THE UNITED KINGDOM CONTRIBUTION TO THE
INTERNATIONAL HYDROLOGICAL PROGRAMME (IHP)
OF UNESCO

Southern Africa FRIEND Phase II

Water Resources Workshop

17th – 21st February 2003, Pretoria, South Africa

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NATURAL ENVIRONMENT RESEARCH COUNCIL

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Executive summary

The Southern Africa FRIEND (Flow Regimes from International Experimental and Network Data) project is one of the regional components of the global FRIEND programme. The aim of the global programme is "Application of methods of analysis using regional data sets". Within the context of Southern Africa, the FRIEND project has the purpose of developing operational hydrological methods and knowledge in flow regimes, following a demand-driven approach, and establishing them in hydrological agencies in the region. This is a step towards the overall goal of making an effective contribution to the sustainable management of water resources in the region.

Transfer of technology and capacity building are key components of the project, and are implemented through a series of regional training workshops, especially on topics related to the specific areas tackled in the overall research programme. These workshops aim to strengthen capacity in the region for surface water resources assessment, planning and management. The three workshops are:

Workshop 1 – Low flow estimation and release of spatial data CD-ROM
Workshop 2 – River flow drought analysis and release of software
Workshop 3 – Water resources assessment and release of software

This is the report of the third workshop, on water resources including the release of the 'Low Flows 2000 – Southern Africa' prototype software for water resources assessment and management in the region. The workshop was held at the Department of Water Affairs and Forestry training centre at Roodeplaat Dam near Pretoria, South Africa between 17th and 21st February 2003. The workshop was attended by 17 delegates from 11 countries. This report provides a record of the workshop and the software and training provided.

CEH would like to thank DWAF staff for their help in the organisation and successful running of this workshop.

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1 Introduction

The countries of Sub-Saharan Africa experience great spatial and temporal variations in climate and water variability across the region. Drought is a frequent event, as the recent droughts in 1981-84, 1991-92 and 1994-95 demonstrate. At the other hydrological extreme, flooding can have just as devastating an effect, as shown by the recent disaster in Mozambique in February/March 2000. Furthermore, demands for water for irrigation, hydropower and domestic and industrial supply are growing rapidly. Water resources planning is complicated by the large number of international river basins (e.g. the Nile, the Niger, the Zambezi).

The availability of water is determined primarily by precipitation, which in the Southern African region varies between around 25 mm and 2000 mm per year. However, the rains are seasonal in nature, extremely variable and increasingly uncertain, and evaporation losses are high. There are few, if indeed any, areas where there is water of assured quantity and quality throughout the year. Forecasts of more frequent occurrences of droughts and the predicted impacts of climate change emphasise the need for a cooperative approach to water resource management of the many shared basins in the region.

Southern Africa FRIEND aims to strengthen the existing technical and institutional capacity of national and regional water institutions. Phase I of Southern Africa FRIEND, which ran from 1992 to 1997, developed regional databases of spatial data and time series data from the then 11 countries involved, with the intention that current and future research projects could utilise these data for the purposes of flood and low flow studies, rainfall-runoff modelling and GIS applications. In terms of regional surface water resources, five areas were investigated, including spatial and temporal variability of annual runoff, baseflow contribution to river flow, flow duration characteristics and estimation, and regional drought assessment.

Phase II of Southern Africa FRIEND, which commenced in 2000, focuses on the development of improved tools for water resources assessment and management for the 12 countries involved, including implementation of the ARIDA (Assessment of the Regional Impact of Drought in Africa) drought assessment software, development and implementation of GIS water resources software, and implementation of the GWAVA water availability assessment software. This research is supported by regional staff training and skills transfer, including training workshops and postgraduate studies.

