DEVELOPMENT OF AN INTEGRATED WATER RESOURCES MANAGEMENT PLAN FOR NAMIBIA

Theme Report 4

THE FORMULATION OF INFORMATION AND KNOWLEDGE SYSTEMS

AUGUST 2010

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INTEGRATED WATER RESOURCES MANAGEMENT PLAN FOR NAMIBIA

Funded by:

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EXECUTIVE SUMMARY

This report presents an assessment of the status of baseline data, information and knowledge systems, as well as the status of monitoring and evaluation activities in the water sector. The report presents what data are currently collected, who collects data, and how data, information and knowledge are stored, used and made available to other institutions and the public. Gaps in data, information and knowledge managements have been identified and a strategy for how to strengthen the information and knowledge management in the water sector is presented.

The report has been informed by representatives from several key stakeholders, i.e. the Ministry of Agriculture, Water and Forestry (Directorate of Rural Water Supply and Directorate of Resource Management with its Divisions of Hydrology, Geohydrology and Water Environment), Regional Councils, Local Authorities, NamWater, the mining industry, and Basin Management Committees (Kuiseb, Okavango, Omaruru, Ishana sub-basin, and the Orange-Fish Basin stakeholder forum).

Findings show several key issues that negatively affect data and information management in the water sector, e.g. equipment used for data collection (e.g. loggers) are prone to failure; limited staff capacity to gather, analyse and manage data; not all required data being collected; poor reporting on abstraction by permit holders to DWAF; no clear standard on how to store data; and o standards for data exchange between databases.

The resulting strategy and action plan presented in this report addresses these and other gaps related to management of information and knowledge in the water sector. The strategy was presented and discussed with key stakeholders in the water sector before being finalised.

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LIST OF ABBREVIATIONS

ArcGIS	GIS software
CETN	Coastal Environmental Trust of Namibia
DEES	Directorate of Engineering and Extension Services
DOS	Disk Operating System
DRFN	Desert Research Foundation of Namibia
DRWS	Directorate of Rural Water Supply
DWAF	Department of Water Affairs and Forestry
DWSSC	Directorate of Water Supply and Sanitation Co-ordination
GIS	Geographical Information System
GROWAS	Groundwater Information System
HYDSTRA	Hydrological Database of Namibia
IPJVN	IWRM Plan Joint Venture Namibia
IWRM	Integrated Water Resources Management
KBMC	Kuiseb Basin Management Committee
MAWF	Ministry of Agriculture, Water and Forestry
MET	Ministry of Environment and Tourism
MS	Microsoft
NAWIC	Namibia Agriculture Water Information Centre
NCR	A ‘database’ based on Excel spreadsheets referred to as the NCR database o at DWAF
NGO	Non-Governmental Organisation
NMS	Namibia Meteorological Services
OmBMC	Omaruru Basin Management Committee
RUWIS	Rural Water Supply Database
SAP	System Applications and Products (business software)
SQL	Structured Query Language
WSASP	Water Supply and Sanitation Sector Policy

FORMULATION OF INFORMATION AND KNOWLEDGE SYSTEMS

1. INTRODUCTION

To strengthen existing, or establish new data, information and knowledge systems for the water sector is central to the implementation of the Integrated Water Resources Management Plan for Namibia. An assessment of the status of baseline data, information and knowledge systems, as well as the status of monitoring and evaluation activities was conducted as part of the report by IWRM Plan Joint Venture Namibia (2010b) produced as part of the IWRM Plan for Namibia. That report provides an extensive account of:

- what data is collected
- by whom it is collected, and
- how it is stored, used and made available to other institutions and the public.

Here the key findings of that assessment are presented, focused on the identification of gaps in data, information and knowledge generated and/or used in the water sector. The gap analysis has also been informed by inputs from representatives of several key stakeholders, i.e. the Ministry of Agriculture, Water and Forestry (Directorate of Rural Water Supply and Directorate of Resource Management with its Divisions of Hydrology, Geohydrology and Water Environment), Regional Councils, Local Authorities, NamWater, the mining industry, and Basin Management Committees (Kuiseb, Okavango, Omaruru, Iishana sub-basin and the Orange-Fish Basin stakeholder forum).

The findings presented in this report form the basis of the draft strategy and action plan for data, information and knowledge management in the water sector, presented in section 4 of this report. The draft strategy and action plan was presented and discussed with key stakeholders in the water sector, before being finalised.

1.1 DEFINING DATA, INFORMATION AND KNOWLEDGE

The terms "data" and "information" are well defined. Data are the results of measurements and can be the basis for graphs, images, or observations of a set of variables. Data are often viewed as the lowest level of abstraction from which information and knowledge are derived (http://en.wikipedia.org/wiki/Data). In terms of data, information can be defined as a collection of facts from which conclusions may be drawn. Information is the result of processing, manipulating and organising data (http://en.wikipedia.org/wiki/Information). Both data and information can be captured and stored in a database. However, the definition of knowledge is more complex. According to the Oxford English Dictionary, knowledge is defined as:

- expertise, and skills acquired by a person through experience or education; the theoretical or practical understanding of a subject,
- what is known in a particular field or in total; facts and information, or

- awareness or familiarity gained by experience of a fact or situation.

Wikipedia (http://en.wikipedia.org/wiki/Knowledge) states that there is no single agreed definition of knowledge. There are two important kinds of knowledge, i.e. explicit and tacit knowledge. Explicit knowledge can be articulated, codified and stored in e.g. books and databases. This knowledge can be communicated and transferred. Tacit knowledge is defined as knowledge that is difficult to transfer to others in written or spoken form. Tacit knowledge is often in the form of habits and culture of which we are not fully aware. Often this knowledge is referred to as knowledge that is only known by an individual and that is difficult to communicate to the rest of an organisation. Both these forms of knowledge are important for the water sector and methods and procedures should be developed to capture both explicit and tacit knowledge generated in the sector. The capturing and storing of knowledge, especially tacit knowledge, is complex.

The focus of this report is on identifying gaps in data and information collected, generated and used in the water sector in Namibia. Information systems are well suited to store explicit knowledge, e.g. in form of procedures and reports, while capturing and storing of tacit knowledge is more difficult. The strategy and action plan presented in section 4 of this report focuses on establishing systems for capturing, storing, analysing and sharing data, information and knowledge.

1.2 KEY STAKEHOLDERS IN THE WATER SECTOR

According to IWRM Plan Joint Venture Namibia (2010b) the following key stakeholders generate data, information and knowledge in the water sector: Directorates and Divisions of the Department of Water Affairs and Forestry; Namibia Meteorological Services; local authorities; Regional Councils; NamWater; and the Mining, Tourism and Irrigation sectors. In this report Basin Management Committees are also included, as they most likely will play a role in the collection and reporting on data and information when established and operational. The private sector, e.g. NGOs and consulting firms also contribute to the generation of data, information and knowledge relevant to the water sector (**Figure 1.1**). Note that Directorate of Rural Water Supply now is referred to as Directorate of Water Supply and Sanitation Coordination (Section 2.1.2).

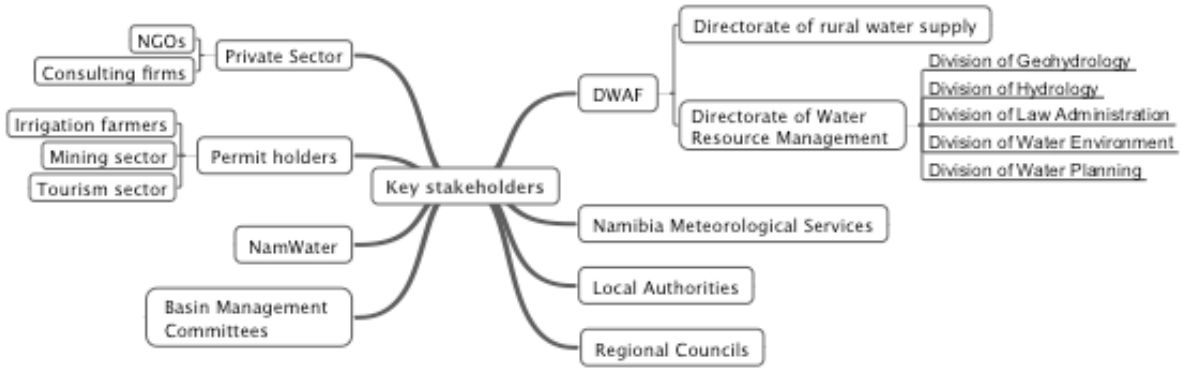

Figure 1.1: Key stakeholders in the water sector.

