E: MALAWI

E.1 INTRODUCTION

As part of the compilation process for the SADC map and atlas, Mr Jan Van Hooydonck of SRK Consulting carried out the Malawi country visit between 10 and 16 March 2002. The data acquisition, management and hydrogeological mapping situation in Malawi was analysed according to a series of interviews conducted with the major stakeholders and institutions involved in groundwater resource management as shown in Table 1.

All interviews were carried out in Lilongwe.

E.2 BACKGROUND

The background information is summarised from the country report submitted as part of the "Development of Code of Practice for Groundwater Development in the SADC Region" by Groundwater Consultants Bee Pee (Pty) Ltd (2001).

E.2.1 Physiography and Climate

The East African Rift Valley bisects Malawi and produces a topographic trough in the form of Lake Malawi (Africa's third largest lake with a surface area of 29,000 square kilometres). Along the eastern and western side of lake Malawi, elevated plateaux occur that rise to between 915 and 1220 m above mean sea level (mamsl). The Nyika upland in the north reaches about 2440 mamsl while to the south, the Shire Highlands reach a maximum height of more than 2740 mamsl.

The average annual rainfall varies between 800 mm and 2500 mm, falling across 18 separate surface water catchments.

E.2.2 Water Resources

Almost 70% of the land area drains into Lake Malawi, which, combined with run-off from Tanzania and Mozambique, generates a mean annual surface inflow to the lake of ~918 m^3/s. The Shire River drains 395 m^3/s out of the Lake. This combined Lake Malawi-Sire River system constitutes the major surface water resource of the country.

E.2.3 Overall Institutional Framework of the Water Sector

The Water Resources Law (Laws of Malawi, Cap. 72:03) is described as *"an act to make provision for the control, conservation, apportionment and use of the water resources of Malawi"*. It is based on the principal that ownership of all public water is vested with the President and controlled by the Ministry of Water Development (MoWD). As per definition, public water includes all surface and groundwater but excludes any stagnant pan or swamp wholly contained within the boundaries of privately owned land.

The MoWD has the overall responsibility for water resources management in the country. In addition to the government institutions, a series of independent and non-governmental organisations are currently operating to meet the community demands with regard to water supply and sanitation. Poor communication between the role players has lead to a de-centralised data collection and management strategy.

E.2.4 Role of Groundwater

The present population is estimated at about 11 million. The economy is agriculture based but groundwater development has mainly been for rural domestic water supply through boreholes and hand dug wells. Groundwater, estimated to supply a population of about 3 million in rural communities, contributes to about 29% of the total domestic water supplies and 3% of overall water uses.

Through the National Water Development Plan, the number of boreholes is intended to be increased to a coverage of 80% in the rural communities. Furthermore, the potential for irrigation through boreholes has been realised in the Shire Valley and may become an extensive source for irrigation water in future.

E.3 GEOLOGICAL AND HYDROGEOLOGICAL FRAMEWORK

E.3.1 Geology and Hydrogeology

Groundwater resources are classified according to two main aquifer systems, namely;

- Weathered Basement Aquifers that occur on the low relief plateau areas and at the base of the escarpments where a well-developed transitional zone between the bedrock and the top argillised layer constitutes the main groundwater-bearing horizon. The depth to groundwater varies between 15 to 25 m below ground surface. The average recharge is of the order of 10-50 mm/year. The transmissivity of the aquifer varies between 5 to 35 m^2/day and the potential yields are relatively low (less than 1 l/s); and

- Alluvial Aquifers that are situated along the lakeshore and the river flood plains. Depth to groundwater varies between 10 m to 30 m below ground surface, receiving an estimated recharge rate of 8 to 60 mm/y. Although transmissivity values of 70 to 330 m^2/day are recorded, the potential yields are variable due to the heterogeneous nature of the lacustrine and fluvial deposits. An average yield of about 0.9 l/s has been estimated (National Water Resource Master Plan) but maximums of 15 l/s have been recorded in sand and gravel horizons.

