SADC-HYCOS Phase III Project Proposal

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1. INTRODUCTION AND BACKGROUND

As the human population continue to increase, efficiency in the use of water has become a key issue and remains an area of concern for all. Africa's economy has been dramatically affected by water shortages. Rising temperatures and increased water demands combined with deteriorated quality of the available supplies increase the strain on the already fragile resource. Devastation caused by floods due to lack of proper forecasting systems results in the displacement of people from their homes. Climatic changes and population growth have been affecting water availability in many parts of the world especially in Africa.

It is a well known fact that water and the availability of its data and information is the key issue for achieving socio-economic development plans in any country or region. Therefore collecting data and information is a must for the economic and social growth of any nation. At the same time dissemination and exchange of such data and information is necessary for strengthening regional co-operation. Water has become one of the most highly valued natural resources in the world. It exerts enormous influence on a country's economy and almost every development is linked to the adequate supply and control of water.

Despite the environmental constraints of hydroclimatically induced water scarcity and the continuous fluctuation of natural freshwater supplies, decision making related to complex issues such as meeting increasing demand for water and food, allocating water between competing users, and ensuring sustainability of freshwater ecosystems in the face of human pressures requires sets of data and information to resolve such issues. For such decisions data and knowledge about natural resources, environmental and socioeconomic components are necessary at national and regional levels. Reliable and accurate data and information with a special mechanism for dissemination is needed to solve these problems. This means that the collection, storage, analysis and dissemination of data in conjunction with free exchange of information are all subjects demanding top priority in national and regional planning. Use of advanced technology in this area will yield better results in the fight against the depletion of economy.

In order to provide the international community with basic data for monitoring and managing the water resources through observations of the hydrological cycle and at the same time to meet the need for innovative technology required for obtaining accurate data, WMO initially in 1993, with the support of the World Bank launched a global programme for monitoring the hydrological cycle. Currently with the support of other financial partners including the Netherlands Government, the European Union, French government and the African Water Facility six projects are at the final stage of completion.

The WHYCOS is a world-wide programme designed to improve co-operation at grassroots and global level in the establishment and improvement of reliable water resources information systems for enhancing sustainable development. It is based on basin/sub-regional network of reference stations transmitting real-time hydrological and climatic data via satellite ensuring high quality data for updating national and regional

data bases. The programme is designed and implemented in independent regional/basin components called HYCOS`s (Hydrological Cycle Observing System), each of them comprising of National Hydrological Services (NHSs) operating within well defined hydrological regions. The WHYCOS ultimate goal is intended to stimulate water resources assessment activities, capacity building and strengthening basin-wide, regional and international co-operation in the field of integrated water resources management.

1.1 SADC- HYCOS Phase I Project

The need to improve the availability of accurate and timely data for water resources planning and management was highlighted during the 1992 Rio Earth Summit. Agencies responsible for hydrometeorological data collection and dissemination were noted to be:

- Lacking resources to maintain observation stations.
- Using different procedures for collecting data.
- Producing data of varying quality.
- Using different standards.
- Dependent on unreliable telecommunication systems.
- Using outdated information management systems.

The World Meteorological Organisation (WMO) and the World Bank formulated the World Hydrological Cycle Observing System (WHYCOS) in 1993 with the objective of strengthening the technical and institutional capacities of National Hydrological Services (NHSs) so that they can meet end-user requirements for water related information. WHYCOS aims at establishing a global network of national hydrological observatories, and facilitating dissemination and use of water-related information. An evaluation of WHYCOS resulted in the refocusing from the global to regional and national initiatives aimed at strengthening the capacity of NHSs for providing regional and basin wide information so as to address the needs of the participating countries. This refocusing led to the development of several regional HYCOS projects, e.g. Mediterranean, SADC regions. Figure 1 shows the status of development of the WHYCOS programme as of 2000 (source: Phase II Implementation document)