2. DATA, INFORMATION AND KNOWLEDGE GENERATE BY KEY STAKEHOLDERS

Below follows a presentation of what data, information and knowledge are generated by key stakeholders in the water sector and gaps perceived by these stakeholders. Information is commonly presented in reports and other written documents. All of the stakeholders illustrated in **Figure 1.1** generate and store data and information of relevance to the water sector. However, the organisation and availability of the information differs among them.

The findings presented here are based on consultations with key stakeholders, including interviews with individual representatives from key institutions, Focus Group Discussions and stakeholder workshops conducted with representatives from the Namibian water sector (including sanitation) as part of the development of the IWRM Plan for Namibia.

2.1 DWAF

The Registry, the centre where all files of the Department of Water Affairs and Forestry are stored is central to the data and information management for the Department and all its underlying Directorates, Divisions and Sub-divisions. The Registry falls under the Directorate of General Services of the Ministry of Agriculture, Water and Forestry, who administrates two separate filing systems, one for agriculture and one for water. Documents generated by the different Directorates, Divisions and Sub-Divisions are filed in the Registry. Example of data and information stored in these files are: technical assessments done in preparation of water permits, actual permits granted to water consumers, monitoring results, decisions made based on results, correspondence to clients etc. There is a code system in place that separates the different Directorates, Division and Sub-divisions, and the geographic location of the permit holder, allowing users to retrieve the required information. Files are requested from the Registry, new information added, and then returned to the Registry. Based on discussions with the personnel in charge of the Water Registry, it is clear that there is no backup system in place, which makes it very vulnerable. However, there are plans to digitize the

information (scanning) and enter it into an information management system. This would provide increased security and improved access to the data and information currently held in the Water Registry.

The Namibia Agriculture Water Information Centre (NAWIC) has plenty of information related to the water sector. The library maintains a searchable catalogue of its assets and is open to the public. Loans from the library can be arranged based on agreement between the library and an institution. However, there are no clear procedures in place to ensure that information is centrally stored in the library. According to representatives of the NAWIC there is a library committee in place with representatives from the different Departments and their Divisions. The purpose of this committee is to ensure that information is provided to NAWIC, and to inform the information centre about information needs within the different Departments. This guides the acquisition of new books and other materials to NAWIC. Even though this committee is in place, commonly specialist literature and reports and other important information tend to end up in individual offices or in departmental information centres. For instance, the Division of Geohydrology and the Water Planning Division has a room where they store reports and other key sources of information. In other divisions there is no central place for storage and access to information. For instance, Division of Hydrology does not have any structured information centre but rather relies on private collections of information, stored in individual offices. When discussing this with representatives from the Division of Hydrology it was stated that a central information system would benefit the staff of the Division, improving their access to information.

During discussions with representatives from the Divisions of Hydrology and Geohydrology it became apparent that there are many external users of data produced by these divisions, ranging from Namibian and foreign scholars to NGOs and consulting firms. However, even though it is commonly requested, just a fraction of all the studies and reports compiled by these ‘outsiders’ are shared with the Divisions. This is considered to be a great loss of information that most likely would be of great value to the individual divisions and NAWIC.

Directorate of Rural Water Supply does not have a central information centre, but relies on the NAWIC and individual staff members to store reports and other information in their offices.

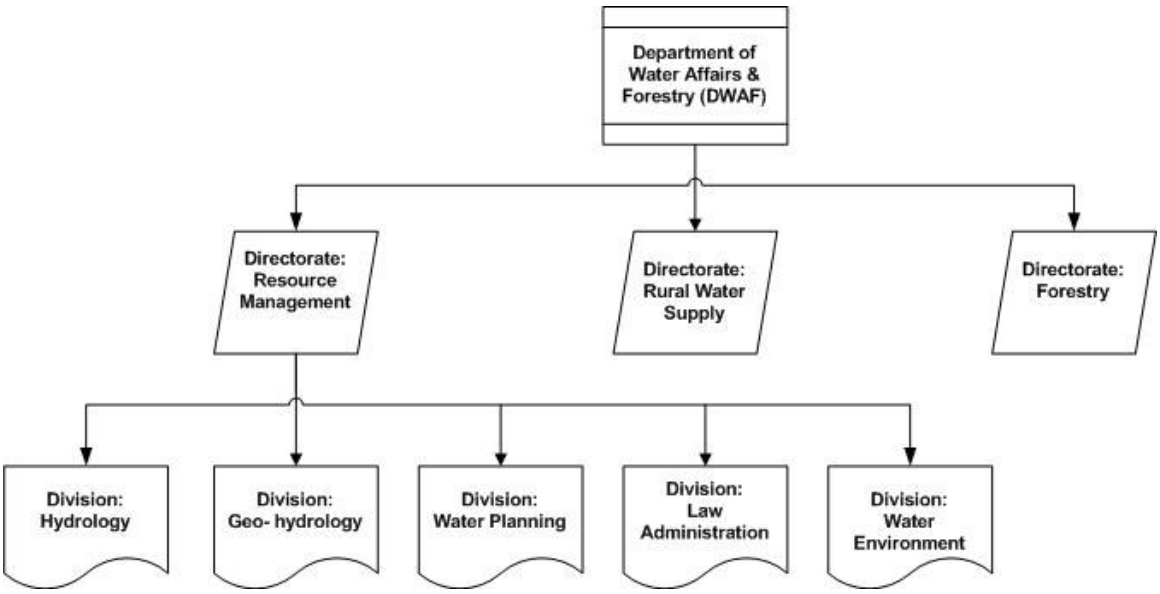

Figure 2.1: Organogram of the Department of Water Affairs and Forestry.

2.1.1 Directorate of Resource Management

There are five Divisions under this Directorate; the Divisions of Geohydrology, Hydrology, and Water Environment, Water Planning (**Figure 2.1**). The data and information generated and stored by these Divisions are presented below.

2.1.1.1 Division of Geohydrology

This division is responsible for groundwater monitoring across the country and has a dedicated monitoring team that collects data at different frequencies. The intensity of monitoring depends on the significance and importance of aquifers, resulting in most frequent monitoring being done in the major aquifers, with a rather low frequency across the reminder of the country (IWRM Plan Joint Venture Namibia, 2010a).

The data stored by the Division of Geohydrology is collected by the staff of the division and by clients, i.e. permit holders that are required to report their water abstraction to the DWAF. The monitoring conducted by the Geohydrology Division is mainly focused on water control areas, e.g. 51% of all boreholes being monitored are located in the Karst aquifers. Key variables being monitored are: water levels, abstraction volumes and water level response to abstraction. The Division keeps records of allocated and abstracted water volumes for each issued groundwater abstraction permit. However, there may be a difference between the allocated abstraction volumes and the actual abstracted figures, the latter the permit holders are required to report to DWAF every quarter as part of the permit condictions.

The Division of Geohydrology experience some problems related to collection of groundwater data. Firstly, the loggers used are prone to failure, commonly leading to loss of data. Manual water level readings are recorded and digitised by entering the data into an Excel spreadsheet, while analogue charts are not digitized any longer. According to representatives from the division it is difficult to keep qualified staff, which results in

limited ability to follow up on granted permits, and backlog in data entry and analysis. The lack of data from boreholes drilled on private land was also said to be a problem.