E.3.2 Natural Groundwater Quality

Groundwater quality is good and generally acceptable for drinking and domestic uses. Nevertheless, groundwater development remains limited to small-scale, rural domestic water supply and irrigation schemes. Consequently, it constitutes only 3% of the overall water use.

E.4 DATA ACQUISITION

E.4.1 Institutional Framework for Data Collection

The institutions and personnel contacted as part of this project are summarised in Table 1.

Table 1. Institutions and Personnel Contacted in Malawi

COMPONENT	INSTITUTION	PERSONNEL
General GW Information Monitoring Data (GW) Hydrogeological Mapping	MoWD: Groundwater Division	Mr. S. Mainala Mr. J. Trensio Banda Mr. K. Mponda
Monitoring Data (SW)	MoWD: Surface Water Division	Mr. W. Chipeta
Water Chemistry Data	MoWD: Water Quality Research and Pollution Control	Mr. T. Phiri
Legal Framework	MoWD: Water Resources Board Secretariat	Mr. F. Mtambo
Mapping Information (geology, topography)	MoNR: Geological Survey	Mr. A. Kathwera
Monitoring Data (GW) Country-wide	MASAF	Mr. G. Salima
Monitoring Data (GW) Lilongwe	CPAR	Mr. M. Qoto
Monitoring Data (GW) Salima, Machinga	Water Aid	Mrs. L. Milazi

(MoWD: Ministry of Water Development; MoNR: Ministry of Natural Resources; GW: groundwater; SW: surface water)

The MoWD, through its Water Resources Department and Water Supply and Sanitation Department, is responsible for policy making and planning, setting of technical standards, water resources data management, master planning and investment co-ordination. Five water boards control the day-to-day practical management of water resources. The Lilongwe and Blantyre Water Board represent the statutory bodies for the two main cities while the remaining three boards cover the north, central and south region of the country.

In addition, a series of independent and non-governmental organisations are currently operating to meet community demands with regard to water supply and sanitation. Although, according to the Water Resources act, these institutions are required to report to the MoWD on a regular basis, they maintain a highly independent data acquisition framework. These main institutions are the following:

- Malawi Social Action Fund (MASAF) is an autonomous organisation within the President's Office and has been set-up by the government to meet the practical community needs with regard to water and sanitation. The organisation is thereby actively involved in groundwater development for community water supply;
- Canadian Physicians for Aid and Relief (CPAR) which is a Canadian-based NGO with a focus to improving health and nutrition in Malawi since 1996. Part of its program focuses on water and sanitation projects, specifically in the Lilongwe area;
- Water Aid, which is a UK-based, international NGO that, since its inception in 1981, has specifically focussed on the provision of drinking water. Water Aid is involved in the development of rural water supply and sanitation in the Salima and Machinga regions.

In the early 1990's Japanese funded organisations were active in water and sanitation development. They have since withdrawn from Malawi and contact could not be established.

E.5 GROUNDWATER INFORMATION SYSTEMS

E.5.1 Hardware and software

There is no systematic groundwater management and information infrastructure. Due to a lack of resources and manpower, rational management of data is not practiced within the institutions themselves. In addition, poor co-ordination between the various agencies prevents the application of common standards and practices.

E.5.1.1 MoWD: Groundwater Division

Within the Groundwater Division of the MoWD, the existing data storage and retrieval system is ineffective since the archive of hydrogeological data is stored in various forms. Most commonly, a borehole data card is used to record drilling information, borehole completion details and basic groundwater records. Although the cards are designed to incorporate all relevant information, the field supervisor does not capture all data adequately. At present, data for about ~6000 boreholes are stored in the card-index file (Cadex).

Table 2. Summary of MoWD-Groundwater Division Information Systems

Database / Source	In use	No. of records	Format	Useable [1]	Comments
Cadex	Yes	~6,000	Card File	No	Data records: 1951-1994
Digital Database	No	5,193	DBase III	Yes	Data records: 1951-1986
Project Files	Yes	15,288	Paper	No	Data records: 1994-2002 Project files contain groundwater information on the successfully completed boreholes during that period.
Excel Master Data	Yes	unknown	Spreadsheet	Yes	Data records: 1994-2002
GW for Windows	No	0	Spreadsheet	No	Software available but not being used.