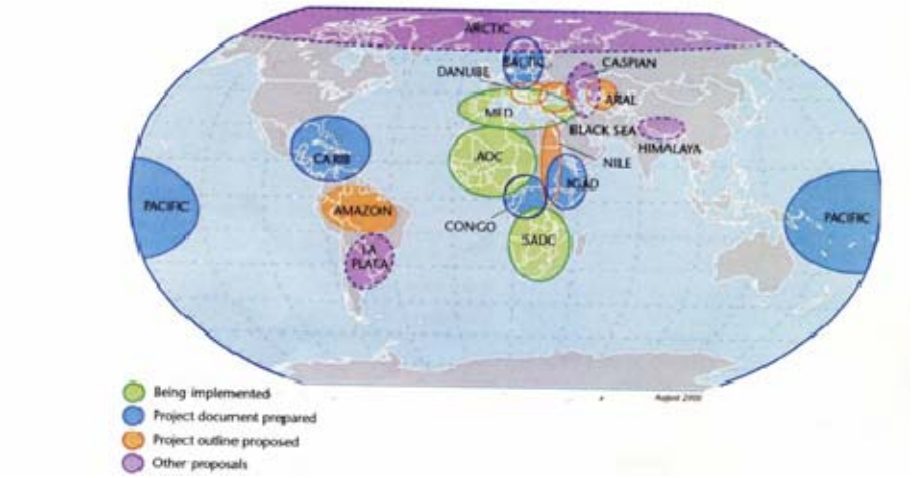

Figure 1 The status of development of the WHYCOS programme

For the SADC Region, the establishment of a reliable region-wide hydrological network has been a long standing priority objective. The importance of this objective was acknowledged by the Region when regional water resources matters were coordinated by SADC Environment and Land Management Sector (ELMS) and by the SADC Water Sector established in 1996.

With the establishment of the SADC Water Sector Coordinating Unit (WSCU) in 1996, conditions were created to manage water and water projects on a regional basis, through the Regional Strategic Action Plan (RSAP). As part of RSAP, SADC-HYCOS was established in 1998 to promote regional co operation between NHSs and to set up a regional information system on water resources.

1.1.1 Objectives of the SADC-HYCOS Phase I Project

The overall objective of SADC-HYCOS Phase I project was to contribute to the regional socio-economic development through the provision of management tools necessary for sustainable and economic water resources development and management. The project was also expected to provide water resources data and information for decision making on all aspects of Integrated Water Resources Development and Management. The specific objectives were:

- To provide SADC with one of the necessary tools (information system) for improving regional water resources assessment, monitoring and management for peaceful and sustainable development of the region.
- To assist participating countries in developing their own national capacity and benefit from the project.
- To facilitate collaboration with other national, regional and international projects and programs aimed at the modernization and improvement of water resources information systems in the continental part of the SADC region and at the international level.

1.1.2 SADC-HYCOS Phase I Activities and Deliverables

The activities that were to be undertaken in order to fulfil the objectives of SADC-HYCOS I included:

- Installation of a network of 50 Data Collection Platforms (DCPs) for data collection and transmission at 3 hourly intervals through the Meteosat data collection system.
- Supporting NHSs in enhancing the management of national databases by providing software and training.
- Setting up a regional database of data from the DCP network, historical data and information provided by the NHSs and the UNESCO-IHP Southern Africa FIEND-project.
- Enhancement of regional co-operation among the NHSs, and between the NHSs and the Pilot Regional Centre (PRC).

To evaluate the project achievements against its objectives, WMO supported two highly qualified consultants to undertake an evaluation mission in 2002. In the evaluation report it was noted that the outcomes of the project included the following:

- SADC-HYCOS Phase I installed 43 out of the planned 50 DCPs in 10 countries. However some of the DCPs were no longer operational for a variety of reasons such as, lack of spares, vandalism, insufficient skills in NHSs due to high staff turn-over resulting in some of the people trained by the project having left the respective NHSs.
- HYDATA software was provided to all participating countries and NHS staff were trained on the use of this software. This provided a platform for data management, exchange and dissemination at the regional level. However the actual exchange of data amongst the countries was low by the end of Phase I due to problems with the project website as most of the participating NHSs had difficulties downloading data from the website.
- A regional electronic network was established and some NHSs were provided with computers and e-mail facilities which greatly improved communication among the participating countries and with the PRC.
- A Regional Database (RDB) consisting of data from the HYCOS project and Southern Africa FRIEND project was developed.
- Some countries lost a lot of critical technicians/hydrologists who were trained by the project and involved in the operation and maintenance of SADC-HYCOS equipment. It was also felt that the training was not as comprehensive as most NHSs required. It was recommended that a much more detailed training program be developed and that additional technicians/hydrologists be trained in the NHSs.
- The design for SADC-HYCOS Phase I network was largely influenced by formal submissions made by the respective countries, which did not always address the need to have adequate data for management of water resources at the river basin level.
- The development and dissemination of hydrological products from the collected data did not materialise.
- Data transmitted from DCPs to the Regional database at the PRC was supposed to be validated. However, this activity was not carried out.