The Water Resources Workshop is the third training activity under phase II, the first being the Low Flows Workshop hosted by Malawi in January 2001 and the second being the Drought Analysis Workshop hosted by Botswana in November 2001. The workshop focussed on the concepts of integrated water resources management within Southern Africa, the use of flow data within water resources assessment and

estimating flow statistics at ungauged sites using relationships between catchment characteristics and flow regimes. These ideas were demonstrated through the use of a prototype water resources management software package developed for Malawi. During the workshop, lecture sessions were augmented by practical individual and group exercises and talks by local experts and the delegates themselves. A CD containing the software will be distributed to the delegates with this report, and this CD will also contain the user manuals, exercises and course notes distributed at the workshop.

2 Water resources workshop

2.1 Organisation of the workshop

The Drought Analysis Workshop was held at the Roodeplaat Dam Training Centre of the Department of Water Affairs and Forestry (DWAF) near Pretoria between 17th and 21st February 2003. The workshop was attended by 17 delegates from 11 countries (Appendix A). A delegate from Angola was unable to attend because of a lack of capacity within the Direccao Nacional de Aguas, particularly with regards to English speaking staff. A representative from the Lesotho Highlands Development Authority (LHDA) also attended.

The delegates ranged from those who had good knowledge of various hydrological techniques for analysing and assessing flow data and hydrological modelling to those who had little knowledge. Some of the delegates had attended earlier FRIEND and SADC-HYCOS workshops where they had used the Centre for Ecology and Hydrology's HYDATA hydrological database software which includes some low flow analysis routines.

Each delegate was provided with a complete set of course notes and copies of the prepared exercises around which the workshop is based. At the end of the workshop, the delegates were each presented with a certificate to formally record their attendance.

The facilities provided by the Training Centre were good and included fifteen networked computers and a laser printer. Also provided were a computer projector, a designated projection screen, microphone and amplification system and an overhead projector.

The main aim of the Water Resources Workshop, run by CEH staff, was to give the delegates a background of the following, all within the context of Integrated Water Resources Management:

- the need for accurate water resources assessment
- the need for hydrological data within the assessment procedure
- knowledge of the techniques used to produce low flow statistics from gauging station data for this purpose
- an introduction to the concepts and realities of modelling flows at ungauged

sites
- how to produce catchment characteristics from GIS systems for input into such models
- as much practical use of a dedicated software tool for managing water resources using hydrological data as possible
- water resources issues within Southern Africa
- modelling water resources for the future using climate change scenarios

The workshop was based around a set of prepared exercises covering the main aspects of the training. These included individual exercises (both written and computer-based) and syndicate group exercises. In addition two sessions of the workshop were given over to presentations from the delegates on water resources issues in their countries. A workshop programme was prepared and this was followed fairly closely (Appendix B).

As part of a review of FRIEND activities, the delegates were asked to complete a questionnaire about the workshop (Appendix D). There were many opinions and little consensus on most topics, as a result of the range of backgrounds of the delegates. However, most commented that they found the computer exercises and group project worthwhile. Most delegates also welcomed the insight provided by the opportunity to share drought management experiences with counterparts from different countries.

2.2 Water Resources Workshop and Low Flows 2000 – SA Software

The workshop was opened by Stefan van Biljon, Director of Hydrology at DWAF. He welcomed the delegates to South Africa and to the DWAF training facilities. He stressed the importance of water resources management within the Southern Africa region and highlighted the pressure placed on National Hydrological Agencies to maintain quality gauging station networks with ever-decreasing funding from central governments. Finally he emphasised the importance of international cooperation for the future of water resources management within Southern Africa and welcomed the contribution of the FRIEND project in strengthening this cooperation.

The first session of the workshop focussed on Integrated Water Resources Management. Water resources management is a complex issue involving many stakeholders and many influencing factors. Delegates initially spent an hour working in groups to discuss some water resources issues and then returned to discuss each group's findings within with the rest of the course.

The lively discussion brought up many issues including:
- The numerous stakeholders within the water resources management process have varying requirements but many of these can be grouped under the ideas of: volumes of supply, temporal variability of supply, quality of supply and reliability of supply.