([1]Easily useable for the regional hydrogeological map; S: spring; B: boreholes)

In the 1980's, a computerised database (dBase III-DOS) was designed to facilitate the transfer of data from the card-system to a digital format. The digital database formed the basis for the 1986 hydrogeological map of Malawi but is limited to storage and retrieval only and does not provide scope for data manipulation and graphical output. So far, 5,193 borehole data points have been entered but, due to its unpopularity with users, additional data entry has been discontinued.

Instead, a master data file, designed in Excel, has been in operation since 1994 but is not regularly maintained. Between 1994 and 2002, it has been sporadically updated with groundwater related information collected during drilling of new water supply boreholes. However, in most cases, the data from the field drilling notes remains "unprocessed" in the respective project files. Currently, a centralised management of a database (in whatever format) is not carried out.

Groundwater for Windows (GWW) software is available but is not being used.

E.5.1.2 MoWD: Surface Water Division

The surface water division maintains a digital database (MS Access) for 197 river gauging stations, which are monitored at monthly intervals across the country (see Table 3). The monitoring routine forms part of the SADC-initiated HYCOS project.

Table 3. Summary of MoWD-Surface Water Division Information Systems

Database / Source	In use	No. of records	Format	Useable[1]	Comments
Hydrological Services Database	Yes	197(*)	MS Access	Yes	1992-recent: all data stored in MS Access database 1948-1992: backlog data in paper format

((*) 197 river gauging stations monitored at monthly intervals since 1948; [1]Easily useable for the regional hydrogeological map; S: spring; B: boreholes)

E.5.1.3 MoWD: Water Quality Research and Pollution Control Division

The Water Quality Research and Pollution Control Division maintains a digital database (Dbase III) which is regularly updated from information contained in the "Annual Minutes Book". Routine monitoring is carried out on four-monthly intervals at 85 of the 197 river gauging stations (see Table 4).

Table 4. Summary of MoWD-Water Quality Division Information Systems

Database / Source	In use	No. of records	Format	Useable[1]	Comments
Annual Minutes Book	Yes	85(*)	Paper	No	Data records: 1984-2002
Water Quality	Yes	85(*)	Dbase III	Yes	Data records: 1986-2002

([1]Easily useable for the regional hydrogeological map; S: spring; B: boreholes)

E.5.1.4 Other Sources

MASAF, CPAR and Water Aid each operate an independent groundwater database which generally includes a description of the drilling methods, geological units, basic groundwater information, an estimate of yield and borehole construction records (see Table 5). All data are stored in MS Excel or MS Word files. In addition, the British Geological Survey (BGS) store groundwater information collated from various Malawi-based projects in their customised GIS data management system (pers. comm. Mrs. L. Milazi).

Table 5. Summary of Additional Information Systems

Database / Source	In use	No. of records	Format	Useable[1]	Comments
MASAF	Yes	2200	Unknown	No	Detailed information was not provided so it is assumed to be not useable.
CPAR: WES	Yes	1500	MS Word	Yes	Data records: 1991-2002 (1991-1996 data stored in Word Perfect)
Water Aid	Yes	32	MS Word	Yes	Data records: 2000-2002
BGS	Yes	Unknown	Unknown	Unknown	Assumed that database is useable.

([1]Easily useable for the regional hydrogeological map; S: spring; B: boreholes)

E.5.2 Data saved

Although the Water Resources Act sets out a series of procedures related to the granting and recording of water rights, the state remains the sole custodian of water resources. By application of its powers to inspect works or "call for information", the Water Board (operating as part of the MoWD) may insist on the installation of hydro-meteorological stations or other sampling points to monitor any potential pollution or alteration of the water conditions.

In practice, however, the powers granted are rarely enforced, resulting in a poorly maintained and ill-distributed cover of sampling points. Furthermore, the five Water Boards do not actively pursue their right to obtain information collected by the various independent organizations involved in water supply and sanitation.