A major success of SADC-HYCOS Phase I was the enhancement of collaboration among SADC NHSs which created a platform for data exchange. Real time data technologies and related training were also introduced in some of the NHSs. This was a major step towards modernisation of hydrological data collection and transmission. Some of the real-time data collected from the Phase I network was of major benefit in monitoring and managing flooding following the occurrence of Cyclone Eline in 2000.

Figure 2 shows the location of Phase I stations and Figure 3 shows the general scheme of the flow of data and information in the SADC-HYCOS Phase1 Project.

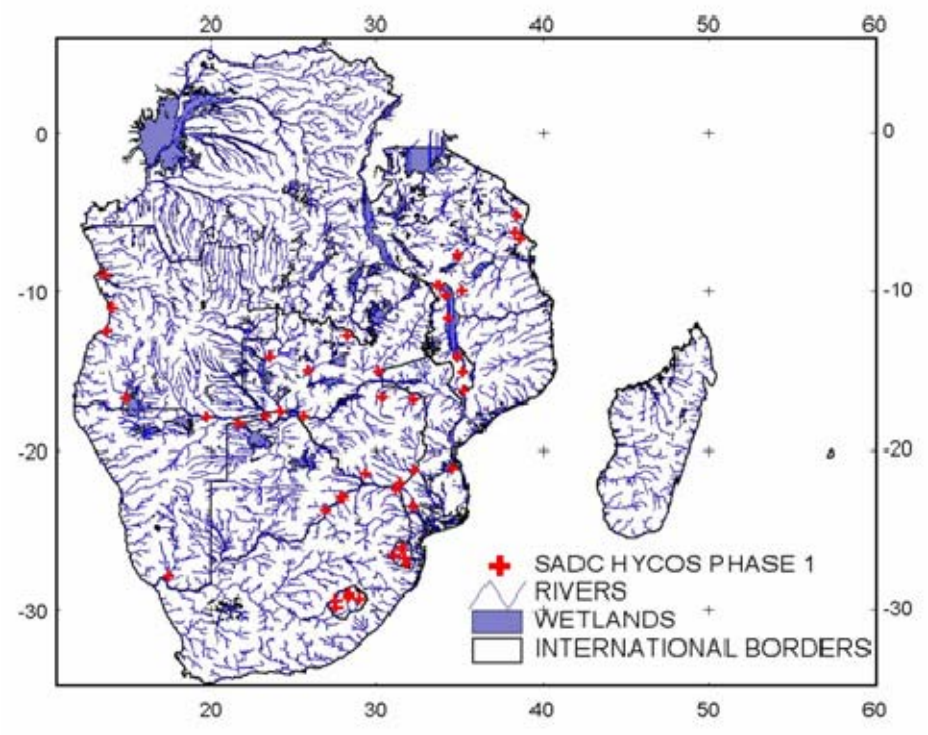

Figure 2: The location of Phase I stations

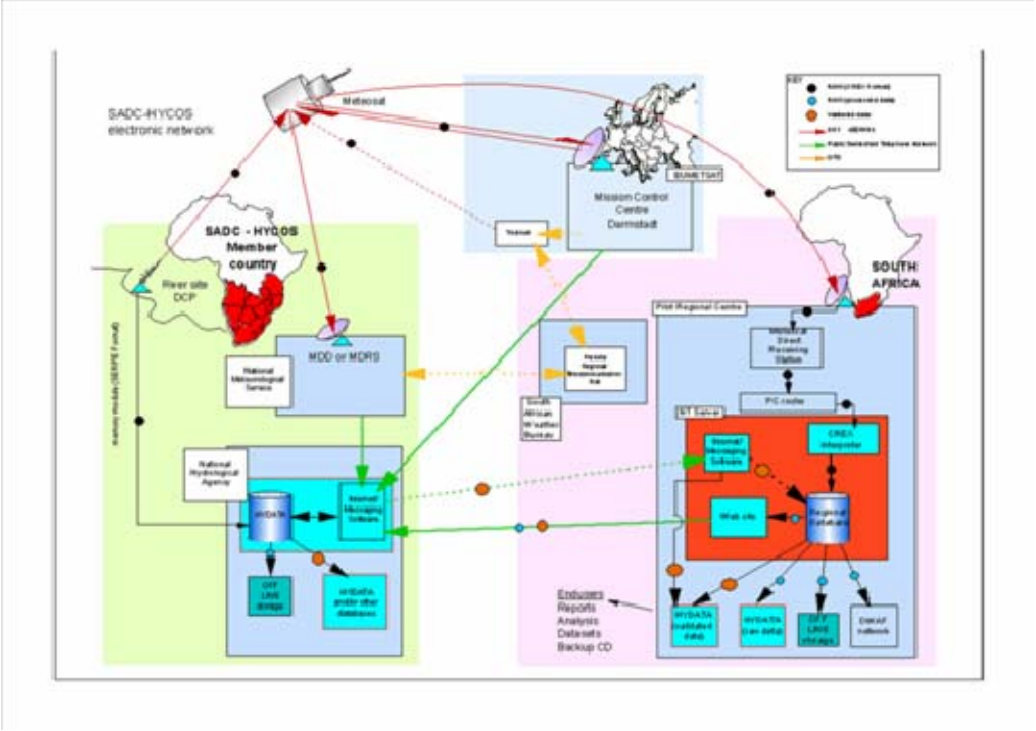

Figure 3: The general scheme of the flow of data and information in the SADC-HYCOS Phase1 Project.

1.2 SADC-HYCOS Phase II

The SADC-HYCOS Phase I project was conceived as an instrument to foster co-operation between SADC Member States in providing hydrological, meteorological and basic water quality data to SADC Members and other end users. As such, it was designed first to involve Member States in the project (by adopting the philosophy of equitable sharing of infrastructure) and secondly providing information on important rivers and basins for the security and wealth of the people. Phase I was also considered a success from the perspective of the co-operative mechanism that had been established to address water related problems on a regional scale and that the nucleus of a water resources information system was in place.

As a follow up to Phase I, the SADC-HYCOS Phase II Project commenced in 2006, and was designed to consolidate and expand on the project activities that were initiated during the first phase. The consolidation was expected to address the need for further institutional strengthening, building capacity in