According to IWRM Plan Joint Venture Namibia (2010b) collected data are used for aquifer management, for example the aquifers operated by NamWater. Data are also collected from aquifers that currently are not managed or used, contributing to a long-term record of observations. Much of these data are stored for future use, e.g. when the need for abstraction from these water sources occurs, for research purposes and to advice future developments opportunities. Data are provided on request to stakeholders both within and outside of the Ministry. According to representatives from the Division, their data are requested by Directorate of Rural Water Supply, local authorities, and the general public. The data are mainly used to summarize, analyze and evaluate groundwater resources, as technical support for management and optimal utilisation of groundwater resources in Namibia. The outputs commonly end up in reports, either compiled by the staff of the Division of Geohydrology or by consultants making use of the data.

The GROWAS database for groundwater related data is central to data management within the Division. The database consists of a number of modules for different datasets, e.g. a water quality module, a groundwater module and an infrastructure module. The groundwater module contains geophysical data regarding borehole site selection, results from drilling and test pumping as well as borehole data relating to water levels, depths, water strikes and abstraction rates and other related variables. Reports related to specific boreholes are also stored in the database. The GROWAS database is operated by a Microsoft SQL server. Currently the Division is developing a new interface to link the information in GROWAS to ArcGIS, a geographic information system.

The Division of Geohydrology has recently initiated a programme for isotope analyses. However, there is currently no programme for standard chemical analyses in place. Water quality is only sampled in newly drilled boreholes, but no continuous monitoring of water quality is done. The lack of time series data is a major concern. However, to rectify this, the Division has started to monitor groundwater quality more regularly at strategic sites throughout the country to improve the understanding of water quality issues.

There are no readily available data to estimate natural recharge in Namibia. To improve this sufficient and relevant historical data on actual rainfall figures, rainfall intensity and rainfall duration are needed. On the other hand, sufficient data on volumes of water infiltrated artificially or pumped into aquifers exist respectively for artificial recharge or water banking, where that takes place.

2.1.1.2 Division of Hydrology

The Division of Hydrology is responsible for surface water monitoring across the country, with an emphasis on monitoring flows in ephemeral and perennial rivers in the country.

The Division collects rainfall data at 21 autographic rainfall stations. Historical data exist from another 30 stations that have been closed. Data quality is hampered by the fact that the autographic loggers often fail resulting in loss of data. However, processing of the

collected data is relatively up to date for a majority of the 21 stations, but a backlog exists for some of the stations. The stations are providing information required to determine rainfall intensity, however, a majority of the rainfall intensity data have only been collected but not analysed due to a shortage of staff. The rainfall data collected by the Division are shared with Namibia Meteorological Service, other institutions and the general public on request.

When it comes to surface water, the Division of Hydrology collects the majority of river flow data in Namibia. The Division operates approximately 150 gauging stations throughout the country in both ephemeral and perennial rivers. Data are recorded automatically at these stations, and collected at regular intervals and converted into flow charts. Data loss or data of poor quality is common when monitoring water flow in ephemeral river systems due to the highly unpredictable water flow. Another complication influencing quality of the data collected are the difficulties associated with calculating the volume of water passing a monitoring station based on the measured water levels. A majority of the data collection is done by a small group of under-qualified technical assistants and this situation has a negative effect on the quality of the data collected and the management of data. Furthermore, the collection of relevant data is given a relatively low priority in the Ministry.

The collected data are stored in a local Oracle database referred to as the Hydrological Database of Namibia (HYDSTRA). The database contains mainly water levels and flows for rivers collected at flow station and dams in the interior and at the borders of Namibia. In addition some rainfall and evaporation data are included. There is currently a backlog of data entered into the database of about three years. The HYDSTRA database is not connected to any other databases in DWAF or elsewhere. However, data is provided on request to stakeholders both within and outside of the Ministry. The data are mainly used to summarize, analyze and evaluate surface water resources, as technical support for management and optimal utilisation of rivers in Namibia. The outputs commonly ends up in reports, either compiled by the staff of the Division of Hydrology or by consultants, researchers and students making use of the data.

2.1.1.3 Division of Water Environment

The Division is responsible for pollution control and water quality monitoring as well as water efficiency and ecological research and investigation. It has three sub-divisions: Water Ecology, Water Quality and Water Technology.

The sub-division Water Ecology carries out water and wetland research and investigations including control monitoring of aquatic invasive plants, Water Demand Management and general wetland investigations. Most data collected and analysed concerns the ecology of Namibia's wetlands. Data are stored in an Access database that incorporates different datasets obtained from different Ministries. This database contains records on aquatic birds, frogs and small mammals as well as reptiles (the Ministry of Environment and Tourism), aquatic invertebrates (National Museum), water quality of springs (Division of Geohydrology), aquatic plants (Herbarium) and its own wetland biodiversity records. The Ecology Unit experiences difficulties in getting access to

new/updated data stored by the other institutions. The data are stored on a desktop computer using MS Access. This is not an optimal database environment, especially as it is run from a personal computer, making the system vulnerable to virus attacks and possible data loss. The information generated by the Ecology Unit is used within DWAF for water conservation/efficient use and wetland management, development of policies and strategies, and by consultants. The results are also used for general awareness rising of the public, presented in brochures and posters.

The mandate of the sub-division Water Quality is to monitor the quality of wastewater, regulate location of wastewater treatment plants, septic tanks and solid waste sites in order to protect water resources from pollution and that final effluent produced from wastewater treatment facilities is within water quality standards and guidelines and not posing any environmental threats. Data are collected during spot checks and routine monitoring. These data together with trip reports and technical assessments form the technical basis for water pollution permits and assessments of clients' compliance to these permits. The sub-division works closely with the Division of Law Administration, who is in charge of issuing water and wastewater permits. All the data and information related to permits are stored in the Water Registry, referred to above. Insufficient staff is a major constraint to the data collection. One staff member can be in charge of several regions, not allowing frequent interactions with clients, nor efficient data collection.

The mandate of the sub-division Water Technology is to investigate emerging water (potable and wastewater) treatment and harvesting technologies, collect data on drinking water quality and develop quality standards and guidelines. The data and information generated are similar to what is collected by the Sub-division Water Quality but with an emphasis on monitoring of quality of potable water. The information generated forms the technical basis for water permits and assessments of clients' compliance to these permits. The sub-division works closely with the Division of Law Administration, who is in charge of issuing water permits (after consulting with the technical divisions). All the data and information related to permits are stored in the Water Registry, referred to above.

The main constraint to monitoring of water quality is insufficient staff. Currently one staff member commonly is in charge of several regions, which does not allow for frequent monitoring of sites or interactions with clients. In average a site is visited ones per year by a representative from the sub-division. To be able to increase the frequency of monitoring in the regions, the division is currently in the process of recruiting new staff.

Currently there is no central database where data and information is stored for the Division of Water Environment. However, all permit related information is stored in the Water Registry, including monitoring results, analyses, findings, environmental reports, recommendations, remedial actions and correspondence to clients. To improve the access to data and information the Division has initiated the establishment of a central database that would store all the data and information collected and generated by the three sub-divisions. The system is referred to as the Water Quality Information System (WAQIS). The database is envisaged to consist of different modules responding to the different types of data and information generated and used within the Divisions of Water Environment and Law Administration. The database will be hosted by the Sub-division

Water Quality. The ultimate goal is, when this database is fully operational, to integrate selected parts of the database to a Ministerial Share-Point Portal, to further improve access to data and information and enable Ministry wide sharing, and to a certain extent, public access to information.