- There are many factors that affect the availability of water, both in the short and the long-term and these include climate, geography, land use, geology and water use.
- In order to predict the need for water in the longer term we need to include predictions of changes in population, agriculture, industry, climate, urbanisation, water use patterns, land use as well as factors such as irrigation efficiency, water treatment, environmental needs
- Data requirements will be key to the efficient and secure management of water resources
- Gauging station data provide key inputs to the quantification of surface water resources
- Where gauging station data is not available we need estimates of river flow data, particularly at low and medium flows, and estimates of the temporal variability of these estimates
- International cooperation is essential to the process of water resources assessment and management

After this first session the focus centred on the provision of and use of data within water resources assessment. Delegates were introduced to, or reacquainted with, some hydrological data analysis techniques and worked on some practical exercises on two of these techniques, flow duration curves and base-flow index, both useful for the quantification and standardisation of flow data from gauging stations.

The second session focussed on the link between catchment characteristics and flow regimes, particularly the flow statistics mentioned above. Delegates discussed the influences on flow data from within a catchment, looking at the possible effects of geology, land use, soil types, etc. Further work looked at the quantification of such catchment characteristics. GIS systems can store this data and can be used to efficiently retrieve catchment characteristics for use within models. The basic ideas of GIS coverages, digital datasets and retrieving data were illustrated through a presentation and a practical exercise using ESRI's ArcExplorer GIS tool. A discussion of existing datasets of catchment characteristics within Southern Africa concerned regional and national datasets, and a questionnaire about data availability and GIS use was completed on a country basis.

Presentations on the second day focussed on the variety of models that link catchment characteristics to flow statistics, including conceptual rainfall-runoff models, regression analysis and flow duration type curves. These models can be used to estimate flows or flow statistics beyond the reach of the gauging station network. Examples of such models within Southern Africa were mentioned. This discussion was further focussed on the low flow estimation method developed for Malawi during this phase of the FRIEND project, whereby flow duration curves are estimated through a process linking catchment soil types and rainfall to flow regimes and flow statistics.

On Tuesday afternoon the delegates had the pleasure of an excellent presentation by Johan van Rooyen, Director of Water Resources Planning at DWAF. The presentation summarised the move towards Integrated Water Resources Management in South Africa and detailed the causes of the process, the reserves for the environment and for Basic Human Needs and the problems with the implementation of these, the need for accurate models and for public participation within this process. Delegates from the other Southern African countries expressed a great deal of interest through their questions and it was generally considered a useful overview of a very important process, and one which may be repeated to various extents within other countries of the region.

