned by the three governments.

For OKACOM decision making, the primary users of data and information are the OKACOM commissioners themselves, OBSC members, and technical teams or working groups delegated to provide technical information for decision-making. Secondary users include government agencies in each country, especially those responsible for water, environment, agriculture, energy, mining, and tourism. Particularly in Angola, where there is a dearth of publicly accessible recent data, these government agencies would likely make good use of data available through the OKACOM Secretariat and expressed a keen interest in having such a data resource available to them. Other users include NGOs and the local communities that are most affected by decisions made at regional and national levels. Working closely with projects like Every River Has Its People can make such direct links to communities a reality.

3.1 Primary Users

As paraphrased from the Agreement to Establish a Permanent Okavango River Basin Water Commission, the functions of OKACOM are to advise the governments of the three participating countries of Angola, Botswana, and Namibia on:

- Measures and arrangements to determine the long term safe yield of the water available from all potential water resources in the Okavango River Basin;
- Reasonable demand for water from consumers in the Okavango River Basin;
- Criteria to be adopted in the conservation, equitable allocation and sustainable utilization of water resources in the Okavango River Basin;
- Investigations related to the development of any water resource in the Okavango River Basin;
- Prevention of the pollution of water resources and control over aquatic weeds in the Okavango River Basin;
- Measures that can be implemented to alleviate short-term difficulties resulting from water shortages in the Okavango River Basin during periods of drought; and
- Other matters as may be determined.

This list of functions implies a need for data and information to determine water supply and availability (yield, sustainable utilization, shortages), water demand (reasonable demand from consumers, equitable allocation), and water quality (pollution). As described by OBSC members and OKACOM commissioners interviewed, the basic procedure for decision-making within OKACOM is that formal proposals are presented to the Commission. These may include proposals for unilateral activities (e.g, irrigation canal construction), bi-lateral activities (e.g., piping of water across a border between two countries) or multi-lateral activities (e.g., a single dam to service all three countries). The Commission debates the proposal and likely assigns technical teams or technical working groups to conduct studies to analyze the likely impact of the proposed activity on their own country's interests, or to assess other issues that may arise. Based on pre-feasibility, feasibility, or other studies completed by these technical teams or working groups, the Commission then either approves the project/activity, disapproves it, or asks for further study. These technical teams or working groups—experts in areas relevant to the proposal at hand—will be primary users of technical and scientific data for informing OKACOM decision-making.

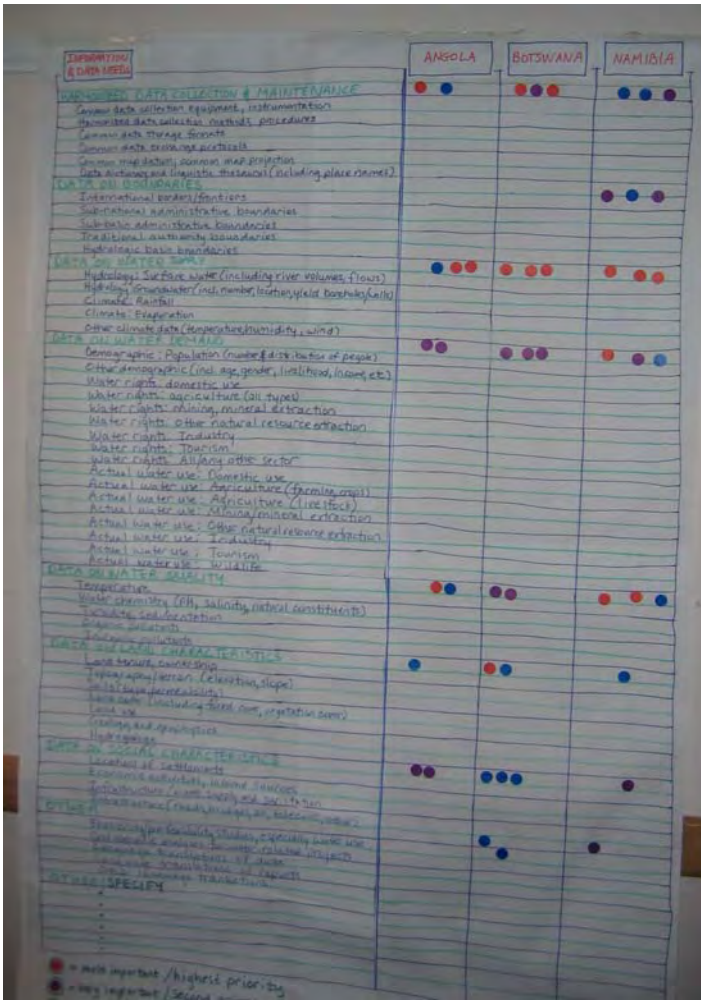
Based on informal interviews, the three data and information needs most often articulated fell into three general categories:

1. **water resources**: river flow rates and volume, groundwater, and hydrologic cycle (weather and climate)
2. **water demand**: population (numbers and densities of people), use by sector (domestic, agriculture, mining, industry, tourism)
3. **water quality**: sedimentation, pollution**,** natural constituents.

Through participatory data verification exercises, delegates from all three countries agreed that the most important, immediate data and information needs fall into four general categories. (For more detail about the exercises, see Annex C.)

1. Water resources,
2. Water demand,
3. Water quality, and
4. Harmonized data collection and maintenance.

The rest of this document focuses on these four categories.



Results of Participatory Data and Information Needs Identification Exercise

4. Findings: Data and Information Resources

In parallel with the user needs assessment, the Consultant also conducted a survey of sources of data and information, focusing on the four general categories described in Section 3.1. Quality, quantity, timeliness and reliability of data vary considerably among the three countries of Angola, Botswana, and Namibia. Angola has a heritage of collecting and maintaining high quality data, but 30 years of war have interrupted this process. In Botswana, there is quite a bit of recent data, but it is scattered, of variable quality, and lacking harmonization. In Namibia, data are plentiful and of high quality. But very experienced government staff are retiring within the next few years, and it is not clear that replacements will be found with the same extent of knowledge and experience in producing high quality data. What all three countries do have in common is a willingness to share data and information among themselves for common good.

4.1 Angola

In Angola, the Ministry of Energy and Water holds the responsibility for the development of hydrological resources. Law 6/02 (June 2002) established the hydrographic basin—rather than any administrative boundary—as the primary unit for managing hydrological resources. This has important implications for participation with OKACOM—it should simplify decision making and interaction with the Ministry. In fact, at the time of this writing, the only institution formally constituted for a hydrographic basin is the Cabinet for the Administration of the Cunene Hydrographical Basin (GABHIC), which includes responsibility for the Kubango basin.

The National Directorate of Water (DNA) of the Ministry of Energy and Water holds historical data from 189 stations nationwide for a period up to 1975. At that time, war destroyed or made these stations inaccessible, and no data were collected for almost 30 years. The data still exists, though, in both digital and paper form. A review of the original field forms and discussions with staff who have been with DNA for 40 years indicate that the data were meticulously and carefully collected, and are of a very high quality that is still useful today. For example, velocity curves were maintained as part of the field data, so that anomalies could be detected immediately. Data collected in other agencies visited—including the Ministry of Agriculture and the Ministry of Geology and Mines and the Department of Geodesy—are of a similarly high quality.

There was a brief attempt to re-establish data collection activities in the early 1990s, but it was soon abandoned when the country fell back into war. The country has only emerged from war in 2002 and is now faced with an overwhelming set of issues: poverty, lack of infrastructure including potable water, electricity, and roads; need for better health care and education.

There is widespread recognition of the need to re-establish data collection activities within the various government agencies, but it is taking time to acquire and install all the necessary instrumentation as well as the computers that will maintain the collected data. In the meantime, private sector firms are developing their own databases. These include petroleum, diamond and other mineral exploration firms; drilling companies; and de-mining companies. Today, these databases contain the most up-to-date information about Angola's surface and sub-surface characteristics, but as privately held data sets they not generally available.

There is also recognition of the need for careful planning and establishing systematic, accurate data collection and maintenance methodologies. The Angolan government staff interviewed were all quite open to the idea of sharing data among themselves, and with their colleagues in neighboring countries. To date, Angola has no formal data sharing network.

4.2 Botswana

In Botswana, data are plentiful and most have been computerized; borehole data are currently being entered into a database from historical and current paper records at the Department of Geological Survey in Lobatse. However, data are scattered and inconsistently collected in time and content. Some of

the data are of questionable quality, including important surface water data. HYDATA, the database containing surface water data for the Botswana portion of the Okavango basin, does not distinguish between zero flow and null (no data).

Equipment is not routinely calibrated or maintained, data are not quality-checked, and no distinction is made between collected data and interpolated data. For these reasons, these data are highly suspect and could actually be misleading. Data are sometimes lost. Computers on which data resides may break or or be lost with no backup, or individuals responsible for maintaining data leave the organization and no one else knows where or how the data are stored.

Researchers and other users of data have mixed success in acquiring the data from government sources. In theory, much of the government's data is "in the public domain," but without at least a memorandum from a high-level government official authorizing the release of the data, it is often not easy to acquire, particularly in a timely fashion. The most successful sharing of data are those cases where there is active participation of agencies holding the data in the activities for which the data is being used (e.g., participation in a working group or advisory board). With time and persistence, most users do eventually get what they need.

Users complain that there is no harmonization: Settlement and other place names differ from one data set to another. The Department of Surveys and Mapping is in the process of creating a new map datum standard for Botswana, but all of the parameters have not been released.

Like Angola, all government staff interviewed in Botswana expressed a willingness to share data among themselves, and with other countries in the region. Botswana has a fledgling National Spatial Data Infrastructure. But with 21 organizations involved, even after four years of work, it has been difficult for them to make progress resulting in tangible results. The Botswana NSDI contains only a few, sparsely populated metadata records.

Important data collections exist, particularly the Okavango Delta Information System at the Harry Oppenheimer Okavango Research Centre (HOORC) in Maun. ODIS is being developed as a resource for the Okavango Delta Management Plan project. ODIS includes data on administrative boundaries, climate, demography and settlements, geology, topography, hydrology, soils, vegetation, wildlife and land use history. The Okavango Delta Information System also includes a metadata component. The primary drawback of the Okavango Delta Information System for the purposes of OKACOM is, of course, that the database covers only the Delta portion of the basin. However, the Okavango Delta Information System represents a resource which could be enlarged to cover the entire basin. (See Section 2.4 for a complementary approach to establishing a basin-wide database.) A related database, the Okavango Basin Data and Literature Resources database, provides information on the Okavango Basin for Angola, Namibia, and Botswana. Most documents are scanned into Adobe Acrobat files for easy access.

4.3 Namibia

In Namibia, data are plentiful, consistently collected in time and in content. Data are quality-checked before being entered into databases, as well as after, and generally of an accurate and reliable quality. Data collection procedures are thorough and well-documented.

Much data is already in digital format, and that which is not is systematically being converted and quality-checked. This includes historical records from Meteorologic Services, and water and hydro-geological data in the Division of Water Affairs. Atypically, data on water quality monitoring are still entirely paper-based. Recent attempts to computerize these data haven fallen short for a variety of reasons, although there is hope that the new Water Resources Management Act ("Water Law") of 2004 will renew efforts to computerize these important data.

What Namibia has in data, it lacks in staff to process and analyze the data. In addition to tabular data, there is also a great deal of remotely sensed imagery covering the entire country available. The remotely

sensed imagery includes complete Landsat coverage for 1998/1999 and 2004 held by the Division of Water Affairs. These images could be used for change detection analysis, and as a baseline for future monitoring. But the Division lacks sufficient staff and training in image processing to carry out this work.

Similarly, maintenance of hydrologic monitoring instrumentation is spotty because of lack of field personnel and the fact that in many cases - as in the case of the Department of Water Affairs in the Ministry of Agriculture, Water, and Forestry—technicians are centralized in Windhoek from which they must travel to maintain equipment. At least for this department, there are no technicians based in the field to check on and maintain equipment.[1]

Namibia has a mature National Spatial Data Infrastructure.[2] It evolved from a 1998 initiative, with support from the Government of Finland, to establish an Information and Communication Service with the Ministry of Environment and Tourism. By 2003, the National Spatial Data Infrastructure was providing metadata representing some 500 data sets from 15 different government agencies. Since that time, the NSDI has continued to expand. Government agencies providing metadata relevant to Okavango Basin planning include the Ministry of Agriculture, Water and Rural Development, Directorate of Environmental Affairs, National Remote Sensing Center and the Desert Research Foundation of Namibia. The National Weather Bureau does not yet provide metadata, but there are plans for it to do so. Many of the data sets represented by the metadata are also available through closely linked data and map servers. The National Spatial Data Infrastructure represents a real commitment on the part of the Government of Namibia for widely and openly sharing many important data resources.