To facilitate the coordination and dissemination of information amongst the different agencies involved in water and sanitation, the Zomba Water Committee was created. On a voluntary and infrequent basis, it invites technical members from the various organisations to participate in groundwater related issues. The main aim of the organisation is to co-ordinate efforts for the benefit of the community, actively promoting the "Community Based Management" of the local water resources.

E.5.3 Quality of Data

The quality of the monitoring data is highly variable, depending on the level of training received by the field supervisor. QA/QC procedures are not followed as part of the data management in any of the institutions involved in groundwater data management.

Within the Groundwater Division and MASAF, supervisory personnel are university trained and receive internal mentorship to a limited extent. Visiting organisations, such as the BGS, provide staff on a temporary and infrequent basis for additional tutoring and guidance. The best example of such a successful international co-operation is the 1986 production of the only hydrogeological map currently available for Malawi. However, a high staff turn-over prevents the establishment of a committed team of highly motivated and trained individuals.

Foreign-funded NGO's provide internal mentorship in the form of short courses and training by visiting experts. In the case of CPAR, supervisory personnel may be educated in foreign based universities to promote the understanding of state-of-the-art methodologies in water supply and sanitation. However, within the context of the relatively basic infrastructure in Malawi, these techniques are only applicable to a limited extent.

Nevertheless, the Surface Water Division and Water Quality and Pollution Control Division within the MoWD apply standardised QA/QC procedures for data capturing and analyses. This indicates that a higher level of control and better quality of groundwater data should be expected.

E.5.4 Resources available for maintenance

E.5.4.1 MoWD: Groundwater Division

The MoWD has recognised the urgent need for a comprehensive compilation of groundwater data in Malawi. As a result, in March 2002, the Groundwater Division appointed Mott MacDonald to develop a code of "best management practices" related to the acquisition, storage and management of groundwater related information. Mott MacDonald is tasked with the design of a GIS-based management tool to complement and, ultimately, replace the Cadex and digital database (Dbase III).

It is anticipated that the new system will be in place by mid-2003 but further details with regard to the practical implementation of the project are not available.

The MoWD, Groundwater Division, includes an annual budget of U$ 3200for SADC purposes. As part of the SADC map and atlas compilation, data, hardware and software would be made available at no cost, although most computer equipment and programmes are outdated.

E.5.4.2 Resources for NGO's

MASAF did not provide any details with regard to contributions, financial or otherwise, to the compilation of a regional SADC map and atlas.

Water Aid has secured independent funding for the development of a local hydrogeological map of the Salima and Machinga areas. The project is due to be completed by mid-2003 and as such, no further information has been made available with regard to standards, scale or legends. The resultant map, based on an unspecified GIS management tool, will focus on groundwater supply potential, considering both yield and water quality. Data, hardware and software would be made available upon request for the compilation of the regional hydrogeological map.

CPAR receives an annual budget of C$ 1,000,000 for the development of water resources and sanitation. Negotiable financial contributions can be made towards the compilation of the regional hydrogeological map if the request is submitted before the start of the new financial year (April 2003). In addition, data, hardware and software could be made available upon request.

E.6 GROUNDWATER MONITORING

There is no established groundwater monitoring network. Instead, the existing information available in the Groundwater Division (MoWD) is based on ad-hoc measurements of groundwater conditions during the drilling of water supply boreholes. Table 6 summarises the borehole distribution network.

Table 6: Borehole Distribution Network

Institute	Region	Boreholes in Operation	Monitoring Frequency
MoWD	Northern region	1972	When drilling
	Central Region	7163	When drilling
	Southern Region	6153	When drilling
	Sub-Total: MoWD	***15288***	When drilling
MASAF	Country-wide	2200	When drilling
CPAR	Lilongwe	700	When drilling
	Nkata Bay	800	When drilling
Water Aid	Salima	32	When drilling

/: data not available; "Others" include all boreholes and wells constructed by institutions other than the MoWD-Groundwater Division.