2.1.1.4 Division Law Administration

The mandate of the Division Law Administration is to issue both abstraction and wastewater disposal permits based on recommendations from the relevant divisions. Abstraction permits have to be approval by the Permanent Secretary, while the Division of Law Administration normally approves wastewater disposal permits based on recommendations from relevant divisions. The Division also manages leasing of GRN boreholes, applications to build dams in rivers and sand mining. The Division receives all client applications and other related documents which then are registered into the Water Registry. Information is also copied and forwarded to the relevant Division and/or Sub-Division. These Divisions provide technical information that forms the basis for the issuing of permits. The flow of information between the Division Law Administration and the other Divisions goes via the Water Registry, which is a central hub of data and information exchange in DWAF.

2.1.1.5 Division Water Planning

The mandate of the Division of Water Planning is to collect data and information about water usage within different economic sectors. The collected data and information from return permits, e.g. crop type, amount of water used by the crop and area under irrigation form the basis for the National Water Accounts. The Division has three sub-divisions: International Water, National Planning and Technical Support.

Currently the Division has data for the period 1998 – 2002 on water accounts, documents on water sources and various institutions involved in e.g. distribution and supply of water and consumer's water. The division of Water Planning keeps all the information including reports in computers. The hard copies of the information are kept in the storeroom of Water Planning Division. In addition to the storeroom, the Planning division stores information (hardcopies) in the registry and the library of the Ministry, which then serves as a backup. The registry also keep general correspondence, Memorandum of Understandings (MoUs) between organisations, reports and correspondence related to MoUs, related to the Water Planning Division.

Reports and relevant information for divisional use is also available from the divisional folder on the server. Some of the reports are sent to Southern African Development Community (SADC) secretariat, Water Division in Botswana.

The Water Planning intends to establish a database that can be integrated with other Divisions and Directorates in the Ministry. Currently, information is stored in Excel, Word and partially in Access file formats, which are considered user-unfriendly by the users.

2.1.2 Directorate of Rural Water Supply

The revised and approved Water Supply and Sanitation Sector Policy (WSASP) (MAWF 2008) proposed that the Directorate Rural Water Supply be transformed into a "Directorate of Water Supply and Sanitation Coordination' (DWSSC) in the MAWF and made responsible for the overall coordination of water supply and sanitation services in the country. An additional prime objective of this institution would be to ensure that sanitation meets the requirements for health and hygiene for the whole population in an acceptable, affordable and sustainable manner. The proposed Directorate of Water Supply and Sanitation Coordination will therefore coordinate water supply and sanitation as a single, inseparable function. The Division for Rural Services, which includes regional, communal rural water supply (RWS), within the Regional Councils, will continue to implement support to communal rural water supply and fully integrate rural sanitation within its functions. The capacity should be extended to ensure that the development goals for basic sanitation are met at household level in rural areas. Local authorities and Regional Councils will be responsible for implementation of water supply and sanitation in the urbanised areas and rural settlements (proclaimed and un-proclaimed) where demand is continually increasing and a growing backlog exists."

However, full implementation of the Department of Water Supply and Sanitation Coordination is not yet in place, which is evident as most representatives from DWAF consulted for this report still refer to the Directorate as DRWS. Therefore the old name will be used in this report.

Currently the production boreholes on communal land in Namibia are the responsibility of DRWS. DRWS operates a MS Access database named the Rural Water Supply Database (RUWIS) for capturing, storing, monitoring and managing data on regional water supply infrastructure. The database contains data about water point infrastructure e.g. location and design and institutional arrangements, e.g. water point committees. A second database containing more technical information about the mechanical installations e.g. pump-sets and pumps used for each borehole also exists. None of these databases are interlinked. The information about location and design of boreholes is the same as entered in GROWAS. No groundwater monitoring is conducted by DRWS and therefore no groundwater data are available. The limited compatibility and a need to avoid duplication among these databases have resulted in the Directorate cooperating with the Division of Geohydrology in developing a system allowing the databases to communicate with each other.

Water levels, abstraction rates and water quality should be measured, but currently none of these are measured during the operational life of boreholes (they are measured only once when boreholes are drilled). The involvement of water point committees and Basin Management Institutions in on-going monitoring would be a solution that could fill some of these data gaps.

2.2 NAMIBIA METEOROLOGICAL SERVICES

The NMS is collecting rainfall data at ten staffed multi-sensor weather stations, located in Katima Mulilo, Rundu, Ondangwa, Grootfontein, Hosea Kutako airport, Windhoek Meteorological Head Office, Eros airport, Walvis Bay airport, Keetmanshoop airport and, recently reintegrated, the Gobabeb Centre in the Namib Naukluft Park. It is important to note that the Gobabeb Centre has collected meteorological data on a daily basis since 1962. NMS also receives data from approximately 200 volunteer observers including schools, hydrologists and farmers. According to the NMS the quality of the data collected by them and the volunteers is generally good. The main issue for effective monitoring is the backlog concerning the processing of rainfall data of both rainfall intensity and daily rainfall quantity data. Presently about 100 stations are reasonably up to date, but only 30 key stations are completely up to date. Many of the voluntary stations do not produce complete records, e.g. no monitoring takes place during school holidays.

To improve the quality of data, NMS is currently establishing a network of automatic climate stations that continuously monitor the climate. These stations work for at least one month without attendance and data can be downloaded remotely. However, the quality of the data depends on the power supply to the station. To ensure that the data are acceptable the batteries have to be replaced on a monthly basis. Since 1995 climate data have been entered and analysed using a free DOS application. However, NMS is currently setting up an Oracle database for storing of the climate data they have and will generate. The plan is to connect all regional offices of the NMS to the Oracle database to allow them to enter their data directly into the system. The data stored in the old system are imported to the Oracle database, so no re-typing will be required. The system has been developed by an international company and requires their assistance for configuration and maintenance.

The NMS has a web site that provides information ranging from daily weather forecasts to seasonal rainfall predictions. There are also various reports, developed both internally and by other institutions that can be downloaded from the site. However, a review of the site reveals that much of the information needs to be updated and general maintenance of the site is rather poor. There is one promising section of the site, the climate and data bank services, which have links to monthly climate bulletins and quarterly climate reports produced by NMS. However, these do not seem to be updated regularly. The information provided is based on the data collected at the ten manned stations. The bulletin is distributed by e-mail to subscribing institutions and individuals in Namibia and abroad. When it comes to storing information produced internally and received from the outside, the same issues as identified in DWAF prevail. Most of the reports end up in the individual offices. However, NMS is currently establishing a library where they store their assets centrally. It is not clear if the library will be accessible to the public or other institutions.

Data and information produced by NMS are mainly used by: the aviation industry, Ministry of Agriculture, Water and Forestry; Ministry of Environment and Tourism, construction companies, consultants, scholars, insurance companies, and the Emergency Disaster Unit in the Office of the Prime Minister.

2.3 NAMWATER

NamWater is one of the major collectors of water data and is responsible for monitoring of Namibia's major dams and other bulk-water abstraction schemes. NamWater collects information about production or abstraction, production hours and rest- and pump water levels from their production boreholes. According to IWRM Plan Joint Venture Namibia (2010b) Namwater is also regularly monitoring the quantity of water in surface water sources, such as the ten large dams in operation in Namibia that form part of the bulk water supply in the country. For some of the major groundwater abstraction schemes water production is monitored in real time and transmitted via a telemetric system. However, the majority of schemes are monitored by manual measuring of the various parameters. They also receive groundwater level data from DWAF (Division of Geohydrology). The collected data are entered into Excel spreadsheets and used to compile production histograms for each production borehole. Data on groundwater levels are used to evaluate groundwater source sustainability. Long-term records of collected data are stored at head office in Windhoek, and can be made available on request. NamWater is not contributing to the GROWAS database at the Division of Geohydrology, nor do they keep up their own GROWAS database. NamWater is supposed to update their GROWAS database with newly drilled production boreholes. When GROWAS was launched, both NamWater and DWAF had the same "copy" of all existing data from the old NCR database. The NamWater representative in Erongo suggested that the naming of boreholes and other features monitored by several institutions should be standardised.