4.4 Regional

The African Water Resource Database is a geographic information system (GIS) of the entire continent of Africa developed with support from the Food and Agriculture Organization. This database has been four years in development, and now includes an impressive collection of layers including water surface bodies, administrative boundaries, population densities, soils, satellite imagery, and multiple watershed models. The significance of the African Water Resource Database is that it is a fully integrated, and fully harmonized data set, with polygons matching across national boundaries and layers matching one to the next. This harmonization alone represents a significant achievement.

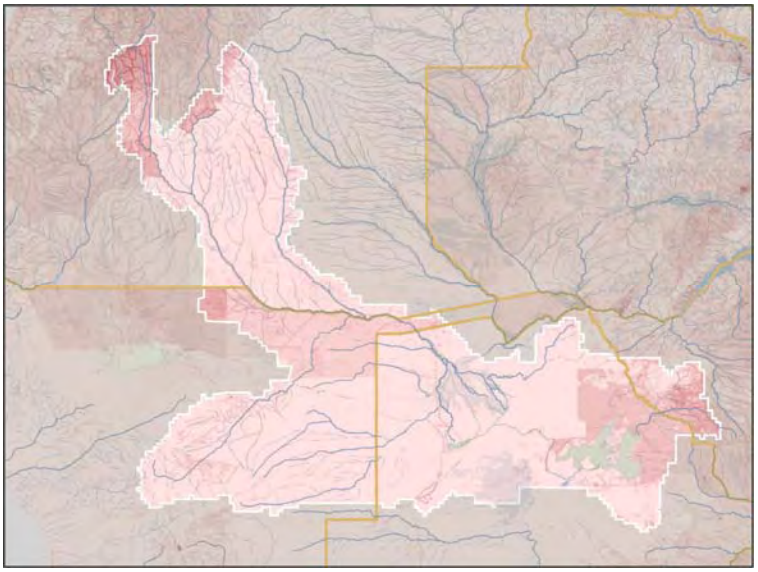
The scale of the data layers range from 1:1,000,000 to 1:5,000,000 (and 1 to 5 km for the satellite imagery). This makes the data useful mostly for regional planning. However, taking only the Okavango River Basin portion of the database would provide an excellent base into which one could insert more detailed data—such as from the Okavango Delta Information System —for localized planning.

Access to the layers are provided through a customized ArcView 3.2 interface—a common, inexpensive GIS tool used extensively throughout Africa and the world. The customization provides access to the data through six "modules." Three of these modules are particularly relevant to Okavango River Basin planning.

- **Surface Waterbodies Module** provides users with access to all the data on water bodies.
- **Watershed Statistics Module** provides tools for analyzing and visualizing watersheds. This tool uses hydrologic relationships between watersheds to identify those that are upstream, those that are downstream, and which ones make up the overall flow regime or "megabasin."

[1] Note, however, that in this arid land many rivers only run for part of the year, and it makes little sense to post technicians permanently in areas where there is literally nothing to monitor for much of the year.
[2] http://www.met.gov.na

- **Data Classification and Statistical Analysis Module** allows users to generate summary statistics for any set of records, calculate probability distributions, classify and rank features, and analyze relationships between data layers.



Population Density Map of Okavango River Basin from ARWD Database

The African Water Resource Database also contains a Web-compatible (HTML-enabled) metadata documentation module that meets international metadata standards, and a customization module that contains additional statistical, data visualization, and spatial referencing tools.

USAID, through the Sharing Water project, funded the development of a data set[3] for data related to the Okavango River Basin, comprised of data coming from a variety of non-government sources. This dataset was developed by Mendelsohn of RAISON in Namibia, is still available on the web and through RAISON and HOORC, and can be searched by keyword, theme, and region. Many of the water data are in Excel format. Maps and graphs are also available. This data set can best be described as a "collection" rather than an integrated, harmonized "compilation" of data such as the ARWD. However, the data are no longer being updated regularly. Also, a test by the Consultant of the database conducted during this assignment resulted in difficulty accessing any of the selected data. Although Sharing Waters and RAISON recommended that responsibility for maintaining this data set be taken up by HOORC and incorporated into a database they were to build and maintain for the entire basin, OKACOM's recommendation regarding management of this data set requires verification. It is not clear whether or not HOORC is going ahead with a basin-wide version of the Okavango Delta Information System.

The consultant also met with individuals involved in the SADC HYCOS project, hosted by the Directorate of Hydrology, Department of Water Affairs and Forestr in Pretoria, South Africa. The HYCOS project covers the 11 countries of the Southern African Development Community (SADC). Its implementation began in 1998 with phase II activities beginning initiated in July 2005. The Consultant met with the HYCOS database manager, learning that the database server for HYCOS data has been out of operation for some time. Visits to HYCOS stations in the region by the Consultant and colleagues determined that much of the equipment is similarly inoperative. Until these difficulties are overcome, it is not recommended that HYCOS be relied on as a source for hydrological data.

[3] http://www.sharingwater.net/OnlineDatabaseSearch.asp

5. Recommendations

As the focus of this consultancy was on *access* to information, the Consultant extracted action-oriented ideas from the interviews that would help facilitate that access.

5.1 Metadata

Government staff and others in all three countries express a willingness to share data and information among themselves and with their counterparts in other countries. The first step to implementing a data sharing mechanism for OKACOM is simply to inventory available data. The most widely accepted way for doing that is through the use of "metadata."

A metadata "record" contains enough information to allow users to determine whether or not the catalogued data or information resource merits further investigation. The metadata record contains basic information about the nature of the data resource—what it is, where it is, and how to get it. Metadata therefore represent a detailed "inventory" of data, allowing users to spend more time using the data rather than tracking down the location of the data.

There are a number of standards for recording metadata. One of the most popular is the Content Standard for Digital Geospatial Metadata, a standard for metadata describing geographic data developed by the United States Federal Geographic Data Committee. The standard is typically referred to simply as the "FGDC metadata standard." The Federal Geographic Data Committee-metadata standard is compliant with the International Organization for Standardization (ISO) Technical Committee's [(TC)211] Metadata Standard 19115, adopted June 2004, for geospatial data.

A full Federal Geographic Data Committee metadata record consists of seven sections:

1. **Identification Information:** Basic information about the data set.
2. **Data Quality Information:** General assessment of the quality of the data set
3. **Spatial Data Organization Information:** Mechanism used to represent spatial information in the data set.
4. **Spatial Reference Information:** Description of the reference frame for, and the means to encode, coordinates in the data set.
5. **Entity and Attribute Information:** Details about the information content of the data set, including the entity types, their attributes, and the domains from which attribute values may be assigned
6. **Distribution Information:** Information about the distributor of and options for obtaining the data set.
7. **Metadata Reference Information:** Information on the currency of the metadata information, and the responsible party.

A complete Federal Geographic Data Committee record can contain a wealth of information about the data resource. However, it is not necessary to complete every field in a Federal Geographic Data Committee record to have useful metadata. For this reason, only a small subset of the information listed above is considered mandatory—most of it is considered as optional. See Annex E for an example of a simplified metadata record containing a description of, and information about how to access, a soil map of the Kasane area of Botswana.

The Consultant recommends using the Content Standard for Digital Geospatial Metadata, a standard for metadata describing geographic data developed by the Federal Geographic Data Committee. Although it was developed as a metadata standard for geospatial data, unlike the ISO standard, the Federal Geographic Data Committee standard is not limited to spatial data. Federal Geographic Data Committee also enables development of "profiles," i.e. customization of the standard to suit the needs of a particular

application domain while staying within the framework of the standard. It can, for example, be used for bibliographic information (i.e., books and other documents) since it already includes publication fields.

The Federal Geographic Data Committee standard is already widely used in the region. Both the Botswana NGIS Metadata Service and the South Africa National Spatial Information Framework Clearing House Node use the Federal Geographic Data Committee standard. The Namibia Spatial Data Infrastructure uses the closely-related ISO 19115 standard. (Other SADC countries also use the Federal Geographic Data Committee standard.)

MetaLite is the software of choice for developing metadata in the Federal Geographic Data Committee standard. MetaLite version 1.7.5 is a free, simple software tool for collecting and validating Federal Geographic Data Committee compliant metadata. It was developed by the United States Geological Survey in cooperation with the United Nations Environment Programme. The software allows a user to quickly document geospatial data while still adhering to Federal Geographic Data Committee metadata standard. The software can be downloaded from the following Web site:

http://edcnts11.cr.usgs.gov/metalite/

Online help is available from the same Web site.

MetaLite is recommended for the following reasons:

- MetaLite is based on the Federal Geographic Data Committee standard.
- The MetaLite software is free, well-supported, and easy to use.
- MetaLite is widely used in the region. MetaLite is used by the South Africa National Spatial Information Framework Clearing House Node and the Botswana NGIS Metadata Service.
- MetaLite used by many sources of international data that are relevant for Okavango River Basin study and planning, including the United States Geological Survey (USGS) and the National Oceanographic and Atmospheric Administration, as well a key international NGOs, such as The Nature Conservancy.
- It is based on Microsoft Access and runs on Windows 95 or higher and Windows NT 4.0 or higher, platforms available to most users.
- It is multi-lingual in English and Portuguese (as well as French and Spanish).
- It is "open source." The source code, in Visual Basic, is readily available from the Internet when customization is required for specific applications.
- Metadata queries from MetaLite can be exported into one of several Web-compatible formats: HTML, XML and SGML.
- Arc/GIS, the most popular GIS software in the region, has metadata tools that are compatible with the Federal Geographic Data Committee standard.
- Its associated keyword set has been developed and refined for more than a decade by users of data representing numerous disciplines in the natural sciences, and therefore represent the combined knowledge of how to usefully describe scientific data and information resources. A sample of some keywords from the MetaLite data dictionary can be found in Annex F.

Other software options either do not use common metadata standards, are not compatible with standard office software, do not support Portuguese language keywords, are not common in the region or are only available by paying a licensing fee.

Because MetaLite allows export in a variety of Web-compatible formats—HTML, XML and SGML—it is easy to include the metadata either as on-line, searchable resource that anyone can access through the Web, or through a password protected Intranet. The user need not be presented with the full metadata record in order to be useful. For example, the National Spatial Data Infrastructure of Botswana uses only four fields from MetaLite for its Web search tool:[4] free text keyword searches on the title, abstract, or

[4] http://www.ngis.gov.bw/metadata/search.asp

theme, and a pull-down list of originating organizations[5]. Additional information, such as the name and contact information of the contact point within originating organization, are shown only when and if the user has identified an information resource of interest and wants to contact the custodian of the resource for more information about how to access it.

Eventually, simply knowing where data are will not be sufficient for rapid, informed decision making. In those cases where data are already available on line, a simple "hot link" can connect the users to actual data identified as being of interest from the metadata. In other cases, data that are commonly used can be housed at the Secretariat, obviating the need to acquire it time and again from its source. Collecting such data should be on a "demand driven," as needed basis—data should not be collected simply for the sake of collecting it.

Initially, it is recommended that access to the metadata be provided through the USAID/OKACOM Project Web site. At such time that the OKACOM Web site, being developed by the Every River Has Its People project, becomes available, access to the metadata should be through the OKACOM Web site.

The functional requirements for designing the Internet hub and database link are therefore as follows:

- Uses the Federal Geographic Data Committee metadata standard;
- Interfaces with SML, HTM, or SGML records exported from MetaLite;
- Uses only a small subset of fields from the MetaLite records as Web-enabled search fields ("database link"), including at least the following:
  - Country or countries for the data (Angola, Botswana, Namibia);
  - One or more keywords taken simultaneously from title, abstract, and keyword fields; and
  - Date range (should be optional to user)
- Responds to "hits" with critical additional information, including at least contact information for acquiring the described data set;
- Provide "hot links" to the actual data set in cases where it exists on the Internet;
- Provides the full metadata record for each "hit" upon request of the user.

Annex G provides a detailed action plan for developing a Web-accessible metadata database for the Okavango River Basin.

5.2 Participatory Basin Boundary Exercise

Determining the precise extent of the basin is critical to establishing the jurisdiction of OKACOM and, as such, is likely to be part of the legal agreement defining rules and procedures for OKACOM. In addition, determining which data sets are relevant is partially dependent on knowing where the basin boundaries are. Defining basin boundaries is more difficult than it sounds. Different models—based on digital terrain models, digital elevation models, or watershed encoding models, give different boundaries. In addition, it is expected that certain critical areas of the basin of particular national interest may not be easily included in the overall basin if it is felt that sovereignty over the activities carried out in those areas is at risk. Questions also arise as to whether or not to include any of the "fossil" watersheds.