using the new technologies for maintenance and operation of DCPs, and in the development and management of regional databases using common standards and operating practices. The expansion was aimed at ensuring that the system is fully responsive to regional needs for water resources assessment, drought monitoring and flood forecasting. This would include improvement of the real-time observation network and data transmission and reception capability, development of a regional water resources information system, as a decision-making tool for water management, generating products for both national and regional applications and continuing the training of staff.

1.2.1 SADC-HYCOS Phase II Project Objectives

The Project had four main objectives that contributed to achieving the above goal:

- To include the new SADC Member States which did not participate in or benefited from Phase 1 of the Project;

- To undertake a comprehensive review of the hydrological observation network throughout the SADC region and propose appropriate improvements to meet the water resources management needs;

- To expand the observational network with Meteosat DCPs or other types of hydrological stations as required, according to the identified needs (i.e. flood monitoring/forecasting on specific rivers, water sharing with downstream users, assessment of the water resource);

- To expand the water resources information system and to ensure its easy accessibility to all NHSs.

1.2.2 SADC-HYCOS Phase II Project Components

The Phase II Project would build on the achievements of Phase I and was planned to be delivered in four distinct components:

- Improvement of the network of hydrological observing stations;
- Further development of the sub-regional and national water resources information systems;
- Identification and development of hydrological products of regional interest;
- Training and awareness building.