In the past NamWater sampled their production boreholes on an annual basis but this monitoring has stopped. Now only reservoir and end product water is sampled. Water quality data are collected monthly or at three monthly intervals at the reservoirs and the distribution supply pipelines. Samples are taken for microbiological analysis and results are normally obtained three days later. Boreholes are sampled before the rainy season (September-October) and after (April-May).

However, due to restructuring of NamWater, the monitoring has not been kept up to date, and currently there are gaps in the data series that have occurred over the past four years. There are plenty of historical data but little analysis and information generated from the data. The water quality information is stored in Excel sheets. According to NamWater Excel works but it is not sufficient, as it does not allow combining of these data with, for instance, sales information, which is analysed using the SAP business system.

There is a need for a database containing all the data gathered by the different NamWater offices. NamWater is currently establishing a GIS system, based on ArcGIS, that will contain information about water quality, infrastructure, sales and production data, all linked to locations. Currently there are only paper-based drawings of infrastructure.

The most frequent users of the data are: Department of Water Affairs and Forestry, Basin Management Committees and local authorities. Water quality information is made available on request to local authorities and other users of the water provided directly by NamWater. Only City of Windhoek is getting on-line information about the free chlorine in

the water delivered. This service will soon be made available to Swakopmund and Walvis Bay municipalities as well.

Currently the Library at NamWater head office is closed due to lack of staff. Staff has either retired or resigned, which has forced NamWater to temporary close the facility. Concerns regarding storage of information were raised as staff tent to store report and other information in their offices or on their individual computers. It was also said that there is no central filing system in place. This becomes a problem when staff members leave the organisation, then this information is often lost.

2.4 LOCAL AUTHORITIES

Local Authorities only collect and monitor data from groundwater sources. No Local Authority operates surface water schemes, except for the City of Windhoek who produce semi-purified water for irrigation from the Goreangab Dam and the Otjomuise water treatment plant. Part of this water is also mixed with water from NamWater and distributed to clients as potable water, excluding Meatco and other industries exporting their products to the European Union and similar highly controlled markets.

Local Authorities that are responsible for their own water supply or supply water in combination with water supplied by NamWater, have to monitor their abstraction. Ideally three variables should be monitored, abstraction volume, water levels and groundwater quality. However, many Local Authorities only monitor their abstraction volumes. The storage of data is commonly done on paper, which makes access and analysis complicated. Local Authorities relying on groundwater require abstraction permits and have to report their water use to DWAF. Most of the Local Authorities doing their own water supply do not collect all required data nor do they comply with the requirements for their abstraction permits.

Only the City of Windhoek samples production boreholes on a monthly basis, resulting in each borehole being sampled at least quarterly. Other Local Authorities supplying their own water do not take samples for chemical analysis. To ensure that water of required standard is provided to the clients, all Local Authorities that supply their own water should sample the quality of their groundwater on a regular basis. This information should also be shared with the appropriate Divisions in DWAF.

2.5 REGIONAL COUNCILS

Consultations with Khomas Regional Council revealed that they mainly depend on the City of Windhoek for monitoring. There are only four other urban settlements in the region, where limited or no monitoring takes place.

2.6 HOLDERS OF GROUNDWATER ABSTRACTION PERMITS

Holders of groundwater abstraction permits are obliged to monitor and record abstraction volumes and water levels monthly and submit these to the Division of Law Administration in DWAF. However, only 50-60% of the permit holders submit their reports, and DWAF

does not seem to have the capacity to control/enforce these obligations. Data collected by permit holders and submitted to DWAF are stored in Excel spreadsheets and are used for permit management purposes. The quality of the data is not easy to determine as the permit holders alone do the measurements. Historical data only exist from the Karst area, the Stampriet Artesian Basin and the water control area in Omaruru town and upstream of Omaruru.

2.6.1 Mining sector

Mines that use groundwater are required to collect and submit groundwater monitoring data to the Division of Geohydrology in DWAF in line with the conditions prescribed in their groundwater abstraction and waste water disposal permits. It is important to note that even if the mines report their water consumption, access to these data is limited due to confidentiality issues. According to representatives from the uranium industry, there is no feedback from the Division to the mines regarding the information they submit. Rössing Mine has calculated its water balance since the opening of the mine and stores all monitoring information, including water supply and usage, in a local database. This information is presented and discussed at the Coastal Bulk Water Users Forum, an initiative that developed as a result of proposals for the first water desalination development. In this forum current and future water usage, the targets and the performance towards these targets are discussed. Currently DWAF, NamWater, local authorities, exploration companies and mines, i.e. Rössing, Langer Heinrich and Areva are involved in the forum.

2.6.2 Tourism sector

According to the review and assessment of the existing situation by the IWRM Plan joint Venture Namibia (2010a), the tourism sector does not have any records of their water abstraction. It is possible that individual tourism operators do record their water consumption but there is no central collection or storage of this information.

2.6.3 Irrigation farmers

Irrigation farmers are required to report their groundwater abstraction to the Division of Geohydrology quarterly. Irrigation farmers seldom sample the quality of the water they use for irrigation, nor the return flow of water that they are ‘leaking’ from their fields. The use of fertilizers is a major risk for pollution of groundwater and should therefore be monitored. However, this is practically difficult and expensive to achieve.

2.6.4 Basin Management Committees

None of the two Basin Management Committees, Kuiseb and Omaruru, consulted for this report gathers any data, and has no centralised data storage facility. However, several members of the Kuiseb Basin Management Committee represent institutions that do so, e.g. the Directorate of Rural Water Supply and Directorate of Water Resource

Management within the Department of Water, Agriculture and Forestry, the Gobabeb Centre, NamWater, CETN, DEES and MET all collect data that are of relevance for the management of the Kuiseb River Basin. Currently there is no centralised database or portal where these data can be accessed. Each data user has to go to the institution holding the required data. It has been suggested that a data-sharing portal be established at the Gobabeb Centre.

2.7 GOBABEB CENTRE

The Gobabeb Centre in the Namib-Naukluft Park has a resource centre that holds information with a specific focus on the Kuiseb River Basin. The material ranges from maps and photographs to book, reports, scientific theses and peer reviewed articles and posters. Currently the Gobabeb Centre, in close co-operation with the Desert Research Foundation of Namibia, is scanning all this information and making it available electronically to the KBMC and other stakeholders in the basin. DRFN and Gobabeb Centre have jointly developed a web based platform where all the reports, articles and other relevant information, including raw data and GIS data, can be accessed and downloaded by staff, partner organisations, and, to some extent by the general public. The usefulness of these approaches still has to be assessed, but preliminary findings show that the DRFN/Gobabeb Centre system has already increased the usage of the information that previously only was accessible in paper form from the two libraries. Other institutions in the water sector could implement similar systems to enhance the accessibility of information.

3. DISCUSSION

3.1 DATA MANAGEMENT

The assessment of who collects and stores what data in the water sector revealed a number of gaps, which are summarised in **Table 3.1**. The table is based on IWRM Plan Joint Venture Namibia (2010a), Focus Group Discussions as part of the formulation of the Strategy and Action Plan and information received from key informants at these institutions.