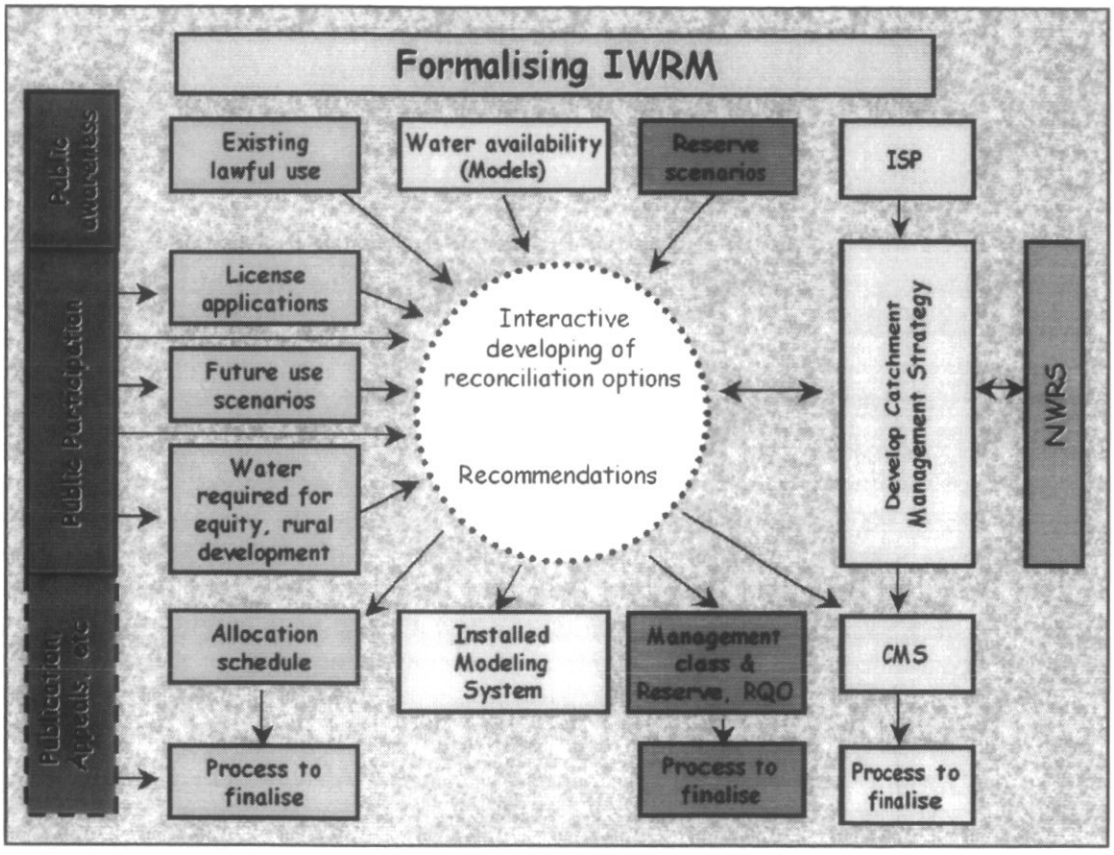

Figure 2.1 Schematic of influences on South Africa's IWRM system (courtesy Johan van Rooyen)

Continuing from this discussion, delegates were brought back to the detail of water resources management with the use of the 'Low Flows 2000 – Southern Africa' software developed for Malawi as a prototype water resources management system for the Southern Africa region. Over the following days a number of exercises were undertaken using the software at a number of levels, including:

- Introduction to the LF2000-SA interface
- Basin definitions
- Natural Flow Estimates
- Adding an abstraction
- Influenced Flow Estimates

- Adding a Discharge and generating water use scenarios
- Adding an impoundment and setting river names
- Using a residual flow diagram for stream assessment

At the end of the week a questionnaire was completed by delegates about the usability and appropriateness of the software within their work. The software was generally found to be very useful by delegates. The idea of linking real and estimated flow data with artificial influence data was new to most of those present, and the GIS visualisation of artificial influences (abstractions, discharges and impoundments) upon the river stretches was considered very powerful and potentially very useful to their licensing departments. In this way the software itself encourages the integration of two areas of the water resources management process: hydrological information and licensing.

2.3 Field trip to DWAF HQ, gauging station and dam

On Wednesday, delegates were taken on a fieldtrip to the Department of Water Affairs offices in Pretoria, to the Kalkheuwel gauging station on the Krokodil River and to Hartebeespoort dam.

At DWAF delegates were shown the flood monitoring system by Johan van Heerden and Brink du Plessis and the SADC-HYCOS centre by Felix Wulff and Gerhard Booysen. Delegates were given a detailed description of the effects of the 2000 floods and of the subsequent reconstruction of gauging stations. The size of the flood is considered to have been as large as a 1 in 1000 year event, and major devastation was caused to the gauging station network in the Incomati, Maputo and Limpopo basins. Peak flow data was also lost through the destruction and the new gauging stations are now designed to record the largest events and are considered some of the best in the world. The flood monitoring system in South Africa is very advanced for the region. Telemetry data is read at the DWAF HQ and fed into a designated software system. This allows river flows and dam levels throughout South Africa's major basins to be monitored. As well as avoiding downstream damage, the system assists DWAF staff to ensure that dams are full at the end of the wet season. A second system allows real-time monitoring, at a one-hour interval of weather systems in and around Southern Africa.

The SADC-HYCOS project funded telemetry systems for water resources management in all of the SADC countries involved in FRIEND, excepting Mauritius. Many FRIEND delegates were also involved in the SADC-HYCOS project either directly or indirectly and so were interested to hear the presentation on the potential of expansion of the network in the proposed second phase. The new database showing real-time data to users across the internet was also demonstrated.