A participatory GIS exercise involving OKACOM commissioners and OBSC members would be an excellent way to demonstrate how different models identify different basin boundaries, and to interactively explore the effects of including or excluding certain areas as part of the basin. It is recommended that an all-day participatory exercise of this nature be conducted using the African Water Resource Database described in Section 4.4 as a base for discussion, with the interactive modeling tools

[5] The model is not recommended for adoption by OKACOM. The originating organization option is of limited use when the main purpose of the metadata are to find the sources (originators) of the data resource. It is offered here only as an example of a how the FDGC standard and MetaLite support simple Web-enable metadata search tool.

to define various basin boundaries based on participant input. A detailed description of the suggested participatory activity can be found in Annex H.

5.3 Sharing Data with Local Communities

Working closely with the Every River Has Its People project can help to ensure that these data and information resources—through the metadata—are also available to the local communities that are most effected by decisions made a the national and regional levels. The same metadata that are available to OKACOM commissioners, OBSC members, and their technical staff can also be made available to these communities through the Basin Wide Forum, with the assistance of the Every River project. Joint workshops can be held to explain the resource to Basin Wide Forum members, and to demonstrate the use of the metadata database.

5.4 Data Extrapolation Exercise

In addition to the three data types—water resources, water demand, and water quality—the OBSC members also identified harmonized data collection and maintenance as a priority area. As described in Section 2.1, the historical hydrologic data in Angola is of excellent quality, and has been recently computerized and quality checked. An exercise could be carried out to statistically correlate these data to downstream and upstream data collected in the neighboring countries during the intervening time. This would be a useful exercise both for "filling in" the missing data, and for exploring how future data can be collected to ease future analysis of data from the three countries.

5.5 A Basin-Wide Data Collection

In a few years time, it may be determined that metadata alone is not sufficient for timely decision making, and having data on hand would be useful as well. When that time comes, the OKACOM Secretariat may want to consider housing its own data set. Two excellent data compilations already exist on which a data set for the entire basin could be established. The first is the Okavango Delta Information System. Although presently this database covers only the Okavango Delta portion of the basin in Botswana, less than a year into its development it has already proven to be a well-used resource by staff from 13 different government agencies who have been trained in its use. The second is the Africa Water Resource Database. Four years in development, this geographic information system covers the entire continent of Africa and includes layers for water surface bodies, administrative boundaries, population densities, soils, satellite imagery, and multiple watershed models. The data layers are fully integrated and harmonized, so that polygons match at national boundaries and from one layer to the next. The Okavango River Basin portion of this database would be an excellent base in which to insert additional data, such as that from the Okavango Delta Information System, to provide detail when and where it is needed.

Annex A: Summary of SOW Activities & Tasks Completed

Task 1 **Meet with USAID, COP and OBSC designated representative to review the scope.**

The Consultant met with the COP in Burlington, Vermont prior to arrival in Gaborone to review a draft SOW. The SOW was refined during the subsequent weeks by email interaction with the Deputy COP and Acting COP. By the time the consultant arrived in Gaborone on 9 October 2005, the SOW was well-understood and agreed upon by all parties. Shortly after her arrival, the COP introduced the Consultant to several key USAID staff and OBSC members. The SOW was broadly reviewed to re-establish the general agreement as to the activities and responsibilities of the Consultant.

Task 2 **Initial User Needs: Identify key water resource users and managers, determine their data and information needs. Review OKACOM charter and functional categories, project documents and other background documents and conduct informal interviews to determine areas of information needs and priorities.**

See Section 2 on "Findings: Data and Information Needs" and Annex B.

Task 3 **Initial Data and Information Assessment: Assess and analyze existing ORB databases through the review of key institutions who are providers of data in each of the partner countries. The review should include: an inventory of data and information available; its relevance to OKACOM and stakeholders; the periodicity of needed updates; potential mechanisms for updating data; and a critical analysis of data quality, reliability, and accessibility. Institutions shall include country-based ones such as universities, relevant ministries and water departments, as well as regional ones such as SADC HYCOS and the Department of Water Affairs and Forestry in Pretoria.**

See Section 3 on "Findings: Data and Information Resources" and Annex B.

Task 4 **Based on the results of the initial user and data assessments (above), conduct additional research as necessary to prepare a short report documenting the needs, value, sources, and estimated maintenance costs for priority data required by the different users. Develop preliminary recommendations relevant for OKACOM, to be reviewed by OBSC in October, and refined as needed for presentation at the OKACOM meeting in Windhoek, October 31.**

See Section 3 on "Findings: Data and Information Resources," Section 4 on "Recommendations," Annex B, and Task 5 below.

Task 5 **Present the results of the assessments and recommendations to OBSC at the OKACOM meeting; solicit feedback on preliminary recommendations; and develop consensus on next steps.**

A list of "talking points" with supporting documentation was provided to the project COP prior to the meeting, and were included in the COP's presentation at the meeting. In addition, a long-list of data resources, derived from the in-person interviews, was presented in the form of and exercise to validate data needs. The exercise resulted in a consensus on four priority areas for data and information needs. (See Annex C for details.) Solicitation of additional feedback was precluded by an already full meeting agenda.

Task 6 **Based on the results of assessments and the workshop, explore methods for connecting/sharing data sources and provide cost-effective recommendations for linking OKACOM representatives and other key stakeholders in the three nations, possibly through an internet-based system. The report should compare options for connecting data and information resources. Such options may include building on and enhancing existing websites (e.g., OKACOM Website). Elaborate the pros and cons of each option.**

See Section 4.1 and Annex G.

Task 7 **Coordinate with the Every River Project and OKACOM on the requirements for a website design. Develop functional requirements and terms of reference for designing the internet hub and database link.**

The Consultant met with ERP staff in Maun, Botswana and in Windhoek and Rundu, Namibia. In addition, the Consultant joined the USAID/OKACOM Project team's Institutional Specialist (acting in the role of interim Executive Secretary for OKACOM) in a meeting with the Every River Project director and Web site developer on 2 November 2005 to review *all* functions of the OKACOM Web site. For the portion of the Web site design covering this task—the functional requirements for the link between the OKACOM Web site ("internet hub") and Web-based metadata search engine ("database link")—see Section 4.1 The terms of reference for the design are listed under Step 4 of Annex G. Also see Section 4.3 for a recommendation for another joint ERP activity.

Task 8 **Make recommendations for establishing, housing and maintaining a meta database and/or portal for accessing data and information, including protocols for accessing and sharing information and proposing categories and criteria for classifying information and managing data security (different requirements for public documents, versus other documents that are not intended for public use (e.g., MOUs).**

See Section 4.1 and Annex G for recommendations for establishing, housing and maintaining a metadata database. The portion of this task having to do with determining criteria for classifying information and managing data security is the responsibility of the Every River Project, developers of the OKACOM Web site.

Task 9 **Prepare recommendations for protocols or guidelines for the entry, maintenance, sharing, and dissemination of data, including standardized metadata. Recommend strategies for maintaining and upgrading protocols or guidelines (including metadata) as the data sharing system evolves and grows.**

See Section 4.1 and Annex G.

Task 10 **The contractor will generally provide "on-the-job-training" by facilitating the participation of a local counterpart from the Department of Water Affairs of each country. This will provide the counterparts an opportunity to stretch and expand their skill base. This includes identifying and exploiting opportunities for mini-training sessions and short presentations that build skills needed to perform the tasks in this scope of work, providing detailed explanations on the "how" and "why" of protocols and procedures used, encouraging active participation in data analysis and report preparation, and providing references and resources to the counterparts that enable them to conduct further study of relevant topics after the consultancy is complete.**

Of key importance to technicians collecting and entering data into Department of Water Affairs' databases is an understanding of the importance and relevance of their work. Two technicians from the Namibian Department of Water Affairs participated in the weekend field trip to Rundu. The Consultant took advantage of this opportunity to discuss with technicians why the databases they were contributing to are important to researchers and decision-makers.

Counterparts were not always available from the Departments of Water Affairs, but the Consultant took advantage of similar opportunities with other ministries. For example, when visiting the Botswana Department of Geological Survey in Lobatse, the Consultant showed data entry staff the importance of the borehole data that they were entering from paper records into an electronic database.

During the meeting with the Every River Project director and OKACOM Web site developer (see Task 7), the Consultant, together with the project's Institutional Specialist, had an opportunity to provide guidance on Web site development. This guidance included a discussion of Web design considerations, an appreciation for the need for policies and procedures for Web content and for a style sheet to ensure consistent formatting, an explanation of the components of a design document, and a discussion of possible changes in functionality of the prototype Web site. It was as a result of this discussion that the Every River project subsequently distributed a brief user survey to the OKACOM commissioners and OBSC members.

Task 11 Suggest appropriate follow-on training opportunities in information management for OKACOM, the Secretariat, and others, including required curricula.

Follow-on training in metadata concepts and procedures may be necessary in order for some ministries and other government agencies to fully participate in the "Internet hub" and "database link" of Task 7. EIS-Africa has a specialized curriculum for this purpose which several SADC countries have taken advantage of.

Task 12 Brief OBSC and USAID on final results.

A briefing was held at USAID offices on 9 November 2005. OBSC members invited to the briefing were unable to attend due to prior commitments. When available, OBSC members will be informally briefed by the COP.

Annex B: List of Individuals Interviewed

Each of the following individuals were interviewed or met in person during the course of the consultancy.

Angola

OKACOM/OBSC

Armindo Mario Gomez de Silva	Director Nacional de Aguas, Ministry of Energy and Water
Carlos Andrade	Water Resources Specialist, Cabinet for the Administration of the Cunene Hydrographical Basin (GABHIC)
Paulo Emilio Mendez	Head, National Directorate of Water

Government Agencies

Gualberto João	Director, Instituto Internatcional Hidrometeorologia (INAMET)
Tomás Pedro Coetano	Director General, Institute for the Development of Forestry
Domingos Narare de Cruz Veloso	Institute for the Development of Forestry
Rodrigues Nanga	Engineer Silvaculture, Institute for the Development of Forestry
Kuvungo Paoulo Marton	Ministry of Geology and Mines
Paulo M'Vika	Mining Engineer, Ministry of Geology and Mines
Helen dos Santos Andre	Environmental Specialist, Ministry of Petroleum
Pedro Miguel José Pereira	Chief, Department of Rural Development, Ministry of Hydrology, Agriculture, and Rural Development
Luzia Das Dores Guilherme Alexandre	Director GIS; Ministry of Geology and Mines
Suzia das Dones	GIS Specialist; Ministry of Geology and Mines

Private Sector Consultants

Maria Aparício	IT Advisor, and others; Sistemas Redes e Comunicações (SRC) Lda., Internet Service Provider and Networking firm
Miro Napoleão	Internet Technologies Angola

Other

Januario Augusto	Director, Maiombe Network (an umbrella NGO)
Harmut Krugmann	Project Manager, Environmental Protection and Sustainable Development of the Okavango River Basin (GEF), FAO
Manuel Quintino	Water Resources Specialist and Angola Country Representative, GEF Project
Joaquim ("Buca") Boavida	Geologist, University Agostinho Neto, Luanda

Botswana

OKACOM/OBSC

Akolang Tombale	Permanent Secretary, Ministry of Minerals, Energy and Water Affairs, Co-chairman: OKACOM
Gabaake Gabaake	Commissioner and OBSC Chairman
Kalaote Kalaote	Principle Water Engineer, Department of Water Affairs; Okavango Basin Steering Committee

Portia Segomelo	OBSC member and Project Manager, Okavango Delta Management Plan (ODMP) project, Maun
Government Agencies	
Ditiro Moalajhi	Technical Officer, Modeling Unit, Hydrology Division, , Department of Water Affairs
Veronica Manthe	HYDATA Data entry clerk, Hydrology, Department of Water Affairs
Lesego Rakitrebe	HYDATA Database Manager, Department of Water Affairs
Terence L. Siamisang	Director, Department of Geological Survey
Samuel Serero	National Integrated Geophysical Information System (NIGIS) Administrator, Department of Geological Survey
Nthophi Ramotsoko Dip	Chief Technical Officer, Dept. of Geological Survey
Magowe Magowe	Hydrogeology Division, Dept. of Geological Survey
Nthophi Romotsoko	Chief Technical Officer, Hydrology Monitoring Unit, Dept. of Geological Survey
David Lesolle	Head of Training and Research Division, Department of Meteorology
Donald Dambe	Head of Climatology, Department of Meteorology
Fish Modimoopelu	Climatology Division, Department of Meteorology
Samuel Machua	Data Processing Division, Dept. of Meteorology
Andres Fernandez, Jr.	Engineering Division, Department of Meteorology
Balisi Gopolang	Training and Research Division, Dept. Meteorology
Julia Ditlhong	National Conservation Strategy Coordinating Agency, Department of Environmental Affairs
Private Sector Consultants	
Tej Bakaya	Managing Director, Water Resources Consultants
Flenner Linn	Principle Hydrogeologist, Water Resources Consultants
W. Kent Burger	Projects Director, F.F.M. Botswana (Pty.) Ltd. (GIS and remote sensing)
Karanja Gakio	Cyberplex Africa
Other	
Comfort Molosiwa	Project Facilitator, Okavango Delta Management Plan (ODMP) project, Maun
Sekgowa S. Motsumi	Public Education/Information Officer, ODMP, Maun
Alistair McDonald	Manager, ODMP components (3 and 4), Gaborone
Steven Johnson	Senior Community Services Advisor, Wildlife Conservation and Management Programme
Deborah Gibson	Senior Research & Monitoring Advisor, Wildlife Conservation and Management Programme, Maun
Cornelis H. M. VanderPost	Senior Research Fellow, Harry Oppenheimer Okavango Research Centre (HOORC), Maun
Jafet Andersson	Water Resources and Livelihood Security, HOORC
Constante ("Connie") Masalila	Okavango Delta Information System (ODIS), HOORC, Maun
Tebolo Namushi	ODIS, HOORC, Maun
Lovermore Sola	Biodiversity Corridor Manager, Okavango Program, Conservation International (CI), Maun
Thatayaone Mmapatsi	Senior Outreach Officer, Every River Has Its People project, Maun
Wayne McDonald	Director, Regional Program Implementation Office, USAID/Southern Africa