Table 3.1: Data and information gaps in the water sector

INSTITUTION	GAPS
Division of Geohydrology	No link between allocated abstraction volumes and actual abstraction figures reported by permit holders
	Loggers used are prone to failure, leading to loss of data
	Manual water level readings are recorded in Excel spread sheets
	Analogue charts are not digitized at all
	No programme for standard chemical analyses in place

INSTITUTION	GAPS
	Lack of time series data for water quality
	No readily available data to estimate natural recharge of groundwater
Division of Hydrology	Rainfall loggers fail, loss of data
	Back log in entering data due to database issues
	Data loss in ephemeral rivers
	Poorly qualified data collectors leads to poor data quality
	Data collection low priority within Department
	Lack of volunteers collecting data for the Division
Division of Water Environment	Insufficient staff to conduct sufficient monitoring and interaction with clients
	Ecological data stored on a desk top computer, MS Access database
Directorate of Rural Water Supply	Internal databases, RUWIS and database with infrastructure info not linked to GROWAS or internally, limited compatibility
Namibia Meteorological Services	Backlog in processing collected data due to insufficient staff
	Low reliability/high maintenance of automatic climate stations, poor data quality
	Complex database solution for storage and analysis of data
NamWater	Most data stored in Excel sheets
	No use of GROWAS database
	No continuous sampling of water quality at production boreholes
Local Authorities	Limited monitoring of abstraction volumes, water levels and groundwater quality
	Data storage on paper
	Many local authorities do not provide abstraction figures in line with requirements in abstraction permits
Regional Councils	No information provided
Permit holders, general	Only 50-60% of permit holders report their abstraction figures to DWAF
	Data stored in Excel sheets
	Not clear quality of data provided by permit holders
	Limited historical data available
Mining sector	No/limited feedback from DWAF to mines after submission of reports according to permit conditions
Tourism sector	No/Limited reporting on consumption
Irrigation sector	No/Limited sampling of water quality before and after irrigation

INSTITUTION	GAPS
Basin management committees	Currently no structured monitoring programmes in place
	Only KBMC has a water resources management plan, including guidelines for data, information and knowledge management

The table above shows that there are some key issues that negatively affect data and information management in the water sector:

- Equipment used for data collection prone to failure,
- Limited staff capacity to gather, analyse and manage data,
- Not all required data are being collected,
- Poor reporting on abstraction from permit holders to DWAF,
- No clear standard on how to store data, and
- No standards for data exchange between databases.

3.2 FAILURE OF EQUIPMENT FOR DATA COLLECTION

The issue of the failing of equipment used for data collection is important as this has a great influence on the quality of the data being collected, and the records being stored. The reasons for failing equipment are due to both technical issues and vandalism. Gaps in data series are never good as it limits the reliability of the results of any analysis based on the data. Some gaps in data series can be filled by interpolation or other data manipulations, but the accuracy of the data will never be as good as if the original observation would have been made. Both Divisions of Geohydrology and Hydrology and Namibia Meteorological Services stated that loggers and automatic stations tend to fail. This signal a need for an assessment of what causes these failures and how the durability of loggers can be improved. This might require a complete change of equipment or just improved maintenance procedures. In areas where equipment is vandalised or stolen awareness raising and involvement of communities in the monitoring could be a solution. The Basin Management Committees could facilitate awareness raising and involvement in the actual monitoring.

3.3 LIMITED CAPACITY TO GATHER, ANALYSE AND MANAGE DATA

An issue related to the quality of collected data is the competence of the personnel conducting the data collection. Both Divisions of Geohydrology and Hydrology referred to data being collected by under-qualified staff. This is a risk as staff that does not have adequate competence will not be able to assess if the recorded data are correct or if it contains anomalies. There are several reasons to why under-qualified staff is doing the data collection. A key reason is that there are just not enough people with the correct training available on the market. To improve on this Government is providing bursaries

and stipends to its staff to further their education. However, many of the staff that receives training decides to leave Government after completing their courses, mainly due to the more favourable remuneration packages they can obtain from the private sector. The mining sector is currently a major employer of newly educated geohydrologists, offering far higher salaries than Government can provide their staff. The loss of staff from Government to the public sector is a serious problem, not only affecting the quality of data collection, analysis and management, but all the functions of the Government institutions. One step towards keeping highly educated staff would be to ensure competitive salaries, incentives and career paths that can compete with the offers from the private sector. Another approach would be to provide extensive, on the job training through a mentoring system, where senior experts within the different departments provide the required training to the staff. It is not clear if this will keep the staff within the Government, but it would at least ensure transfer of knowledge among the staff. If this does not take place, then much valuable knowledge is lost each time a senior staff member leaves the organisation.

3.4 NOT ALL REQUIRED DATA ARE COLLECTED

Division of Geohydrology and NamWater both indicated that not all data, required for them to produce the information they need, are collected. For instance, Geohydrology is only sampling water quality in newly drilled boreholes but does not conduct continuous monitoring of water quality, something that is required for standard chemical analyses. NamWater has gaps in their time series of water quality due to institutional restructuring. Division of Hydrology also indicated that collection of the required data is given a low priority in the Department.

To ensure that required data are collected, each department should conduct an internal assessment of their current monitoring systems and their current and possible future data needs. This would identify where the gaps are. The next step would be to determine if any other institution collects the required data. To establish agreements with institutions already collecting required data would be far more efficient than establishing new monitoring systems. However, if the data are not collected by anyone else, then data requirements have to be prioritised, a plan has to be developed for how best to obtain the data, and sustainable funding secured. If this does not happen, then the required data will not be obtained. Institutional restructuring is something that sooner or later will happen to any institution. By having a well developed strategy for collection of core data, the availability of data that are required for an institution to fulfil its mandate will be assured and the risk of an institutional restructuring leading to loss of data, as currently experienced by NamWater will be reduced. However, the overarching issues when it comes to collection of data are funding and human resources. By clearly defining the data requirements for an institution, the required funding and skills can be defined and acquired. It is important to keep in mind that it is expensive to collect and store data. Commonly data related expenses are the first to be cut when budgets are cut. A related issue is that qualified staff is required to conduct data collection and data management,

otherwise the quality of expensive data collection efforts risk to be compromised by the use of uneducated or poorly trained staff.

3.5 POOR REPORTING FROM PERMIT HOLDERS

Division of Geohydrology stated that only 50-60% of permit holders report their abstraction volumes to the Division of Law Administration. According to IWRM Plan Joint Venture Namibia (2010b) the tourism and irrigation sectors reports less stringently compared to the mining sector. The information received by the Division of Law Administration from permit holders is currently entered into Excel sheets, which does not allow cross-referencing with the actual volumes allocated in the permits. This makes it difficult for the Division to monitor the water consumption, and to react when over abstraction takes place.

To improve reporting from permit holders it is important that permit holders are held accountable to what the allocations made in the permits. The main reason for the limited reporting seems to be the limited risks of getting caught or being penalised. The reason for this seems to be insufficient staff, as was indicated by the representatives from the Divisions of Water Environment and Geohydrology, stating that they do not have enough staff to monitor all permit holders. Another reason seems to be the limited possibilities of cross-referencing permitted volumes versus actual abstraction. Instead of entering data into Excel, it would be advisable to develop modules in the GROWAS database for permitted volumes and the actual reported abstraction volumes. This would improve DWAF's capacity to monitor reported abstractions against permitted volumes.

The limited feedback from DWAF to permit holders, as stated by representatives from the mining sector, is another issue that most likely contributes to the low rate of reporting. In the future, Basin Management Committees and their related stakeholder forums can play the role as central platforms where information can be exchanged and feedback provided from DWAF to all stakeholders, including the permit holders. However, presently it is not likely that representatives from the mining sector would get involved in basin management committees as the committees currently have limited mandates, and very little resources.