The Krokodil river flows from Pretoria and Johannesburg, into the Hartebeespoort Dam and out to the Limpopo river. The station at Kalkheuwel is upstream of the dam.

Delegates were shown the telemetry system and measured the flow of the river at 5.6 cumecs. Over the subsequent days of heavy rain, at intervals during the training course, delegates monitored the change in flow over the internet through its increase to 120 cumecs and subsequent subsidence.

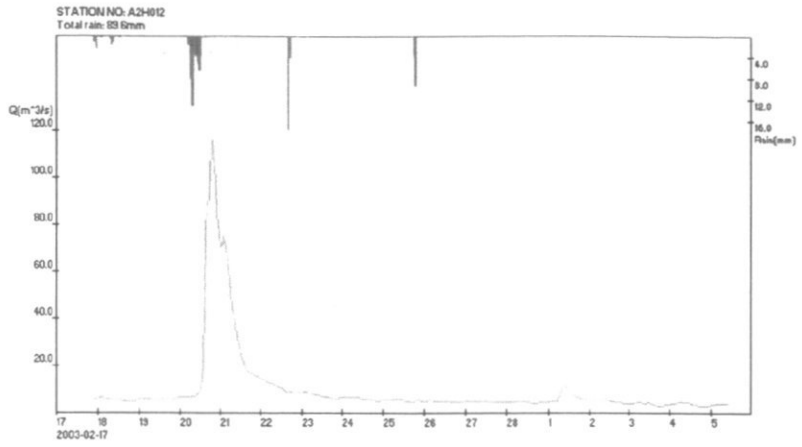

Figure 2.2 Graph of flow gauging record from the Krokodil at Kalkheuwel during the week of the workshop, from the DWAF website

Hartebeespoort dam was built in 1930 to provide work in times of economic hardship and is currently used for irrigation, public supply and recreation. Information on the dam was distributed to delegates.

The field trip was very successful and showed South African hydrology and water resources management to be at the forefront of both science and infrastructure within the region, illustrating the potential for the future of many of the countries with delegates present.

2.4 Presentations of water resources assessment models and Southern African water resources issues

Thursday saw a return to the training centre and some continuation with the exercises described above. In the latter part of the morning a case-study of the GWAVA Global Water Availability Assessment in Swaziland was presented by staff of CEH and Department of Water Affairs (DWA), Swaziland. This detailed a grid-based approach to water resources modelling, explaining the theory and practice involved in applying it to model potential changes in water stress over fifty years under three different climate change scenarios. Delegates were presented with a copy of the report on the application of GWAVA to Swaziland and some additional GWAVA information.

In the afternoon the delegates were invited to present a single-slide on one or more water resources issues within their country. The presentations were excellent and wide-ranging whilst providing a good comparison between water resources assessment in each country, particularly on the similarity and differences between the

licensing procedures followed. Predictably much discussion was provoked and the session ran on until a social barbecue held at the training centre that evening. A summary of the delegate presentations is provided in Appendix C.

On Friday delegates finished their software exercises and were asked to contribute to a discussion of the use of the system. The DFID-funded OASIS resource centre was also presented before delegates were thanked for their participation and presented with certificates

3 Summary

The Drought Analysis Workshop held at the Department of Water Affairs and Forestry's Roodeplaat Training outside Pretoria, South Africa between 17th and 21st February 2003, was attended by 17 delegates from 11 countries. The workshop was an activity of Phase II of Southern Africa FRIEND. Delegates were introduced to Integrated Water Resources Management and the use of hydrological data in the water resources management process, particularly linking real and modelled flow statistics, derived from catchment characteristics using GIS, to water use information using a dedicated water resources management tool for Southern Africa. The skills taught in the workshop will strengthen capacity in the region for surface water resources assessment, planning and management. This workshop builds on, and complements, the training given in the two previous SA FRIEND workshops on low flow analysis and drought analysis.