Rosalyn Waters-Jensen	Deputy Director, Regional Program Implementation Office, USAID/Southern Africa
Keith Kline	USAID/OKACOM Okavango River Basin Project Cognizant Technical Officer, USAID/Southern Africa
Chris Schaan	Natural Resources Program Specialist, USAID/Southern Africa

Namibia

OKACOM/OBSC

Piet Heyns	Undersecretary, Department Water Affairs and Forestry, Ministry of Agriculture, Water, and Forestry
Stefan de Wet	Acing Director, Directorate of Resource Management and Deputy Director Water Environment Division
Laura Namene	Department Water Affairs and Forestry, Ministry of Agriculture, Water, and Forestry

Government Agencies & Parastatals

Guido Van Langenhove	Deputy Director: Hydrology Division, Department Water Affairs and Forestry, Ministry of Agriculture, Water, and Forestry
Roland Roeis	Water Quality Division, Department of Water Affairs and Forestry, Ministry of Agriculture, Water and Forestry
Antje Eggers	Chief Hydologist, Surface Water Database Subdivision, Hydrology Division, Department of Water Affairs and Forestry
Marina Coetzee	Chief Agricultural Researcher, Analytical Services, Ministry of Agriculture, Water and Forestry
Kevin Roberts	Water Environment, Ecology Section
Ndina Nashipili	Water Environment, Ecology Section
Quintin Hammond	Chief Technical Assistant, Hydrometry Sub-section, Hydrological Support Services Section, Hydrology Division, Department of Water Affairs and Forestry
Samfried Riruako	Chief Technical Assistant, Hydrometry Sub-section, Hydrological Support Services Section, Hydrology Division, Department of Water Affairs and Forestry
Franz Uirab	Director of Meteorological Services, Directory of General Services, Ministry of
Sepiso Mwangala	Head of the Climate Section, Meteorological Services
André Mostert	Manager: Hydrology, Namibia Water Company Ltd. (NAMWATER)

Private Sector Consultants

John Mendelsohn	Research and Information Services of Namibia Consultants

Other

Dorothy Wamunyima	Country Coordinator, Every River Has Its People
Mwasi Mwasi	Web developer, Every River Has Its People
Jacob J. Burke	Senior Water Policy Specialist, Food and Agriculture Organization

Regional

Stéfan van Biljon	Project Manager, SADC-HYCOS Project, Department of Water Affairs and Forestry, South Africa
Johannes Calitz	Hydrometry Specialist, Department of Water Affairs and Forestry, South Africa
Gerard Booysen	Consultant-Information Technology and Data Manager, Department of Water Affairs and Forestry, South Africa
Joe Dooley	Spatial Data Services and mapping, Africa Water Resource Database

Annex C: Workshop Exercises to Validate Priority Data Needs

During the conference"16th Meeting of the Okavango Basin Steering Committee" held in Windhoek, Namibia from 31 October to 5 November, 2005, the Consultant conducted two short "validation" exercises to validate earlier findings of data and information needed for informed decision making. For Exercise #1, each OBSC delegate was given a set of colored stickers and asked to indicate which data resource they felt was "most needed for informed decision making." More precisely, they were asked to indicate which two data and information resources were the

- Most important (high priority), indicated by red (R) stickers
- Very important (second priority), indicated by purple (P) stickers
- Also important (third priority), indicated by blue (B) stickers

Two delegates from Angola and three delegates each from Botswana and Namibia participated in the exercise. The results of their "votes" are shown in the table below.

Priority Data Needs	Angola	Botswana	Namibia
Harmonized data collection and maintenance	**R B**	**RR P**	**BB P**
Common data collection equipment, instrumentation			
Harmonized data collection methods, procedures			
Common data storage formats			
Common data exchange protocols			
Common map datum and/or map projection			
Data dictionary and linguistic thesaurus (including place name thesaurus)			
Data on boundaries			**PP B**
International borders/frontiers			
Sub-national administrative boundaries			
Sub-basin administrative boundaries			
Traditional authority boundaries			
Hydrologic basin boundaries			
Data on water supply/availability	**RR B**	**RRR**	**RRR**
Hydrology: Surface water (including river volumes, flows)			
Hydrology: Groundwater (including number, location, and yield of boreholes/wells)			
Climate: Rainfall			
Climate: Evaporation			
Other climate data (temperature, humidity, wind)			
Data on water demand	**PP**	**PPP**	**R P B**
Demographic: Population (number & distribution of people)			
Other demographic (including age, gender, household size, livelihood, income, health, education)			
Water rights by sector: Domestic, agriculture, mining/mineral extraction, other natural resource extraction, industry, tourism			
Actual water use: Domestic, agriculture (crops/farming, livestock), mining/mineral extraction, other natural resource extraction, industry, tourism, wildlife			
Data on water quality	**R B**	**PP**	**RR B**
Temperature			
Water chemistry (pH, salinity, natural constituents)			
Turbidity, sedimentation			
Organic pollutants			

Priority Data Needs	Angola	Botswana	Namibia
Inorganic pollutants			
Data on land characteristics	**B**	**R B**	**B**
Land tenure, ownership			
Topography/terrain (elevation, slope)			
Soils (type, permeability)			
Land cover (including forest cover, vegetation cover)			
Land use			
Geology and geophysics			
Data on social characteristics	**PP**	**BBB**	**P**
Locations of settlements			
Economic activities, income sources			
Infrastructure (water supply and sanitation)			
Other infrastructure (including roads, bridges, air, telecoms)			
Other		**B**	**P**
Feasibility/pre-feasibility studies, especially for water use		**B**	
Cost-benefit analyses for water-related projects & programs			
Language translations of data			
Language translations of reports			
Other (specify)			
Other (specify)			
Other (specify)			
Other (specify)			

Table C.1: Exercise #1: Long List of Priority Data Needs

By assigning values to the priorities, it is possible to tabulate the results from Exercise #1 numerically. The highest priority (R) dots were given a score of 3, the second priority (P) dots a score of 2, and the third priority (B) dots a score of 1. These scores were added ("raw scores") and then weighted by the number of delegates "voting" from each country, so that no one country had more influence than the others. The results are shown in the table below.

Priority Data Needs / Rank Ordered	Weighted Scores (Counts)
Water supply (or "water resources")	**11.00** (25)
Water demand	**7.00** (16)
Water quality	**6.83** (15)
Harmonized data	**6.33** (16)
Social characteristics	**4.00** (9)
Boundaries	**2.50** (5)
Land characteristics	**2.33** (6)
Other	**1.33** (4)

Table C.2: Tabulation of Results from Exercise #1

Before proceeding with this discussion, it is important to clarify certain aspects of the way in which Exercise #1 was conducted. Because the exercise was not part of the agenda, it was carried out during a break in the meeting. Also for this reason, the explanation of the criteria for "voting" and purpose of the exercise proved to be inadequate. It was only after the exercise was completed that the Consultant learned that some participants misunderstood the instructions to "identify which data and information resources are most important for informed decision making." Specifically, some participants thought that they were meant to identify data gaps.

In any case, the Consultant recognized that the small number of individuals (seven) that participated in the exercise precluded assigning any real meaning to the numbers in Table C.2. Rather, this table was used

simply to split the categories into two groups: Highest ranked categories and lowest ranked categories. The highest ranked categories were:

Water supply	Water quality
Water demand	Harmonized data

A subsequent exercise, Exercise #2, was then designed to try to gain a more detailed understanding in these four highly ranked categories. Exercise #2 asked the delegates to "vote" for the two most important subcategories within each of these four general categories (see Table C.1 for the sub-categories). This time, the criteria for selection were clearly explained as "identify which data and information resources are most important for informed decision making" and translated simultaneously into Portuguese. Apparently, however, the instructions were still not understood by everyone and, subsequent to the exercise, that Consultant learned that some participants were still identifying data gaps. Furthermore, the Consultant also learned that at least one term was confusing to some—the term "water supply" had a different meaning for different groups of people. Some individuals thought that the appropriate term should have been "water availability," others that it should have been "water resources." In fact, OKACOM itself requested that the Consultant change the term to "water resources." (This has been done in the main body of this report.) A few delegates added some additional data types that were not in the original list, after other delegates had already voted For these reasons, a consolidated version of the results from Exercise #2 is shown below in Table C.3. It is "consolidated" because it does not show the detail—because of the problems mentioned above. (For the record only, the full detail is provided at the end of this annex.) Exercise #2 can be considered as a refined version of the first exercise—with more respondents and some clarification to the instructions.

	Weighted Scores (Counts)			
Priority Data Needs	**Angola**	**Botswana**	**Namibia**	**TOTAL**
Water supply (or "water resources")	**2.75** (11)	**1.75** (7)	**2.22** (9)	**2.25** (27)
Harmonized data	**2.22** (9)	**4.00** (12)	**1.75** (7)	**2.17** (28)
Water demand	**2.22** (9)	**1.50** (6)	**2.00** (8)	**1.91** (23)
Water quality	**1.25** (5)	**1.75** (7)	**2.22** (9)	**1.76** (21)

Table C.3: Tabulation of the Consolidated Results from Exercise #2

What Exercise #2 did provide was an increase in the number of respondents from just seven to 12. In addition, while Exercise #1 was conducted only in English, Exercise #2 included a Portuguese translation, allowing more of the Angolan delegates to participate. While twelve is still too small a number of respondents to draw any conclusions from the numbers themselves, the numbers do indicate some tantalizing insights that might be revealed by a more detailed and statistically valid survey—differences not only in data and information needs between the three countries, but also potential areas for future conflict. For example, both water supply and water demand seem to be more important to Namibia and Angola than to Botswana, and this makes sense since Namibia and Angola are looking to the Okavango as a source of water for consumption and development, respectively. Water quality is more important to Namibia than the other two countries. Again, this makes sense. Water is scarce in Namibia, which faced a near crisis situation in 1994-1996 with a severe drought that has not been forgotten. At that time, the most likely solution would have been to completing the Rundu to Grootfontein link of an existing Eastern National Water Carrier by pumping water from the Okavango River, providing additional water for human consumption.

A more detailed, scientifically designed survey might also reveal opportunities for technical assistance. In this case, looking down the column for Botswana, one notices immediately the apparent importance to Botswana of harmonized data compared to specific data resources, as well as the importance of harmonized data relative to the other two countries. This may reflect the knowledge that, while data are

plentiful in Botswana, they are not always of high quality or comparable from one data set to the next. In that case, it would indicate a need for capacity building in this area.

But rather than reading too much into this table, one is urged instead to view it as an indication of possible interpretation of results that *could* be revealed by a well designed, systematic, and statistically valid survey of data and information needs.

For the record only, what follows are a transcription of the charts from Exercise #2.