E.6.1 Monitoring Network and Frequency

Monitoring is only carried out as part of drilling campaigns and includes the following:

- **Drilling Information**: date of construction, location, method, drilling diameter and depth;
- **Geological Information**: brief description of soil-rock type;
- **Groundwater Information**: water strike, estimated yield, basic chemistry (such as EC, pH, temperature and major ions)

- **Borehole Construction Information**: casing diameter, basic pump specifications, borehole number.

Twenty-six autographic recorders are available in the country but they are yet to be installed, as properly designed boreholes are not available. Besides, no funds have yet been allocated or provision made for drilling of new observation boreholes.

E.6.2 Quality of Monitoring Data and qa/qc

Formal quality control and quality assurance procedures are not carried out by any of the institutions involved in groundwater resources. The quality of the data remains highly dependent on the personal training received by the respective staff members and the type of equipment available.

The same comments as detailed in Section 5.3 apply.

E.7 HYDROGEOLOGICAL MAPPING

E.7.1 Existing Hydrogeological Map

Between 1976 and 1986 the hydrological unit of the BGS provided a training and staff-strengthening programme to the Groundwater Section of the Ministry of Works and Supplies. During the period, nine reconnaissance hydrogeological maps (1:250,000 scale) were produced, along with a report describing the hydrogeology. The map is a compilation of various sources, including:

- MoWD-Groundwater Division: Archive of boreholes and dug wells (Cadex-Dbase III);
- MoWD-Water Supply and Sanitation Department: Rural piped water supply network;
- MoWD-Surface Water Division: Surface Water Catchment geometry, basin topography and surface water drainage patterns; and
- Ministry of Natural resources: Geological Survey maps of 1:100,000 to 1:1,000,000.

E.7.2 Derivative maps

Derivative maps are not available.

E.7.3 Classification and Legend of Maps

The map series synthesise the geology, hydrogeology, geographic features and grid details for each of the nine regions using the legend as outlined in Table 7.

The base map consists of a topographic plan overlain by a simplified geological interpretation based on six rock type categories (weathered and fractured Pre-Cambrian basement, Permo-Triassic Karoo Formation, Jurassic Karoo Volcanic, Mesozoic Chilwa Alkaline Province, Cretaceous-Pleistocene Sediments and Quaternary Alluvium).

The hydrogeology is represented according to "Water Resource Areas", which are a direct translation of the surface water catchments. It therefore includes pictorial representations of surface water features such as springs, rivers, lakes and swamps. Within the boundaries of the Water Resource Areas, groundwater information is limited to elevation of the piezometric surface (mamsl) as derived from borehole records. In combination with the alluvial thickness, a saturated thickness can therefore be estimated. In addition, where available, EC values of the groundwater are depicted according to three main categories (750, 1500 and 3000 µS/cm).

Table 7: 1986 Hydrogeological Map of Malawi: Legend and Scale

Map Feature	Symbol	Colour	Description
Topography	Lines (contours)	Dark green	• Elevation contours (in mamsl)
Geology	Infill (lines, shading, dots)	Light green	• Six major geological units; • Major gw-bearing faults; • Alluvium thickness.
Hydrogeology	Lines and numbers (boundaries)	Black	• International boundaries; • Water Resource boundaries; • Gw project area.
	Lines (contours)		• Regional gw levels (in mamsl).
	Dots and numbers (boreholes)		• Borehole reference number; • General classification according to EC (750-1500-3000 µS/cm).
Geography	Pictorials	Blue	• Surface water features (lakes, rivers, springs, swamps, areas prone to flooding)
Scale	Scale bar	Black	• 1:250,000
Grid Ref.	Text and numbers	Black	• Transverse Mercator (zone 36); • No: 36 LWB 5785
Derivatives	Separate inset map	Black	• Detailed location of boreholes when clustering around one position occurs.

CPAR and Water Aid present borehole location data in plan view for reporting and presentation purposes. These maps are included in progress reports submitted to the parent organisation to indicate borehole positions but are not an attempt to provide hydrogeological information.