Appendix A – List of workshop participants

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Appendix B – Workshop programme

Monday 17th February

am Welcome to South Africa – Stefan van Biljon, Director of Hydrology, DWAF
Introduction to Water Resources Workshop
Terminology

pm General Hydrology and Catchment characteristics
Catchment data and GIS

Tuesday 18th February

am Surface water modelling
A low flow estimation method for Malawi

pm Johan van Rooyen – Director of Water Resources Planning, DWAF
Water resources management in South Africa
Low flow estimation and licensing in the UK
Introduction to water resources software for Southern Africa

Wednesday 19th February

Field trip to DWAF flood monitoring station and SADC-HYCOS centre
Field trip to gauging station and Haartebeespoort Dam

Thursday 20th February

am Use of water resources management software for low flow estimation
GWAVA – Global Water Availability Assessment, Sidney Dhlamini, DWA, Swaziland

pm Delegate presentations of water resources issues in Southern Africa

Workshop barbecue at Roodeplaat training centre

Friday 21st February

am Group project

pm Review
Course closure

Appendix C – Summary of delegate presentations

During the Southern Africa FRIEND water resources workshop, held 17-21 February, Pretoria, South Africa, delegates spent an afternoon dicussing water resources issues within their own countries. Each delegate was asked to prepare and present a single overhead or computer presentation slide on a water resource issue, and the following list was given to suggest appropriate themes:

- How abstractions are managed / licensed within your country.
- How river flows are estimated at ungauged sites within your country.
- How water requirements are estimated within your country.
- The use of spatial data / GIS within your organisation, particularly catchment characteristics (rainfall, runoff, geology, soil, land use, etc.) or water use information.
- An example of a recent project in your country that worked upon abstraction licensing, flow estimation or estimating water requirements within a catchment or catchments.
- Recent changes to the structure of your organisation and how these changes affect abstraction licensing, flow estimation or water requirement estimation.
- Specific problems or issues of water availability or water use within your country.

A summary of the presentations is given below:

Botswana

IWRM – Problems in the Gaberone catchment area (Daniel Kemiso)

A catchment situated in the South-East area of Botswana and extending into South Africa was described. The problems of surface and groundwater pollution were highlighted. These problems are exacerbated by the fact that the land is administered by different authorities and therefore development is often unplanned and information gathering can be difficult and intensive farming in this area, as well as small industries such as brickmaking, pollute streams and groundwater. Action and mitigation plans have included a study to coordinate land use plans, pre-treatment works for some industries and improved monitoring of streams. Existing legislation for licensing of discharges and prosecution of polluters has sometimes proved difficult to enforce.

Lesotho

Changes in the structure of Department of Water Affairs in Lesotho (Liphaphang Khaba and Sephiwe Rafutho)

Since the movement of the SADC Water Sector Coordinating Unit (WCSU) from Maseru to Botswana there has been a need for a change in the structure of the national water authority, the Department of Water Affairs, to accommodate the staff released from duty within SADC WSCU. These changes have principally involved the creation of a post of commissioner between the Director of DWA and the Minister for Water as well as the inclusion of a post of Principal Water Resources Engineer.

Applicability of Haan (1977) vs Shaw (1994) Extreme Value type III equations (Liphaphang Khaba and Sephiwe Rafutho)

The EVIII distribution describes the probabilistic distribution of extreme events. Two versions of this distribution and their application to annual minimum flows from 13 catchments within temperate mountainous Southern Africa were described. The first was considered suitable for use in this region, but the second was considered unsuitable as parameters were incalculable where the standard deviation (of a sample of annual minima) exceeds the mean.