	Number of "Votes"		
Data on Water Resources (Demand, Availability)	**Angola**	**Botswana**	**Namibia**
Hydrology: Surface water (incl. water volume, flow)	2	4	3
Hydrology: Groundwater (incl. number, location of wells)	2	3	3
Climate: Rainfall	2		
Climate: Evaporation	3		
Other climate: Temperature, humidity, wind.	2		
Other. Specify: *Ecological water requirements*			3

	Number of "Votes"		
Data on Water Demand	**Angola**	**Botswana**	**Namibia**
Demographic (population, number of people)	4		1
Other demographic (e.g., age, gender, household income)			1
Water rights (domestic, agriculture, mining/minerals, etc.)	1	3	1
Actual water use (domestic, agriculture, mining/minerals, etc.)	4	3	3
Other. Specify: *Water demand management*			2

	Number of "Votes"		
Data on Water Quality	**Angola**	**Botswana**	**Namibia**
Temperature			
Water chemistry (pH, salinity, natural constituents)			1
Turbidity, sedimentation	3	3	3
Organic pollutants	1	4	3
Inorganic pollutants	1		
Other. Specify: *Nutrient concentrations, eutrophication*			2

	Number of "Votes"		
Harmonized Data Collection and Maintenance	**Angola**	**Botswana**	**Namibia**
Common data collection equipment, instrumentation	3	1	2
Harmonized data collection methods, procedures	2	4	3
Common data storage formats	2	2	1
Common data exchange protocols	1	3	1
Common map datum		1	
Common map projection	1	1	
Data dictionary and linguistic thesaurus (incl. place names)			

Annex D: Interview Protocol for Assessing Data and Information Resources

General Organizational Questions

	Date/Initials of Interviewer(s):
1.1 Name of agency/organization	
1.2 Informant name/role/department. Contact info.	
1.3 Organizational mandate. Organizational relationship to other ministries/agencies/ entities—especially if agency is under one of the ministries. (*Note*: Try to get an organigram.)	
1.4 Description of staff, facilities.	
1.5 In your job, what kinds of information are you responsible for (e.g., evaluations, assessments and decision making; periodic or *ad hoc* reports; spreadsheets; data analyses; charts, tables, maps)? (*Note*: Look at examples of these information "products." Get copies if it seems appropriate.) What decisions do you make? Where do you get the information to make these decisions? To whom do you provide information (e.g., reports)?	
1.6 What are the information gaps that reduce the usefulness of your activities (i.e., make it difficult for you to do your job)?	

General Questions about Data/Information Use and Sharing

	Date/Initials of Interviewer(s):
2.1 What information/data (such as libraries, archives, catalogues, reports, data sets, databases) does this organization maintain?	
2.2 Who has access to this information/ data? (External/internal.) Who uses it? What do they use it for?	
2.3 Which of these information/data resources do *you* use? How often? For you, which are the most important of *this* organization's data/information resources, and why?	
2.3 What are the impediments to accessing or using this data/information?	
2.4 What information/data do you use from *other* organizations? Which ones? What do you use it for?	
2.5 What are the impediments or obstacles to accessing or using data/information from these *other* organizations?	
2.6 What do you see as the advantages and disadvantages of openly sharing data and information resources? What sorts of principles do you think should guide such sharing?	
2.7 Are you familiar with any formalized data sharing networks? Which ones? Have you used them? How often and for what?	
2.8 What other comments or insights do you have about inter-organizational data/information sharing?	

Questions About Specific Data/Information Resources

	Date/Initials of Interviewer(s):
3.1 For primary data/ information resource(s) that you use: How many databases, how extensive are they (how many records/fields/bytes)? What is the format of these databases? Where are the databases physically located? (In one place, or in many different places?) If the latter, are they connected? How? Who manages the databases? (*Note*: Schedule a meeting with that person.) What kind of software is used for data entry and query? Who is authorized to modify, delete or add to the databases? Are these databases connected to a LAN? The Internet? If so, how? If not, why not? (*Note*: Try to get the individual to demonstrate the use of these databases. Note how the interfaces look; what software is used. How easy it is for the end-user (not the database manager) to extract data from the databases.) (*Note*: Get printouts of the database file structure, example data records, data dictionary or other items that give an idea of the nature and contents of the database.)	

Questions About Specific Data/Information Resources *(Cont.)*

	Date/Initials of Interviewer(s):
3.2 How are these databases/data sets catalogued?	
3.3 Is the way you catalogue these data consistent with others? Describe.	

(*Note*: If metadata are used, get a copy of the metadata definitions.)	
3.4 How do you measure and monitor the accuracy and currency of your data? How do you ensure its continued accuracy and currency? How often are the data updated?	
3.5 How much and when, and how and why, do you add to your databases?	
3.6 What other data sets – especially data from other organizations – do you use in conjunction with (e.g., integrate with, link to) the data from these databases? For what purpose? Describe.	
3.7 Please share you thoughts about the possibility of organizations sharing their data openly over the Internet.	

Annex E: Example of a Metadata Record

A simplified metadata record can provide critical information that allows a user to quickly evaluate whether or not a data resource is of interest. The following is an example of a simplified metadata record using the FGDC standard. It was developed using information taken from the Botswana NGIS Metadata Service Web site for a soil map of the Kasane area of Botswana, the metadata of which follows the FGDC standard.

Keywords

Theme: Soil map

Place: Kasane, Botswana

Temporal:

Description

Abstract

This dataset represents the KASANE sheet of the Soil Mapping and Advisory Service of Botswana.

Purpose

This dataset is intended to provide information on soil types and their distribution at a scale of 1:250 000.

What it is.

Supplementary Information

***** Spatial Reference Information (Beg) ***** Projection Parameters Spatial Information Vector: Scale of original/hardcopy map: Feature Type: Attributes: ***** Spatial Reference Information (End) *****

Links to graphics describing the data

Spatial Domain

Bounding coordinates in decimal degrees

West: 24.99997
East: 26.00065
North: -17.74917
South: -19.00166

Where it is.

Status of the data

Progress: Complete

Data update frequency: Unknown

Time period for which the data is relevant

Beginning date and time:

Ending date and time:

Description: publication date

Data storage and access information

Type of data: Map

Location of the data: \\ECPWG003\E$\gis\user\peace\geo-2\soil\250\SOIKASAF

Distribution_Information:

Distributor:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: **Ministry of Agriculture,**
Soil Mapping and Advisory Service of Botswana
Contact_Person: **Mr. B. Kopelo**
Contact_Position:
Contact_Address:
Address_Type:
Address:
City: **Gaborone**
State_or_Province:
Postal_Code:
Country: **Botswana**

How to get it.

Contact_Voice_Telephone: **(267) 3950522**
Contact_Facsimile_Telephone:
Contact_Electronic_Mail_Address: **bkopelo@gov.bw**
Hours_of_Service:

Constraint on accessing the data

Access constraints: No constraints.

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Details about this document

Contents last updated: 20041004

Standards used to create this document

Federal Geographic Data Committee FGDC-STD-001-1998.

Annex F: Sample of Keywords Available from MetaLite

The following is a sample of keywords taken from the MetaLite data dictionary, showing the depth and breadth of keywords available that are relevant to Okvangao Basin decision making. This list represents less than one third of the keywords available for use by MetaLite.

UNIQUEID	ENGLISH	SPANISH	FRENCH	PORTUGUESE
630	Other	otras	Autre	Outro
515	Wetlands	humedales	Humides terres	molhadas terras
517	Islands	islas	?les	Consoles
519	deserts	desiertos	déserts	desertos
521	Soils	suelos	Sols	Solos
522	Vegetation	vegetación	Végétation	Vegetaçio
526	Floodplain	planicie inundable, planici	Floodplain	planície da inundaçio
529	Meander	meandro	Méandre	Meander
530	Rainfall	lluvia	Précipitations	queda da chuva
531	Lowlands	tierras bajas	Terres en contre-bas	Planícies
535	Pollution	contaminación	Pollution	Poluiçio
536	Waste	basura, desperdicios	Perte	Desperdício
537	Altitude	altitud, altura	Altitude	Altura
544	National Park	parque nacional	Parc National	Parque Nacional
545	National Forest	bosque nacional	Forêt Nationale	Floresta Nacional
546	Shrub	arbusto	Arbuste	Shrub
550	Stream	corriente de agua, arroyo	Jet	Córrego
551	First Order Rivers	ríos de primer orden	Premiers Fleuves De Comm	Primeiros Rios Da Ordem
552	Second Order Rivers	ríos de segundo orden	Fleuves Du Second degré	Segundos Rios Da Ordem
553	Third Order Rivers	ríos de tercer orden	Troisième Fleuves De Com	Terceiros Rios Da Ordem
554	Limnology	limnología	Limnologie	Limnology
555	Pond	charca, estanque	Étang	Lagoa
557	Lake	lago	Lac	Lago
566	Meteorologic	meteorológico	Météorologique	Meteorológico
585	Canopy	dosel	Écran	Dossel
603	Catchment	captación	Cachment	Catchment
604	Gradient	gradiente	Gradient	Gradient
609	contour	curva de nivel	Curva de Nível	contorno
610	Sand	arena	Sable	Areia
611	Silt	limo	Vase	Silt
612	Clay	arcilla	Argile	Argila
614	Roads	carreteras	Routes	Estradas
617	Settlement	asentamiento	Règlement	Estabelecimento

UNIQUEID	ENGLISH	SPANISH	FRENCH	PORTUGUESE
618	Population	población	Population	Populaçio
632	administrative divisions	divisiones administrativas	divisions administrative	divisies administrativas
637	base map	mapa base	carte de base	mapa baixo
644	census	censo	recensement	census
647	contaminants	contaminantes	contaminants	contaminadores
649	crops	cultivo, cosecha	collectes	colheitas
651	deforestation	deforestación	déboisement	deforestation
654	digital elevation model	modelo digital de elevación	modèle digital d'altitud	modelo digital da elevaçio
656	dominant species	especies dominantes	espèce dominante	espécie dominante
658	eutrophication	eutroficación	eutrophication	eutrophication
659	exotic vegetation	vegetacion exótica	végétation exotique	vegetaçio exotic
671	indigenous vegetation	vegetación endémica	végétation indigène	vegetaçio indígena
674	irrigation	riego	irrigation	irrigaçio
676	land classes	classes de terreno	classes de terre	classes da terra
677	land cover	cobertura de suelo	couverture de terre	tampa de terra
678	land management	administración de la tierra	gestion de terre	gerência da terra
679	land productivity	productividad de la tierra	productivité de terre	produtividade da terra
680	land resources	recursos de terreno	ressources de terre	recursos de terra
681	land tenure	tenencia de la tierra	tenure de terre	tenure da terra
682	landforms	formaciones terrestres	landforms	landforms
694	nutrients	nutrientes	aliments	nutrientes
696	phosphorus	fósforo	phosphore	phosphorus
701	political divisions	divisiones políticas	divisions politiques	divisies políticas
703	reforestation	reforestación	reboisement	reforestation
705	restoration	restauración	restauration	restauraçio
719	vegetation cover	cobertura vegetal	couverture de végétation	tampa da vegetaçio
720	vegetation index	índice de vegetación	incrément de végétation	deslocamento predeterminado
721	vegetation species	especies de vegetación	espèce de végétation	espécie da vegetaçio
722	water management	manejo del agua	gestion de l'eau	gerência da água
723	wetlands	humedales	wetlands	wetlands
738	aquatic habitat	hábitat acuático	habitat aquatique	habitat aquático
739	aquifers	acuíferos	couches aquifères	aquifers
740	arid land ecosystem	ecosistema terrestre árido	écosystème aride de terr	ecosystem arid da terra
754	boundries	límites	boundries	boundries

UNIQUEID	ENGLISH	SPANISH	FRENCH	PORTUGUESE
785	erosion	erosión	érosion	erosio
799	flood control	control de inundaciones	commande d'inondation	controle da inundaçio
800	flora	flora	flore	flora
812	grassland	pradera, pampa, campo	prairie	grassland
813	groundwater	agua subterránea	eaux souterraines	groundwater
819	hydrologic processes	procesos hidrológicos	processus hydrologiques	processos hydrologic
821	irrigated agriculture	agricultura por riego	agriculture irriguée	agricultura irrigated
822	irrigation	riego	irrigation	irrigaçio
823	lakes	lagos	lacs	lagos
825	land classes	clases de terrenos	classes de terre	classes da terra
826	land cover	cobertura de suelo	couverture de terre	tampa de terra
827	land processes	procesos terrestres	processus de terre	processos da terra
828	land records	registro de la tierra	enregistrements de terre	registros de terra
829	land surface	superficie terrestre	surface de terre	superfície da terra
830	land use/land cover	uso del terreno/cobertura d	couverture de la terre u	tampa da terra use/land
831	landscape	paisaje	horizontal	paisagem
832	landscape ecology	ecología paisajista	écologie d'horizontal	ecology da paisagem
833	livestock	ganado	bétail	animais domésticos
856	protected species	especies protegidas	espèce protégée	espécie protegida
858	range	rango	intervalle	escala
863	reservoirs	depósitos	réservoirs	reservatórios
864	resources	recursos	ressources	recursos
865	rivers	ríos	fleuves	rios
866	saline lakes	lagos salados	lacs salins	lagos saline
867	savanna	sabana	la savane	savanna
868	sediment	sedimento	dépôt	sedimento
869	sedimentation	sedimentación	sédimentation	sedimentation
870	semi-arid	semiárido	semi-aride	semi-arid
871	shrubland	matorral	shrubland	shrubland
872	slash and burn	corte y quema	barre de fraction et brû	slash e queimadura
874	soil	suelo duro	sol	solo
875	soils	suelos	sols	solos
878	subsistence	subsistencia	subsistance	subsistence
892	water characteristics	características del agua	caractéristiques de l'ea	características da água
893	water forms	formas acuáticas	formes de l'eau	formulários da água
894	wetlands	humedales	wetlands	wetlands

UNIQUEID	ENGLISH	SPANISH	FRENCH	PORTUGUESE
895	winds	vientos	vents	ventos
896	yields	rendimiento	rendements	rendimentos
897	zoology	zoología	zoologie	zoology
898	Wetland	humedal	Wetland	Wetland
899	fauna	fauna	faune	fauna
900	land	tierra	terre	terra

Annex G: Step-by-Step Action Plan to Establish a Metadata Database for OKACOM

Step 1 Download and install MetaLite and download supporting materials; both are available from http://edcnts11.cr.usgs.gov/metalite/. The USAID/OKACOM Project's Information Management Specialist should practice using MetaLite for some sample metadata.