3.6 NO STANDARD ON DATABASE SYSTEMS OR DATA FORMATS

The assessment of the different systems used for storing, analysing and distributing data in the water sector shows that there are no standards for database systems or data formats for the sector. There are no standards within DWAF for what kind of databases to use or what formats to store data in. For instance, the Division of Geohydrology is using the GROWAS database, which is based on a Microsoft SQL Server, with modules for, *inter alia*, water quality, water production and, borehole information. The Division of Hydrology on the other hand is using an Oracle database with a tailor-made interface for entering and analysing data. The sub-division Water Ecology, falling under the Division of Water Environment is storing its data on a desktop computer, using Microsoft Access. The Namibia Meteorological Services are currently establishing an Oracle database, also

with a tailor-made interface based on their requirements for entering and analysing collected data. Department of Rural Water Supply is operating two databases, the RUWIS database for information about water points and water point associations and committees, and a second database where information is stored about the infrastructure and other technical specification of each water point that the Department maintains. Apart from these database platforms, several institutions, e.g. Geohydrology, Hydrology, NamWater, and several Local Authorities are entering their data into Excel spread sheets.

The GROWAS database was developed to be used both by the Division of Geohydrology and NamWater, but has so far only been used by Geohydrology. The idea was to have to separate databases, but linking them to allow the information to be updated automatically in both databases. For instance, if data were added at NamWater, then this data would also be transferred to the database at the Division of Geohydrology. However, this was never put into practice. This example illustrates the complexities of sharing information, even if the same platform (in this case a MS SQL Server with the same database interface) is used. The current lack of standards makes direct exchange of information among key stakeholders in the water sector even more complex.

Another risk with not having any clear database standards in all Departments and Divisions within MAWF is that so much different expert knowledge is required. For each database system specific skills are required, making the systems vulnerable. The function of each system relies on few key individuals, while, if the same database system was used for all databases in an organisation, then the collective knowledge would be greater, and the dependence on key individuals less. It is important to clarify that it is not suggested that all Departments and Divisions should store their data in one central database, but that they should strive towards using the same database system for all their databases.

The level of complexity of the database systems used is also a major factor that should be considered. For instance the Oracle databases used by Division of Hydrology and NMS both require outside experts to configure, adjust and maintain the databases. This is a risk as it is a costly solution, and does not promote in-house ownership of the data management system. The use of a common platform as MS SQL Server on the other hand is less complex, less costly and, maybe most importantly, there is a large community working with this system, both in Namibia and globally, making it relatively easy to get expert advice, and find solutions either via the Internet or in the literature. These findings suggest that a standard for databases and data formats should be developed, firstly within the DWAF, but it is recommended that other institutions in the water sector also contribute to establishing these standards and strive towards implementing these.

The use of Excel for data management, e.g. storage and analysis of data is not adequate for a professional institution. NamWater and others stated that the use of Excel does not allow them to analyse their data to its full potential, nor to cross reference data from different divisions, e.g. financial records and production figures. Excel does not provide any automatic backup functions or other data security features, which proper database

engines do. It is therefore recommended that all institutions currently relying on data being stored and analysed using Excel move towards establishing their own data storage systems, based on their specific data and information management needs, taking the issue of data security into consideration, in close cooperation with institutions already having functioning and reliable data management systems established.

3.7 NO STANDARDS FOR DATA EXCHANGE BETWEEN DATABASES

Central to data management is the access to information, both within an institution and between institutions. Currently there is not a single database that is communicating/exchanging data with another database on a regular basis. Data are provided between different organisations on request. For instance, several other institutions in the water sector use rainfall data from the NMS. However, there is no direct link to the NMS database, where these stakeholders can retrieve data.

Another example of limited data exchange is the RUWIS and GROWAS databases, both dealing with boreholes and groundwater, but currently not communicating with each other. For instance, a water point that is entered in both databases does not have the same name or any other common reference. This makes it very difficult to get all related data for one specific water point. However, Directorate of Rural Water Supply and the Division of Hydrology are now cooperating towards harmonizing the two databases, to avoid duplication and optimize the ability to query both databases for specific water points.

Each of the data producing institutions consulted for this report was asked how best to exchange data. The suggestion ranged from one central main computer/database holding all data of relevance for the water sector to completely isolated systems (the current situation). None of the respondents would like to go for a central database. There are many reasons for not wanting a central database. For instance, lack of ownership of the data, loss of control of data that an institution collects and general problems related to maintenance and upkeep of such a central system. Instead it was suggested that a portal of some sort be established. Such a portal could be a web-based interface where selected parts of the data collected and stored by the different institutions are made available to a wider audience. For instance, flow data from the Division of Hydrology could be retrieved from such a portal, as well as water levels in all NamWater reservoirs and borehole data from RUWIS and GROWAS. The key to this system would be that each institution would be in charge of their current data collection, analysis and storage of data, in their current system. The only addition is a function of opening up selected parts of the databases to be accessed from such a web-based portal. All data would still be stored in the different databases. This solution would increase the access to data, both within and outside the different institutions, with a minimal effort. Updates of information would be instant, not requiring the data to be entered twice; when data is entered in a database it is automatically made available via the web portal. The IT department within the MWAF has suggested that a share point portal be established within the Ministry. This would be a very good starting point to develop an interface that allows improved access to selected parts of the different databases within DWAF. If

successful, then this concept can be extended to also include data from other institutions, outside of DWAF, and provide data and information to the entire water sector.

3.8 INFORMATION MANAGEMENT

Within DWAF the filing system referred to as the Water Registry is central in storing information related to the different permits issued by the Department, e.g. monitoring results either submitted by clients or collected by DWAF staff, analysis results, remedial actions and related correspondence. This system is currently only in paper format and no backups exist, which makes the filing system very vulnerable. However, there are already plans in place to improve the system by introducing a digital document management system, in which all current and future information will be stored digitally, allowing easier access and higher data security.

Apart from the Water Registry, the assessment of information management shows that there are a few operational information centres of relevance to the water sector. The information centre of MAWF (NAWIC) is central, and so are the newly established library and the web site of the NMS. However, as was shown, both these institutions must be strengthened in order to keep their information systems relevant and up to date. In the case of NAWIC, there is a library committee that should be the interface between departments and the centre. However, it seems as if this committee does not function optimally as there are limited contributions of information from the Departments to NAWIC. It also seems as if the value of the information centre should be advertised and promoted more extensively within the MAWF.

A major issue that all institutions consulted face is the storage of information in individual offices. The problem with individual storage is that there is no knowledge about the existence of this material outside the mind of the ‘owner’. No central file or database exists that can be queried for the information.

To increase the access to information that currently ends up in individual offices, it is proposed that procedures be developed that would enable the library at MAWF to store these documents in the library. The same applies for all institutions in the sector because central storage of information will benefit all the staff of an institution. However, it is important that all information held in libraries and other information centres is catalogued in a library system or some other database to allow library users to find the information they are looking for, and to prevent key documents from getting lost. To further improve on access to information it is suggested that key reports and other information that frequently are referred to are digitized and made accessible via an intranet, or as in the cases of the DRFN/Gobabeb web based information system, made accessible directly on the web.

4. ACTION PLAN

Based on the assessment of current usage of data and information and related gaps in the water sector according to previous reports compiled for the IWRM Plan and interviews conducted with key stakeholders, a Strategy and Action Plan for data and information management in the sector is presented in **Table 4.1**. Note that the committee referred to is the same for all activities outlined below. It is proposed that DWAF chairs this committee.

Table 4.1: Strategy and Action Plan for data and information management.