Malawi

Management of licensing and abstractions in Malawi (Oswald Mwamsamali)

The procedures and processes involved in licensing an abstraction in Malawi were detailed. Applications are made to the Water Resources Board (WRB), an independent panel made up of stakeholders in the water sector in Malawi. This board has no staff but its functions are carried out by the Ministry of Water Resources Development in Malawi. Applications are scrutinised by the WRB with the help of the surface or groundwater sections of the MWRD. The WRB then advertises the application in the media for the sake of public information and / or to allow objections to be raised. Applications can be deferred while more information is requested. Accepted applications are then issued and are endorsed by the Minister. The License is then monitored to check compliance with the stipulated conditions. All licenses are currently dealt with through this process. The effectiveness of licensing within the country is being limited because of the difficulty of enforcement, mainly due to the current 'financial drought'. A recent consultancy project has recommended the transition of the WRB to an independent self-financing body.

Mauritius

Management of water abstractions in Mauritius (Suzanne Boodhoo)

As a small island with very limited water resources, the management of abstractions needs to be well planned. Abstractions from rivers total 408 MCM per year (370 of which is used for agriculture) whilst the usage of water from dams amounts to 124 MCM (excl. hydropower) and groundwater 135 MCM. Surface water abstractions rights are considered a priori and are mostly owned by sugar cane plantations which provide a powerful lobby against water law reform. The surface water allocation is already at its limit. Groundwater is considered public property and licenses are granted though charges can be high. Issues are the quantification and classification of these water rights, and the research of effects of abstraction on the groundwater aquifers.

Water Demand Management (Manta Nowbuth)

Since the serious drought of 1999, Mauritius has concentrated a substantial effort on water demand management. As the provision of water resources is expensive, water demand management has been seen to be an efficient way to effectively harness increased water

availability. Example initiatives include minimising losses in water supply networks, adopting more efficient irrigation systems and reuse of wastewater for irrigation, raising public awareness of water issues. Existing fragmented water laws need to be improved to tackle the upcoming problems in water resources management.

Namibia

Summary of water resources issues in Namibia (Walto Metzler)

1. Abstraction licensing procedures are similar to those in Malawi, as described above
2. Low flow estimation is performed using a rainfall-runoff model and a unit runoff map for the whole of the country
3. Spatial data is used for certain small projects and the recent border Namibia-Botswana delimitation project
4. Estimations of water requirements are made using data from the population census, growth figures for crops and livestock and licenses for mines
5. Recent changes in the law have shifted the system from one of riparian rights to one based upon equity, wherein households are given priority, followed by industry and then farming
6. The future for water management was outlined through examples of proposed schemes for inter-basin transfers from Congo, Angola and rivers bordering Namibia.

South Africa

Classification of South African resources in terms of ecological reserve determination (Estelle van Niekerk and Ans Naude)

The recently proposed water reserve has two components: Ecology and Basic Human Need. Basic Human Need is defined as 25 litres per person per day. However ecological requirements are harder to quantify. On application for an abstraction licence the 'Instream flow requirements' must be determined in order for the stream to fit one of four categories: Near natural (25-60% of natural MAR), Good (25% of NMAR), Fair (15% of NMAR) and Poor (<15% of NMAR). The classification of a stream into one of these classes can be done at a number of levels, with different levels of confidence and expense. A desktop assessment provides an instantaneous modelled flow value. A rapid assessment is a desktop assessment with a field measurement for calibration. An intermediate assessment requires two field trips, at low and high flows, and a comprehensive assessment is as rigorous as an intermediate assessment, but involving public participation. Rivers are assessed viewing the natural and present MAR, the water quality (pH, temperature and dissolved oxygen), ecology (rapid invertebrate surveys are performed as well as fish surveys using stunning equipment), geomorphology and riparian vegetation. Specialists then decide what reserve will be required to keep the river in its present state, as well as to produce its future state, for the desired class as well as the class above and below this. Problems are due to the difference in interpretations of ecological data and in the monitoring of compliance.