Step 2 Prepare presentation and request to OBSC to seek approval for developing metadata for OKACOM, and eventually linking it to the OKACOM Web site.

Step 3 In parallel with Step 4, the USAID/OKACOM Project Information Management Specialist should begin filling in metadata records using the priority list of data resources (water resources, water demand, and water quality) established by the OBSC and OKACOM and list of contacts developed as a result of this Consultant assignment. Some relevant metadata already exists on the Botswana and Namibia NSDIs, and can be copied, and need not be re-created.

Step 4 Hire a technical consultant to develop a Web link ("internet hub") and Web-based metadata search engine ("database link"). The **scope of work (SOW)** should include at least the following.

- Work with interim OKACOM Secretariat to select appropriate search fields..
- Review and refine functional requirements provided in this report for the Web-enabled metadata search engine ("database link"). Revise if necessary.
- Design prototype user interface, interacting with interim OKACOM Secretariat and others, as appropriate, to refine interface.
- Create a menu item for the metadata database, initially for use on the USAID/OKACOM Project Web site, later to be moved to the OKACOM Web site being developed by the Every River Has Its People project.
- Create program to render XML (or other Web-compatible) files exported from MetaLite onto the Web site. This will establish the technical link between metadata search engine ("database link") described above. Include functionality to link to actual data sets, for those available on the Internet.
- Conduct user acceptance testing prior to final deployment.
- Upload metadata from MetaLite. Deploy on the USAID/OKACOM Project Web site until such time as the OKACOM Web site is complete and ready to accept the application.

Step 5 In parallel with Steps 3 and 4, the USAID/OKACOM Project Information Management Specialist should prepare metadata guidelines and train others to create metadata.

Step 6 Develop a plan or strategy for keeping the metadata up-to-date. The best way to do this is to have the originating organizations to maintain their own metadata.

Step 7 In conjunction with Step 6, provide training to ministry staff, as needed, so that data originators may develop and maintain their own metadata. (EIS-Africa provides metadata training in the SADC region.)

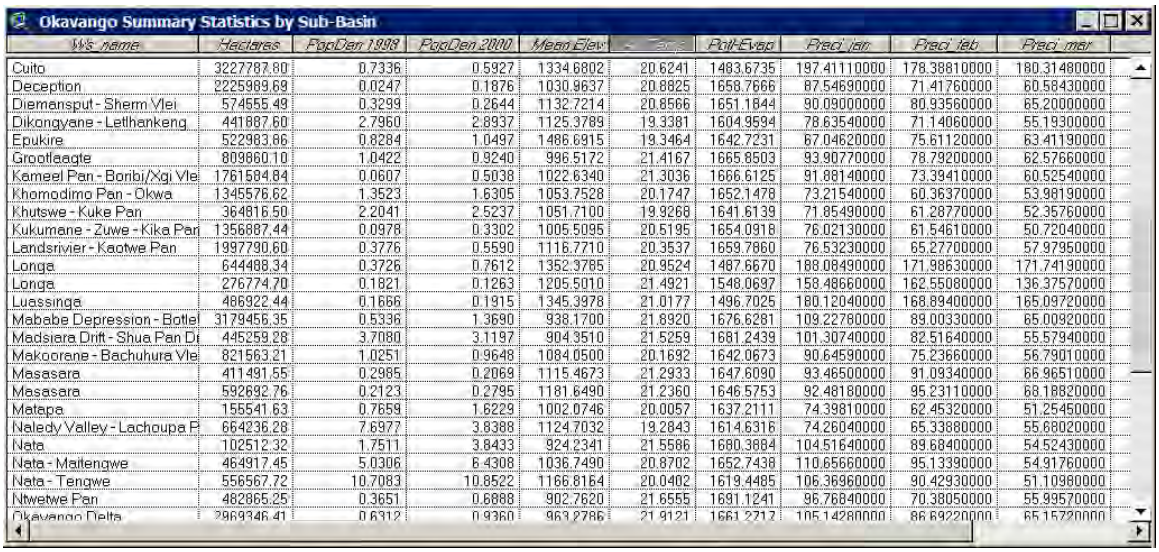
Step 8 Incorporate the metadata strategy into the OKASEC Information Management Strategy.

Annex H: Details of Participatory Basin Boundary Exercise

This annex was prepared with the kind assistance of Joe Dooley, one of the developers of the Africa Water Resource Database.

The demarcation of the Okavango River Basin will comprise both the delineation of the basin as a whole and the areal extent of the sub-basins comprising the broader basin. As it is expected that certain critical of areas of particular national interest may not easily be included in the overall basin, the specific identification of sub-basins in question point to one method for moving the definition of basin boundaries forward towards agreement. It is recommended that a participatory workshop involving OKACOM commissioners and OBSC members be organized to conduct a participatory basin boundary definition exercise.

The purpose of the workshop would be the delineation of the basin boundaries based on areas of common agreement, and the identification of those sub-basins comprising areas of particular sovereign interest. To accomplish this, the workshop should be focused around an interactive exploration using GIS tools to develop scenarios detailing the effects of including or excluding certain areas as part of the basin. The African Water Resource Database, described in Section 3.4, was identified as an available resource which can be used to conduct such a spatial exploration. The workshop should be led by a professional facilitator to coordinate the discussion, plus someone familiar enough with the software to quickly generate scenarios that result from that discussion.


Okavango Summary Statistics by Sub-Basin

Ws_name	Hectares	PopDen 1998	PopDen 2000	Mean Elev	Pot-Evap	Preci_jan	Preci_feb	Preci_mar
Cuito	3227787.80	0.7336	0.5927	1334.6802	20.6241	1483.6735	197.41110000	178.38810000	180.31480000
Deception	2225989.69	0.0247	0.1876	1030.9637	20.8825	1658.7666	87.54690000	71.41760000	60.58430000
Diemansput - Sherm Vlei	574555.49	0.3299	0.2644	1132.7214	20.8566	1651.1844	90.09000000	80.93560000	65.20000000
Dikongyane - Letlhankeng	441887.60	2.7960	2.8937	1125.3789	19.3381	1604.9594	78.63540000	71.14060000	55.19300000
Epukire	522983.86	0.8284	1.0497	1486.6915	19.3464	1642.7231	67.04620000	75.61120000	63.41190000
Grootlaagte	809860.10	1.0422	0.9240	996.5172	21.4167	1665.8503	93.90770000	78.79200000	62.57660000
Kameel Pan - Boribi/Xgi Vle	1761584.84	0.0607	0.5038	1022.6340	21.3036	1666.6125	91.88140000	73.39410000	60.52540000
Khomodimo Pan - Okwa	1345576.62	1.3523	1.6305	1053.7528	20.1747	1652.1478	73.21540000	60.36370000	53.98190000
Khutswe - Kuke Pan	364816.50	2.2041	2.5237	1051.7100	19.9268	1641.6139	71.85490000	61.28770000	52.35760000
Kukumane - Zuwe - Kika Pan	1356887.44	0.0978	0.3302	1005.5095	20.5195	1654.0918	76.02130000	61.54610000	50.72040000
Landsrivier - Kaotwe Pan	1997790.60	0.3776	0.5590	1116.7710	20.3537	1659.7860	76.53230000	65.27700000	57.97950000
Longa	644488.34	0.3726	0.7612	1352.9785	20.9524	1487.6670	188.08490000	171.98630000	171.74190000
Longa	276774.70	0.1821	0.1263	1205.5010	21.4921	1548.0697	158.48660000	162.55080000	136.37570000
Luassinga	486922.44	0.1666	0.1915	1345.3978	21.0177	1496.7025	180.12040000	168.89400000	165.09720000
Mababe Depression - Botle	3179456.35	0.5336	1.3690	938.1700	21.8920	1676.6281	109.22780000	89.00330000	65.00920000
Madsiara Drift - Shua Pan D	445259.28	3.7080	3.1197	904.3510	21.5259	1681.2439	101.30740000	82.51640000	55.57940000
Makoorane - Bachuhura Vle	821563.21	1.0251	0.9648	1084.0500	20.1692	1642.0673	90.64590000	75.23660000	56.79010000
Masasara	411491.55	0.2985	0.2069	1115.4673	21.2933	1647.6090	93.46500000	91.09340000	66.96510000
Masasara	592692.76	0.2123	0.2795	1181.6490	21.2360	1646.5753	92.48180000	95.23110000	68.18820000
Matapa	155541.63	0.7659	1.6229	1002.0746	20.0057	1637.2111	74.39810000	62.45320000	51.25450000
Naledy Valley - Lachoupa P	664236.28	7.6977	3.8388	1124.7032	19.2843	1614.6316	74.26040000	65.33880000	55.68020000
Nata	102512.32	1.7511	3.8433	924.2341	21.5586	1680.3884	104.51640000	89.68400000	54.52430000
Nata - Maitengwe	464917.45	5.0306	6.4308	1036.7490	20.8702	1652.7438	110.65660000	95.13390000	54.91760000
Nata - Tengwe	556567.72	10.7083	10.8522	1166.8164	20.0402	1619.4485	106.36960000	90.42930000	51.10980000
Ntwetwe Pan	482865.25	0.3651	0.6888	902.7620	21.6555	1691.1241	96.76840000	70.38050000	55.99570000
Okavango Delta	2969346.41	0.6312	0.9360	963.2786	21.9121	1661.2712	105.14280000	86.69220000	65.15720000

Figure H.1: Example of summary sub-basin statistics for the Okavango basin available via the African Water Resource Database

A secondary output of the workshop might be an appraisal by participants of the African Water Resource Database's suitability as a cost-effective solution for meeting both central and individual national information management requirements specific to OKACOM (as described in Section 4.5).

The African Water Resource Database is recommended for the workshop and evaluation, due primarily to its depth of spatial and ancillary data, e.g. human population statistics, as well as its extensive set of GIS and statistical analysis tools programmed into the interface. The analysis tools associated with the African Water Resource Database are suitable for both non-technical managers and dedicated GIS technicians.

The following figures represent some of the outputs available via the African Water Resource Database based on simple mouse clicks to the screen from within the interface of the tool-set.

Figure H.2: Example of summary statistics for total ORB available via the African Water Resource Database

Total Area Selected: Okavango Megabasin, 685065.55 square kilometers
Summary Statistics:
ANNUAL POT. EVAPOTRANSPIRATION DATA (\dbf_data\alcomwwf_peva_ann.dbf)
Average Annual Pot. Evap.: 1621.895 mm
Maximum Annual Pot. Evap.: 1699.000 mm
Minimum Annual Pot. Evap.: 1368.000 mm
Annual Pot. Evap. Range: 331.000 mm
Annual Pot. Evap. Standard Deviation: 67.2360 mm
ANNUAL PRECIPITATION DATA (\dbf_data\alcomwwf_prec_ann.dbf)
Average Annual Precipitation: 500.848 mm
Maximum Annual Precipitation: 1348.000 mm
Minimum Annual Precipitation: 303.000 mm
Annual Precipitation Range: 1045.000 mm
Annual Precipitation Standard Deviation: 202.6424 mm
ELEVATION DATA (GT30BATH) (\dbf_data\alcomwwf_elev.dbf)
Mean: 1153.63 meters
Maximum Elevation: 2310 meters
Minimum Elevation: 883 meters
Elevation Range: 1427 meters
Elevation Standard Deviation: 185.872 meters
MEAN ANNUAL AIR TEMPERATURE (\dbf_data\alcomwwf_airt.dbf)
Average Mean Annual Air Temperature: 20.908° C
Maximum Mean Annual Air Temperature: 22.375° C
Minimum Mean Annual Air Temperature: 15.917° C
Mean Annual Air Temperature Range: 6.458° C
Mean Annual Air Temperature Standard Deviation: 0.8792° C
MONTHLY POT. EVAPOTRANSPIRATION DATA (\dbf_data\alcomwwf_peva.dbf)
Annual Mean: 1621.865 mm
January Mean: 162.311 mm
February Mean: 137.330 mm
March Mean: 138.948 mm
April Mean: 118.802 mm
May Mean: 105.439 mm
June Mean: 87.423 mm
July Mean: 93.587 mm
August Mean: 116.433 mm
September Mean: 147.826 mm
October Mean: 173.054 mm
November Mean: 169.168 mm
December Mean: 171.544 mm
MONTHLY PRECIPITATION DATA (\dbf_data\alcomwwf_prec.dbf)
Annual Mean: 500.954 mm
January Mean: 109.457 mm
February Mean: 102.110 mm
March Mean: 85.366 mm
April Mean: 37.123 mm

May Mean: 5.250 mm
June Mean: 0.734 mm
July Mean: 0.123 mm
August Mean: 0.181 mm
September Mean: 4.051 mm
October Mean: 20.535 mm
November Mean: 54.289 mm
December Mean: 81.736 mm

POPULATION DENSITY 1998 (\dbf_data\alcomwwf_pop98.dbf)
1998 Pop. Density Mean: 1.630 people / sq. km.
1998 Pop. Density Maximum: 3455.000 people / sq. km.
1998 Pop. Density Minimum: 0.000 people / sq. km.
1998 Pop. Density Range: 3455.000 people / sq. km.
1998 Pop. Density Standard Deviation: 10.6582 people / sq. km.