1.2.3 Current Project Status: Achievements and Lessons Learned

The delay in commencing the implementation of the project phase greatly affected the implementation status of the project taking into account that the project only commenced in November 2006 instead of November 2005. Each of the four main components of the Project has activities which will not be completely achieved (100%) by November 2009 and the impact of some activities is greater than others.

1.2.3.1 **Component 1 – Improvement of the Hydrological Network**

Network Design Review

The first task under this component was the design of a strategic and optimum network for all the 15 transboundary river basins in the SADC Region. The network design took into account the specific requirements of island Member States, and any other special cases which warranted consideration. The network was supposed to address the following strategic objectives:

- Hydrological monitoring for basin-wide water resource assessment and planning.
- Flood and drought monitoring, forecast and mitigation, for management purposes.
- Water quality and pollution monitoring and control.
- Monitoring to support environmental and ecological management.
- Monitoring compliance with international agreements between basin states in line with SADC protocol on shared water courses.
- Groundwater monitoring and management.

A consultant was recruited to identify the location of the proposed Phase II stations (50 DCP stations and 50 Data logger stations), taking into account the locations of the 43 DCPs installed during Phase I. South Africa also pledged to include 11 DCPs on various tributaries of the Limpopo basin for flood management and water resources planning.

The final network design comprised of 41 DCP stations, 30 Data Logger stations, 14 groundwater monitoring sites and portable water quality kits for each NHS. The final network design report was evaluated against the above strategic objectives and approved by the participating countries.

Figure 4 shows the distribution of SADC-HYCOS Phase II DCP stations according to the Network Design Report.

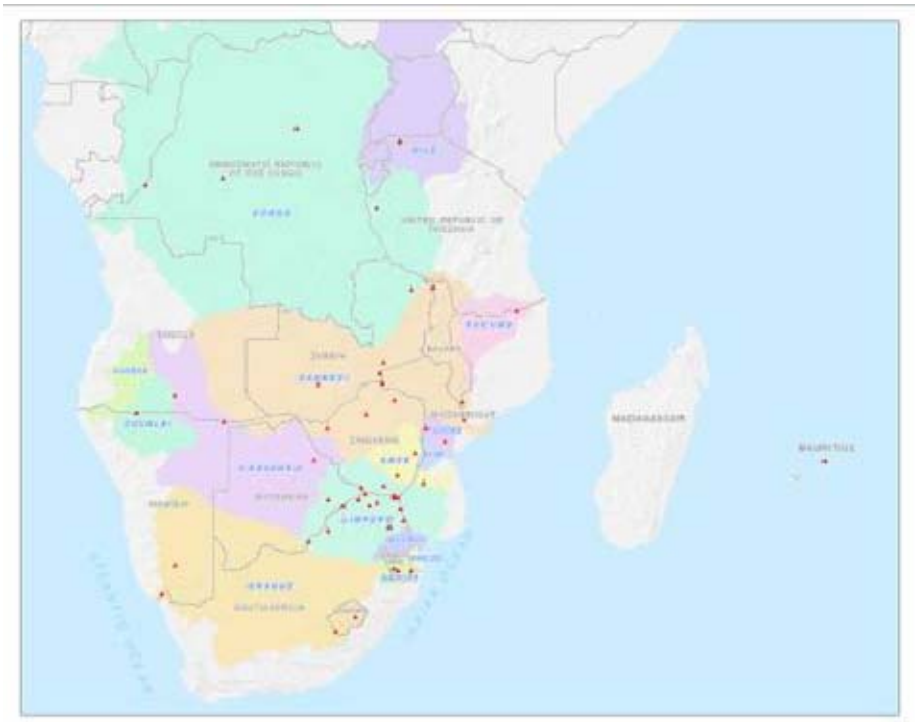

Figure 4: The distribution of SADC-HYCOS Phase II DCP stations

Rehabilitation of existing SADC-HYCOS Phase I stations and Equipment installation on Phase II stations.

Subsequently, the second task under this component was the establishment and operation of this network of key monitoring stations on the transboundary rivers within the SADC sub-region contributing to reliable and timely data.