OBJECTIVE	STRATEGY	ACTION	RESPONSIBILITY	INDICATORS
Reliability of data collection and capture will have been improved	Engage all institutions in the water sector in assessing and solving issues related to data collection	Form a sector wide committee to coordinate the assessment of current issues with data collection Identify most reliable and cost efficient solutions to identified issues Replace equipment and/or adjust management procedures according to solutions Committee to reassess reliability of equipment for data collection every second year	Committee to be chaired by DWAF All data collecting institutions in the water sector	Committee formed and issues related to data collection identified and documented Equipment being replaced and/or management procedures adjusted according to solutions At least one reassessment of reliability of equipment and resulting data before 2014

OBJECTIVE	STRATEGY	ACTION	RESPONSIBILITY	INDICATORS
National capacity to gather, capture, analyse and manage data will have been improved	Establish institutional capacity to gather, capture, analyse and manage data Establish competitive salary, incentives and career paths for staff	Determine current and future sector capacity needs Conduct current skills assessment Each institution that is collecting data/information establish institutional plan to increase staff capacity Establish recruitment policy Develop curriculum for internal training and contribute to curriculum development at tertiary institutions Establish and implement on-going on-the-job training and mentoring programme Assess possibilities of establishing market related salaries, incentives and career paths within DWAF and other Government institutions	DWAF, All data collecting institutions in the water sector	Each institution has conducted and documented current and future capacity needs before mid of 2010 Skills assessment conducted and documented before mid of 2010 Recruitment policy based on skills needs formulated before end 2010 At least one internal course developed and implemented by mid 2011 Mentoring and on-the-job training in place by mid 2011 Assessment conducted and documented by mid 2011

OBJECTIVE	STRATEGY	ACTION	RESPONSIBILITY	INDICATORS
Required data will be collected	Sector wide assessment of current and future institutional data needs and identification of who that shall collect the data	Conduct gap analysis of current and future data needs for mandated services by each institution in the water sector Develop data collection strategy and action plan based on consultations with data collecting institutions in the sector Pool resources towards data collection Apply standardised methods for data collection	Committee All data collecting institutions in the water sector	Gap analysis of current and future data needs conducted and documented and shared with all institutions in the water sector by mid 2011 Data collection strategy developed and implemented by end 2011
Reporting from all permit holders is taking place	Develop measures ensuring that permit holders submit reports as part of the permit conditions	Conduct assessment of why so few permit holders submit reports Review and adjust permit system/procedures Investigate possible incentives and enforcement strategies	Division for Water Administration Geohydrology Permit holders Basin Management Committees and Basin Management Support	Assessment of permit system conducted and documented by 2010 Permit system reviewed and adjusted by 2010 Incentive and enforcement strategies in place by 2011

OBJECTIVE	STRATEGY	ACTION	RESPONSIBILITY	INDICATORS
Clear standards for processing and storage of data will have been established	Compatibility between systems should guide the development of standards	Conduct cost, benefit and risk assessment of different system options Establish pool of expertise for operation and maintenance of standard systems Formulate and implement sector wide standards	Committee All data collecting institutions in the water sector	Cost, benefit and risk assessment done for any new investment in data systems (on-going) Institutions using same platforms have established expert pools that exchange information/support on a needs basis by 2011 Sector wide standard for data systems developed and implemented by 2013
Clear standards for data exchange between databases will have been established	Compatibility between systems should guide development of standards	Assess current data formats used and their compatibility between current systems Develop and implement data exchange portal for selected data sets Develop inter-institutional data sharing/exchange policy	Committee All data collecting institutions in the water sector	Assessment of data formats and compatibility conducted and documented by end of 2010 A data exchange portal developed and operational by 2012 Inter-institutional data sharing/exchange policy developed and implemented by 2013

OBJECTIVE	STRATEGY	ACTION	RESPONSIBILITY	INDICATORS
Current information centres, e.g. NAWIC of MAWF and NMS will have been strengthened	Establish institutional capacity to provide required services	Review and formalise functions of the library committee of DWAF to strengthen its interaction with the different Directorates and Divisions of DWAF Review current and future staff requirements to provide required information services Assess current capacities of staff to identify gaps and shortcomings Establish institutional plan to strengthen staff capacity Develop curriculum for internal training and contribute to curriculum at tertiary institutions	NAMIC DWAF NMS	Library committee of DWAF plays a major role in information collection and dissemination within DWAF by 2011 Staff requirements reviewed and current gaps identified and documented by 2010 Institutional plan to strengthen staff capacity developed and implemented by 2011 At least one internal course developed and implemented by 2011
Access to information will have been improved	Develop and implement information management systems	Identify all information centres with information pertinent to the water sector and formulate MoUs and exchange agreements Develop and implement procedures to receive information from individual staff members to be stored in information	DWAF All institutions in the water sector, including Public, Private, Education sectors	All relevant information centres identified and MoUs and exchange agreements established among all these institutions by 2011 Internal procedures for information collection established and

OBJECTIVE	STRATEGY	ACTION	RESPONSIBILITY	INDICATORS
		centres/libraries Establish cataloguing system for information stored in information centres' all libraries Investigate possibilities of establishing digital information management systems to increase access to key information sources		implemented by 2011 Cataloguing systems in place in all major information centres in the water sector by 2012 At least one digital information management system in place and functioning within DWAF by 2011

5. REFERENCES

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6. APPENDIX 1: INDIVIDUALS CONSULTED

	Name	Organisation	Position
1.	Susan Roux	CETN/KBMC	Chairperson/Member
2.	Joel Kooitjie	DEES/KBMC	Agricultural technician
3.	Maria Amakali	DWAF/KBMC	Acting Director
4.	Sebedeus Swartbooi	Topnaar community	Representative
5.	Emily Mutota	Gobabeb	Outreach Coordinator
6.	Uahorehua	DRWS	Regional Head (Erongo region)
7.	E.P. Shiluama	NamWater/KBMC	Area Manager
8.	H Mufadda	OMBMC	Secretary
9.	D.J. Kuaere	DRWS	Control/RWEO
10.	E.E. Nowaseb	OMBMC	Basin support officer
11.	Joh Henschel	Gobabeb Centre	Executive director
12.	Reinhard Kubirske	Swakopmund municipality	Manager: Operations
13.	Hellao !Naruseb	Swakopmund municipality	Manager: Finance
14.	W Swiegers	Uranium Institute	Director
15.	Andre Burger	Walvisbay Municipality	Engineer: Water
16.	Ignatius Thudinyane	Walvisbay Municipality	Manager: Finance
17.	Hilia Hitula	Walvisbay Municipality	Town Planner
18.	Monica Thomas	Walvisbay Municipality	Environmental Officer
19.	Saltiel Shaanika	NamWater	Engineer
20.	David Adams	NamWater	Engineer
21.	Vynand Seimons	NamWater	
22.	R Schneeweiss	Rossing	Supt: Land use
23.	Dup Calitz	Rossing	Manager: Projects
24.	R Przybylski	Rossing	Supt: Mining Projects
25.	F Anderson	Rossing	Manager
26.	W Pelvich	Langer Heinreich	Environmental Specialist
27.	C. Cleghom	Langer Heinreich	Environmental Manager
28.	M Tjipita	Langer Heinreich	Engineer Manager
29.	B Morwe	Rossing	Manager Process
30.	P Rooi	Rossing	Manager: HSE
31.	Kevin Roberts	DWAF: Ecology section	Sub-division head
32.	Teopoline Mbandja	DWAF: Geo hydrology	Geo-hydrologist
33.	Ndina Nashipili	DWAF: Water Environment	Hydrologist
34.	C Munikasu	DWAF: Water Planning	Chief development planner
35.	C Christelis	DWAF: Geohydrology	Deputy director

36.	Guido Van Langenhove	DWAF: Hydrology	Deputy director
37.	Harald. Koch	DWAF: Rural Water Supply	Director
38.	F Witbooi	DWAF: Law administration	
39.	Cynthea Ortmann	DWAF: Water Quality	Senior hydrologist
40.	Laura Namene	DWAF: Water Environment	Acting Deputy Director
41.	M Amakali	DWAF: Resource Management	Acting Director
42.	Matthew Katjimune	DWAF: Geohydrology	Geohydrologist
43.	Charlotte Nakanduugile	Namibia Agriculture Water Information Centre (NAWIC)	Librarian
44.	S. Mwangala	Namibia Meteorological Services	Chief meteorological technician: climate
45.	Judith Henderson	Independent consultant	Knowledge management expert