POPULATION DENSITY 2000 (\dbf_data\alcomwwf_pop2k.dbf)
2000 Pop. Density Mean: 1.623 people / sq. km.
2000 Pop. Density Maximum: 1303.000 people / sq. km.
2000 Pop. Density Minimum: 0.000 people / sq. km.
2000 Pop. Density Range: 1303.000 people / sq. km.
2000 Pop. Density Standard Deviation: 5.5632 people / sq. km.

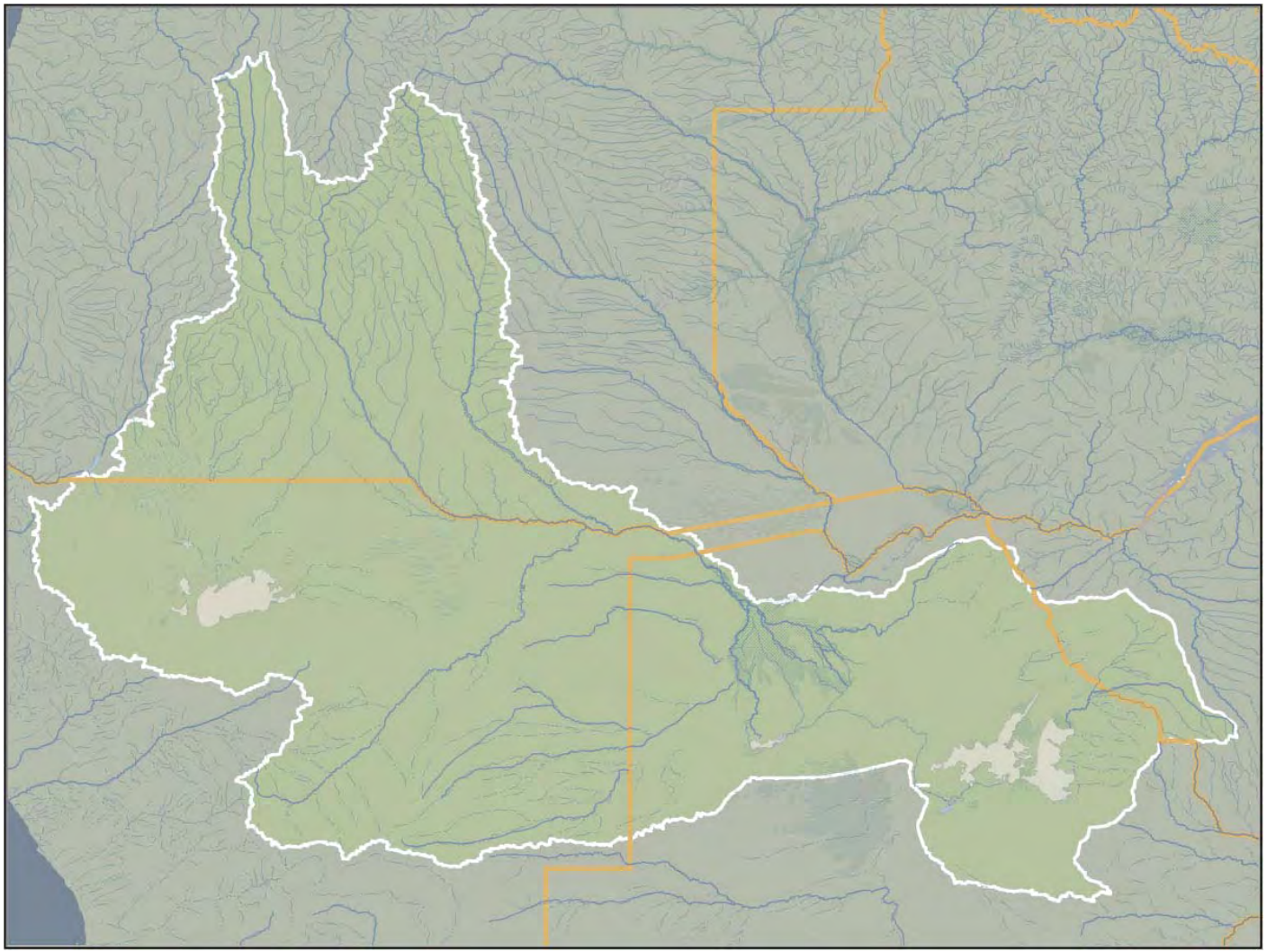


Figure H.3: Base hydrology for ORB, delineated by World Resources Institute Watersheds of the World

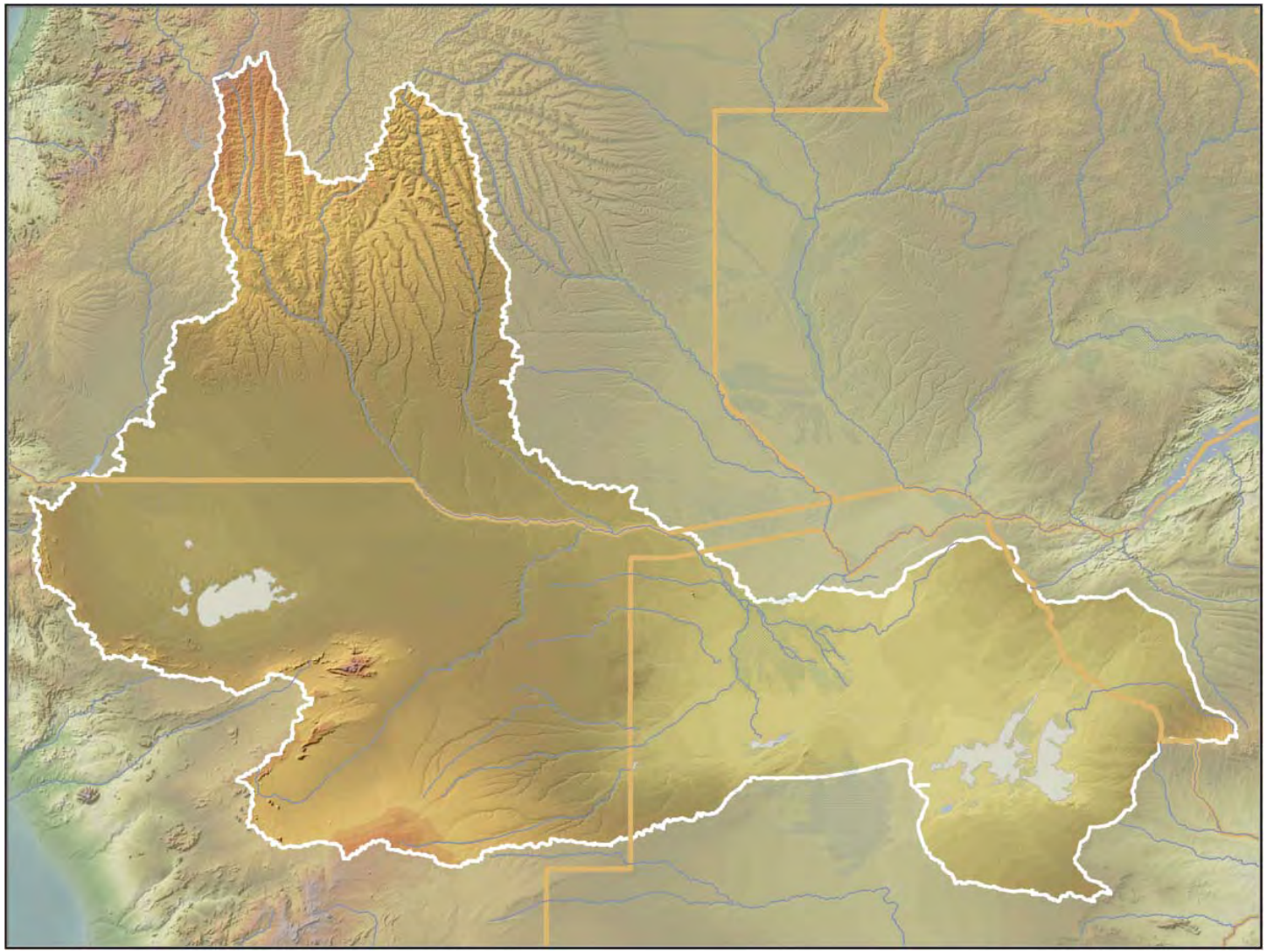


Figure H.4: Topography and rivers for ORB, delineated by World Resources Institute Watersheds of the World

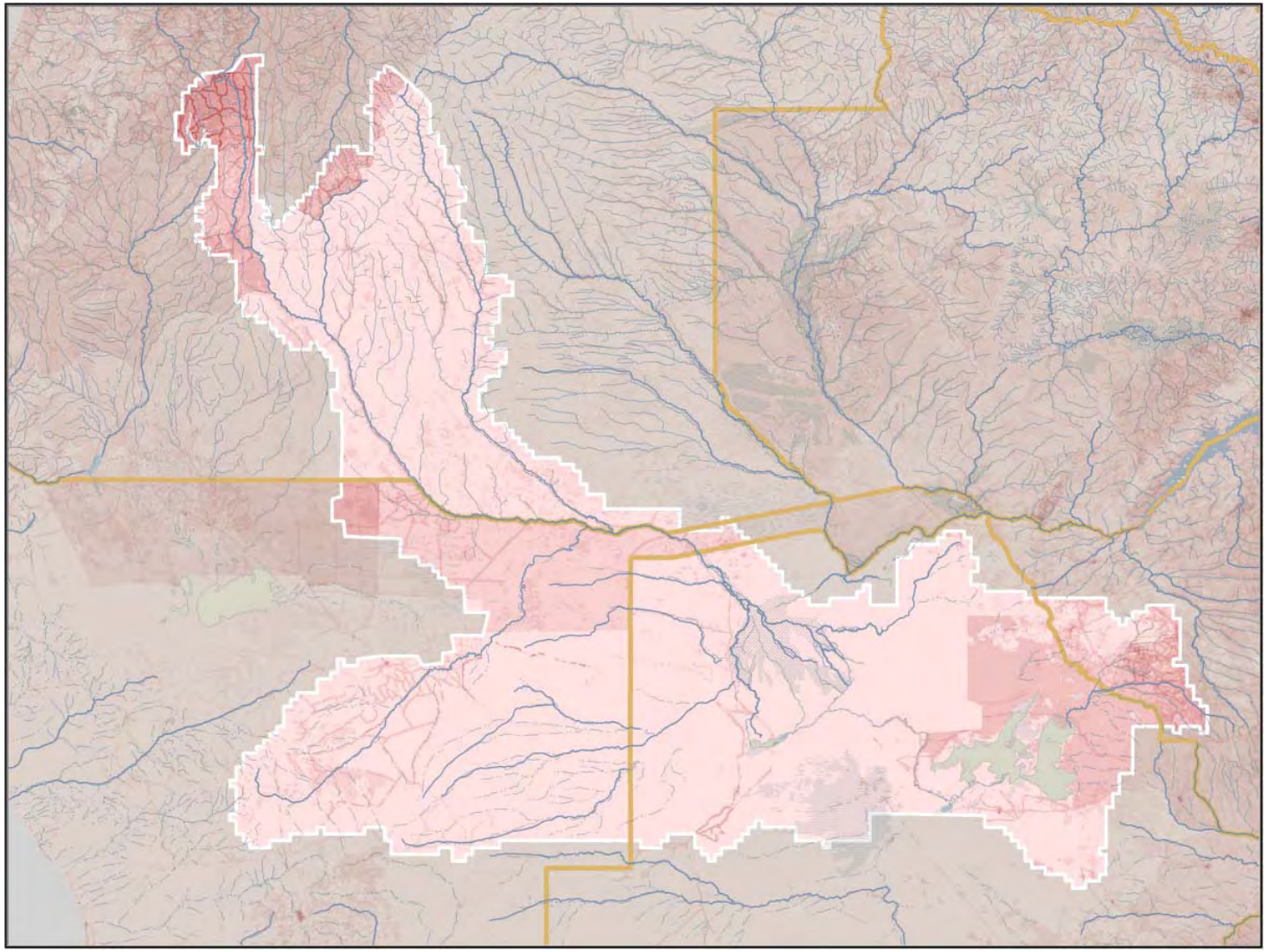


Figure H.5: Population density of ORB, delineated by UNEP/GEF Global International Waters Assessment watersheds