E.7.4 Existing Geological Maps

The Ministry of Natural Resources (Geological Survey) has published two geological maps for Malawi, including:

- Geological Map of Malawi (1966), scale 1:1,000,000, which overlies a geographic/topographic base map that covers the entire country. The geology is classified according to "igneous rock types" and "others", the latter covering the range of sedimentary and metamorphic formations. The map represents structural features, such as foliation, faulting and boundaries and also includes a radiometric age determination for the main igneous rock types and minerals. Dots indicate hot springs;
- The Geological Map and Handbook Series (1968), scale 1:100,000, which provides a detailed history and analysis of the rock formations, including the Basement complex. It is based on 1:50,000 topographic maps (see below) and uses borehole records to extend the interpretation of the mapped surface geology.

In addition, a "mineral resources and occurrences" map at scale 1:1,000,000 has been published by the Geological Survey (2000). The base map comprises the topography as defined by the Digital Chart of the World and UNEP 1 km elevation grid. In addition to general infrastructure and political boundaries, it identifies mineral location, type and resource estimates across the country.

Table 8 lists available geological maps.

Table 8: Summary of Available Geologic Maps

Map	Scale	Date	Number of maps
Geological Map of Malawi	1:1,000,00	1966	1
Geological Map and Handbook Series	1:100,000	1969	24
Mineral Resources and Occurrences	1:1,000,000	2000	1

E.7.5 Existing Topographic Maps

The Directorate of Overseas Surveys has published three topographic maps, including:

- Topographic Map (1965), scale 1:50,000, which is based on aerial photographs. The base map comprises a contour elevation plan that is overlain by geographic features and man-made infrastructures. The geographic features include surface water (rivers, lakes, swamps, springs), physiography (vegetation cover and land type) and demography (populated areas and urban centres). The infrastructure overlay includes man-made features such as dams, pipelines and supply boreholes.
- Topographic Map (1976), scale 1:100,000, which includes all the features presented in the 1:50,000 map.
- Topographic Map (1990), scale 1:1,000,000 which is a compilation of the 1:50,000 maps but includes a 3D elevation block model.

Table 9 lists the available topographic maps.

Table 9: Summary of Available Topographic Maps

Map	Scale	Date	Number of maps
Topographic Map of Malawi	1:50,00	1965	48
Topographic Map of Malawi	1:100,000	1976	24
Mineral Resources and Occurrences	1:1,000,000	1990	1

E.7.6 Aerial Photographs and Satellite Imagery

Malawi has been covered by black and white aerial photography, scaled at 1:40,000 (1978). Further information has not been provided but prints of the Central Region are available from the Groundwater Division who apply aerial photograph interpretation for the location of water supply boreholes.

In addition, satellite images (RGB 753) at a scale of 1:100,000 are available for the southern part of Malawi (1997). It depicts basic geological contacts (alluvium-hard rock, structures) and regional surface water features such as lakes and rivers. Copies are available from the Ministry of Natural Resources, Geological Survey.

E.8 DATA AVAILABLE FOR THE SADC HYDROGEOLOGICAL MAP

Based on the existing data sets and mapping, Table 10 summarises the data available for specific legend items that may be desirable to portray on a regional hydrogeologic map.

Table 10: Hydrogeological Map: Legend Summary

LEGEND	SOURCE DATA	PROCESSED DATA
Topography: • Contours (mamsl)	Topographic map (1965) Digital chart of the world (2000)	Hard copy only ASCII
Aquifers: • Aquifer type and extent • Water Resources Area	Geological Map (1966) Hydrogeological Map (1986)	Hard copy only Hard copy only
Groundwater: • Groundwater Level (mamsl) • GW chemistry (EC value only)	Hydrogeological Map (1986) CPAR, Water Aid	Dbase III (1951-1986) Master Data (1994-2002) MS Word (1994-2002)
Boreholes: • Location • Drilling details	Hydrogeological Map (1986) CPAR, Water Aid	Dbase III (1951-1986) Master Data (1994-2002) MS Word (1994-2002)
Springs: • Location	Topographic Map (1965) Hydrogeological Map (1986)	Hard copy only Hard copy only
Surface Water • River Gauging Stations (location) • SW chemistry (major ions) • SW flow rate	Hydrological Services Database Water Quality Database	HYCOS database
Supply Infrastructure: • Gravity fed pipeline • Village Supply	Hydrogeological Map Water Aid (Salima and Machinga)	Hard copy only MS Word (2000-2002)