Tanzania

Water Resources Issues in Tanzania (Dr Raymond Mngodo)

The abstraction licensing process in Tanzania is similar to that in Malawi and other countries as mentioned earlier. Licenses are issued by regional authorities rather than a national body. For large abstractions, such as those required for mining, spot gauges are performed to assess flows and a verification process of the license with existing users nearby is completed, informing stakeholders. The board issues the right, paid for annually by (licensed) volume and are initially temporary whilst initial monitoring takes place. The example of a license to increase the public supply to a town near Morogoro was given, where the license was refused because of the detrimental effect on the river flows and the inevitable impacts of sediment from increasing erosion upstream. Tanzania is currently in the process of changing its water management practices, moving to a catchment-based approach. Currently 5 of 9 basins have undergone some stages of this process; including the Pangani; Rufiji,-Lake Victoria and Lake Nyasa basins, with 1 more to be added soon. The new water policy reflects the multi-sectoral approach to water resources management.

Zambia

Water Resources Action Programme (Hastings Chibuye)

Zambia's new programme was detailed, explaining how the national water policy is being supported to promote sustainable development and use of water. The programme addresses issues ranging from institutional reform to water resources assessment, human resources, financing mechanisms, water quality, technology and information systems. It is based on principles of recognising the importance of water in socio-economic development, vesting the ownership of water resources under state control, integrated management, defining institutional responsibilities, developing an effective legal framework, disaster preparedness and recognising water as an economic good. This last point was discussed, focussing upon the meaning of recognition of the economic value of water.

Zimbabwe

Licensing of abstractions in Zimbabwe (Wellington Dzvairo)

A new water act was introduced in Zimbabwe in 1998, the headline of which was that previously perpetual rights have now been converted to permits. Catchments are run with the involvement of stakeholders and the processes are assisted by ZINWA, a quasi-governmental body for water affairs and each catchment has a Catchment Outline Plan. The Minister has control of the abstraction licensing process, within which licenses are analysed against flow duration curve information from the catchment. A processing fee and a levee payable by volume is due, and the administration of the process and the catchment authorities are self-financing, without assistance from central government. Abstractions within certain catchments within the country are restricted, principally those surrounding major cities and towns.

Appendix D – FRIEND Review Questionnaire

Southern Africa FRIEND Water Resources Workshop
17th – 21st February 2003, Pretoria, South Africa

Review of FRIEND training

An external review of the FRIEND project is currently being completed, including an assessment of training and capacity building opportunities. As you have just completed a FRIEND workshop your views on the training provided and its relevance to your job are of particular interest. It would therefore be appreciated if you could answer the questions below as fully as possible. Thank you for your help.

Name ..... **Job title** .....

1. Have you had any other training opportunities through FRIEND?
   If yes, please underline type of training and give details e.g. date, location, duration

   HYDATA training
   Hydrological Data Processing course
   Flood Frequency Analysis course
   Low Flows Estimation workshop
   Rainfall-Runoff Modelling course
   Drought analysis workshop
   In-house training within your organisation
   Study visit to another organisation
   Other

2. Did you have any knowledge of water resources and flow estimation before this Workshop?
   Please underline as appropriate:
   very good good some poor no knowledge

3. Has the Water Resources Workshop been enjoyable and of benefit to you?
   Please comment on your answer.

4. Was the Workshop material presented at an appropriate level and in an interesting way?
   Please comment on your answer.

5. Was there sufficient practical content to try out new skills?
   Please comment on your answer.

6. How good were the training facilities provided?
   Please underline as appropriate: **very good** **good** **adequate** **poor**

7. How good was the accomodation provided?
   Please underline as appropriate: **very good** **good** **adequate** **poor**

8. How relevant has the Workshop been to your job? Do you think you will have an opportunity to apply your new skills?
   Please give details.

9. Please underline what you see as the key applications of the Workshop to your work.

- **Irrigation**
- **Public Water Supply**
- **Hydropower**
- **Abstraction licenses**
- **Industrial effluent dilution**
- **Instream Ecology**
- **Water quality**
- **Low flow/ drought forecasting and monitoring**
- **Water resource management**
- Other – please explain

10. Do you think the skills learnt will improve your ability to do your job?
    Please comment on your answer.

11. How could the Water Resources Workshop be improved in the future?

12. Do you think workshops like this make an effective contribution to water development issues in your country?
    Please give details.

13. What issues would you like expanded upon in any further workshops? What issues that have not been covered would you like to be covered?