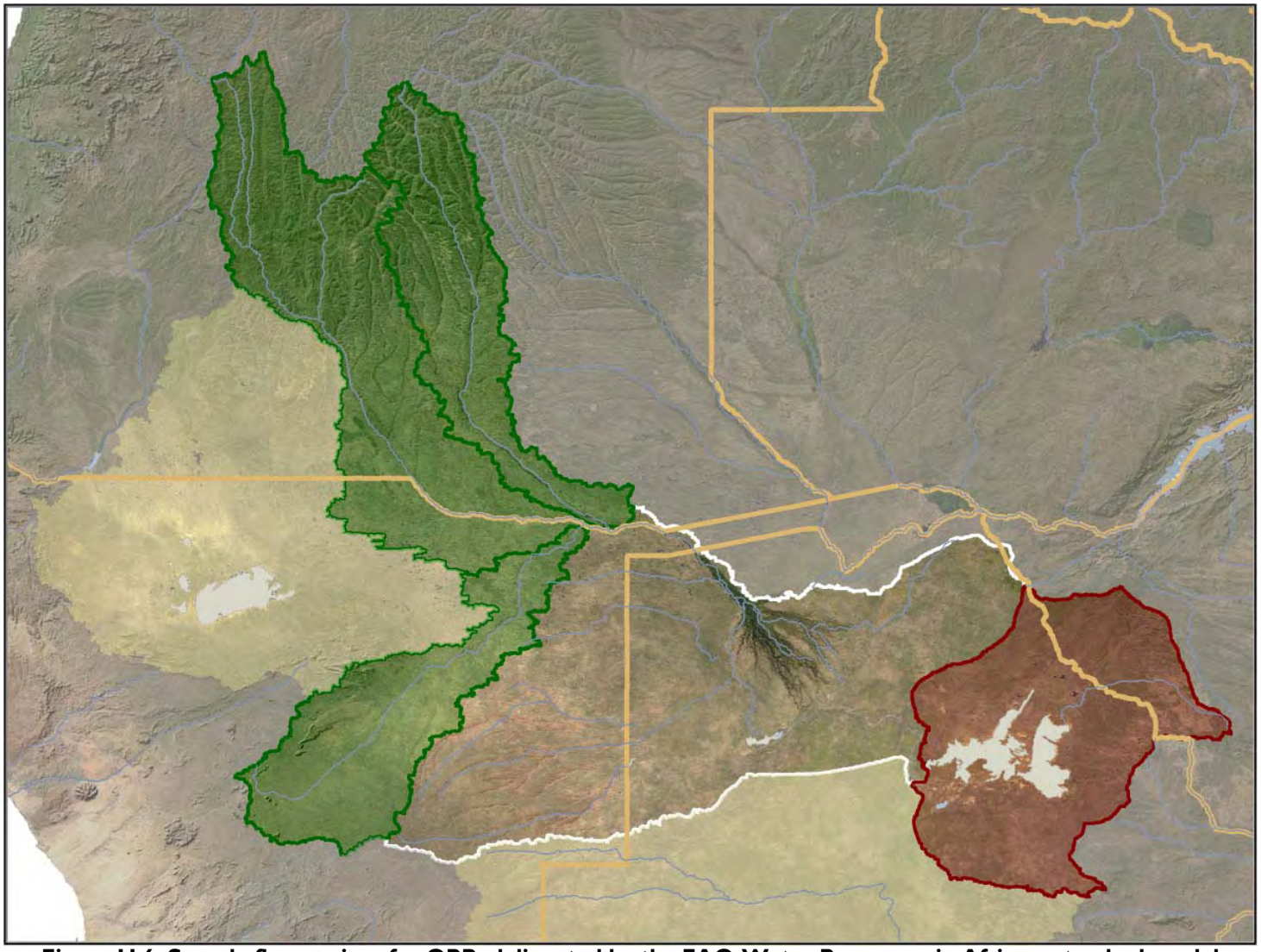


Figure H.6: Sample flow regime for ORB, delineated by the FAO-Water Resources in Africa watershed model

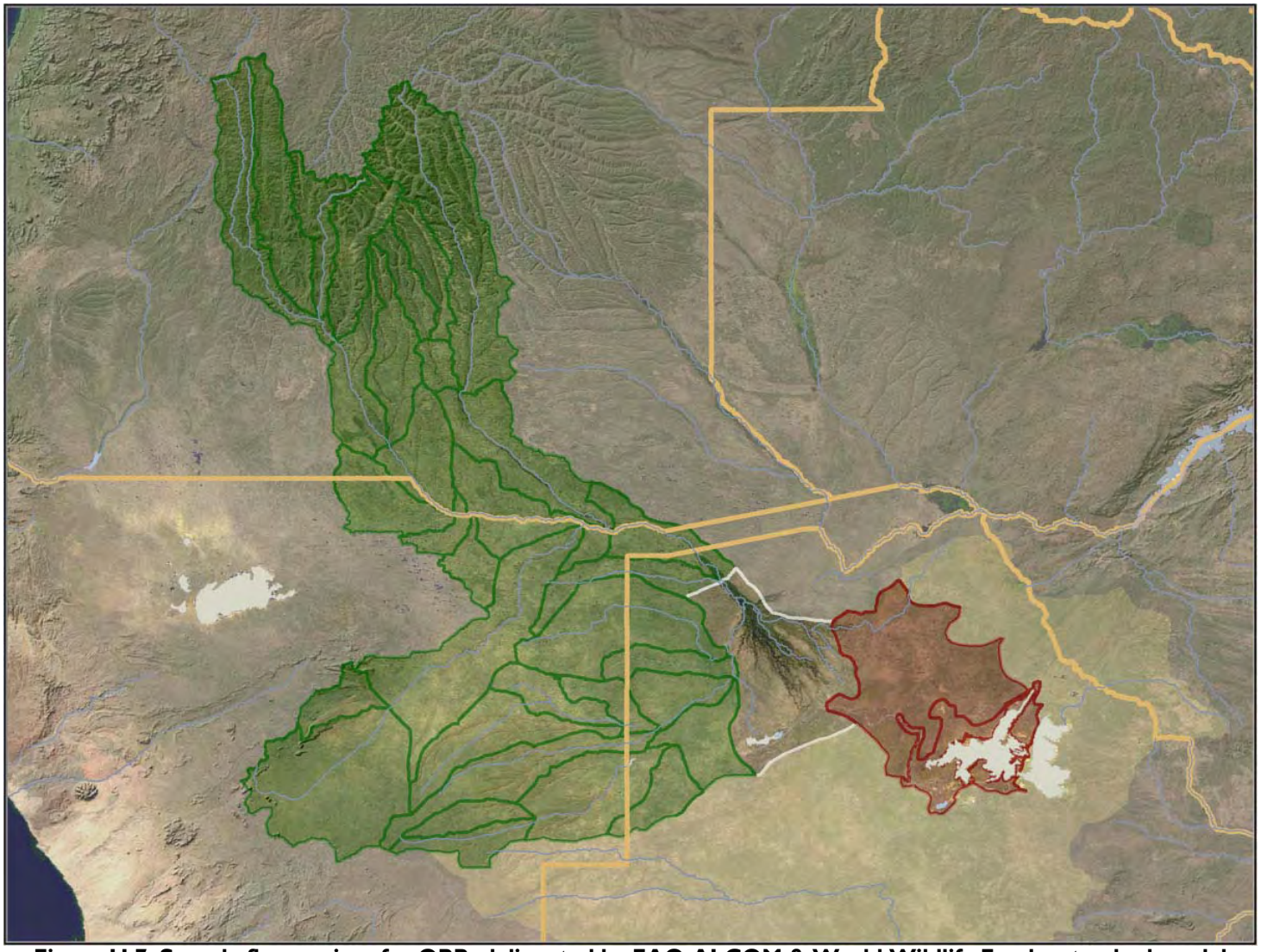


Figure H.7: Sample flow regime for ORB, delineated by FAO-ALCOM & World Wildlife Fund watershed model

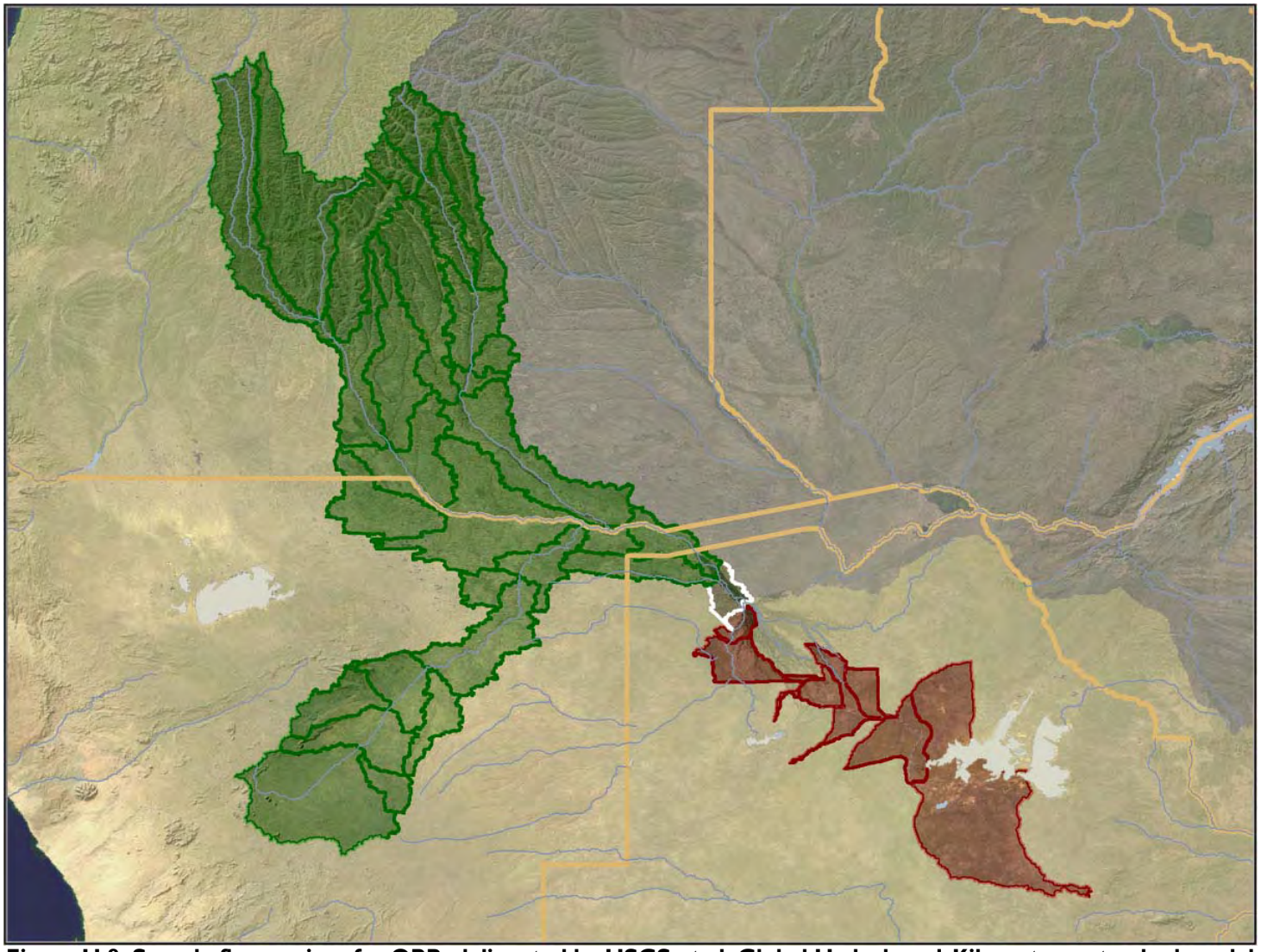


Figure H.8: Sample flow regime for ORB, delineated by USGS-et.al. Global Hydrology 1 Kilometer watershed model