E.9 COMMITMENTS AND CONCERNS

E.9.1 Commitments on Contribution to the Regional Mapping Project

The MoWD and the independent organisations involved in water and sanitation understand the importance of a regional groundwater map and are therefore committed to contributing to the proposed project. In practical terms, the following commitments were defined:

- The MoWD annually includes a budget for SADC related issues. For the Groundwater Division this amounts to 230,000 Malawi Kwacha (~3200 US$) for the period between July 2001 and June 2002. The MoWD-Groundwater Division will make available the hardware, software and manpower upon request and dedicate personnel as required;
- Independent organisations, although not contributing financially, would assist in data sharing and dedicate an unspecified amount of resources to the successful completion of the SADC regional map and atlas.

However, it is anticipated that project participation will provide reciprocal benefits such as training and capacitation of managerial and technical staff.

E.9.2 Concerns

Currently, very little communication occurs between the major institutional role players involved in groundwater resource management. Prior to contributing positively on a regional SADC scale, the MoWD, with the assistance of Mott Macdonald, aims to improve national communication by means of the following activities:

- Harmonise and improve groundwater data acquisition and management based on the "best management practices" developed by Mott Macdonald. A set of data collection and management protocols will be devised for implementation on a national scale;
- Create a nerve centre for groundwater resource management to complement the existing Zomba Water Committee, which is a voluntary platform for groundwater related issues. This centre will actively promote the use of agreed data acquisition and management tools; and
- Formalise and rationalise groundwater resource related investment by open communication between funding and donor organisations.

MASAF, CPAR and Water Aid actively support the above approach and would contribute to the development of such a national "nerve centre" which would ultimately act as the Malawi representative of groundwater resource management to SADC. However, assistance from the SADC WSCU is requested to overcome practical complications with regard to the implementation of an internal communication network, including:

- Ensuring that data acquisition and collection on a regional scale is compatible by providing protocols and guidelines. The SADC is requested to provide assistance on a country to country basis, actively supporting the development of a "nerve-centre" at all levels of national governance;
- Apply communication networks already in place and "lessons learnt" from SADC projects such as drought relief and hydrology (HYCOS);
- Providing a regional groundwater database, that can be accessed by each contributing member state whereby each country will be capacitated to produce and develop customised groundwater resource maps. This means that Malawi would be willing to share information with SADC member states, and particularly with Mozambique, if the same level of access to the regional database is provided to them.

In Malawi, the emphasis remains on capacitating of local experts in the production of customised groundwater resource maps based on a common regional database, rather than the development of an overall, generalised SADC map and atlas.

E.10 CONCLUDING REMARKS

Since the initial publication of the hydrogeological map for Malawi in 1986, no further progress has been made. On the contrary, protocols and data management techniques implemented in the late 1980's by the MoWD-Groundwater Division have deteriorated. In addition, since 1996, various other organisations have become involved in water and sanitation projects within Malawi. This has led to a de-centralised management of information. Furthermore, communication between organisations is carried out on a voluntary basis (Zomba Water Committee) since the MoWD does not enforce its lawful right to obtain drilling and water related information collated by the NGO's. Consequently, hydrogeological monitoring is limited to basic groundwater information (water strike, estimated blow yield, major ion chemistry) recorded during drilling only and specific QA/QC procedures are not practiced.

Nevertheless, all institutional role players understand the importance of a centralised database system to improve the management of water resources. Firstly, the MoWD will develop a standardised "code of best management practices". Subsequently, by mid-2003, meaningful contributions to the SADC mapping projects can be made. In return, the SADC project is anticipated to assist in capacitating groundwater specialists and managerial personnel.

E.11 REFERENCES

Groundwater Consultants, Bee Pee (Pty) Ltd, June 2001, Development of a Code of Practice for Groundwater Development in the SADC Region, Situation Analysis Report: Malawi, 13 pages.

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