At the onset of Phase II it was realised that most of the Phase I stations were no longer operational, the delay between the end of Phase I and the start-up of Phase II affected the operation and maintenance of stations. A number of stations were damaged or washed away by floods, vandalised or destroyed by other natural causes. This resulted in an unanticipated six months rehabilitation programme being incorporated into the component. A total of 43 stations were visited and 33 rehabilitated, the remaining 10

stations were either washed away by floods, completely damaged by natural causes or vandalised and are meant to be recommissioned during the installation programme of Phase II stations.

The installation and initialising of new stations which has the biggest impact on overall performance of the project, has been greatly affected by the delay in the start of the project activities. It is anticipated to be 50% complete by the end of the Phase II Project (30 November 2009). It is worth noting that had the full 4 year span of the project been dedicated to this activity, it may have been possible to achieve 100%. The 6 months allocated to rehabilitation of Phase I stations proved to be inadequate. The procurement of new equipment, although expedited through a South African Department of Water Affairs and Forestry tender, still proved to be a lengthy process, with the Project subjected to the Implementing Agent's processes and timing regarding the tender. Registration of stations with EUMETSAT also took longer than anticipated.

The installation programme was also dependent on the early completion of civil works by Member States. There were considerable delays experienced in the completion of the civil works mainly due to the prolonged and exceptionally wet rainy seasons of 2007/2008 and 2008/2009, this resulted in most rivers being flooded and stations being inaccessible and hence a long period was experienced where no civil works took place. Some Member States did not have budgetary allocations for the project and this also delayed the onset of the civil works.

Due to the small size of catchments within Mauritius, a GSM/GPRS communication system was installed there during January 2009. The advantage of such a system is that due to steep slopes and fast flowing rivers from small catchments, hourly data transmissions (as requested from EUMETSAT for all SADC-HYCOS DCPs) are not feasible. It is known that the satellite based system does have flood level alert facilities, but a preference for a more hands-on approach was agreed with Mauritius. The frequency of receiving messages can be set according to the needs at the specific NHS to assist with flood level warnings. Similar to the satellite DCPs, flood level alerts can be programmed via the system software.

1.2.3.2 **Component 2 – Development of Water Resources Information System**

During Phase 1 of the project, work was initiated to develop a regional database as a repository for real time data transmitted to the PRC from the DCP network. A website to disseminate data from the database was also developed and was accessible by Member States using passwords.

The major purposes of component 2 of Phase II were to further expand the regional database by including historical data sets from selected stations throughout the sub region, upgrade computer hardware at each NHS, review and redesign or select a new national database management system that would replace HYDATA introduced in Phase I, develop and introduce quality assurance procedures and provide training in the use and maintenance of the database management system and associated procedures.

Component 2 of Phase II commenced with the redesign and redevelopment of the regional database and the SADC-HYCOS website, following the collapse of the PRC's SADC-HYCOS web server after the termination of Phase I. The completion of this task invariably involved expansion of the regional database as per the purpose of component 2. Following a review of national hydrological systems installed in Phase I, HYDSTRA was selected and procured as the new database management system to replace HYDATA. The upgrade of computer hardware is expected to be completed by the end of the project. With the support of the PRC, it is anticipated that the majority of the Member States will have had their database management systems upgraded to HYDSTRA by the end of Phase II. A data census carried out in 75 percent of the Member States shows that further delays on national database system implementation may result from technological and data operational challenges that individual countries are facing. A further concern is that while the Project may deliver on the target outputs, it remains up to the Member States to 'take ownership' to ensure sustainability.

Protocols for data exchange between the regional database and national databases will not be achieved by the end of the project as these are dependent on the completion of implementation of the new national database system. Another area of concern under this component is the quality assurance of unverified data stored in the regional database. Hydrological observation data disseminated on the website invariably includes abnormal values and errors that are caused by faulty DCPs. However, Member States have continued to face challenges in performing validity checks against control readings collected at the stations. These challenges must be addressed together with national and regional database management system improvements but it must be noted that they will not be concluded by end of Phase II.

1.2.3.3 **Component 3 – Development of Hydrological products**

The expected end of Project outputs of this component were mainly common data analysis tools and information products available to the user community.

The Project developed a number of products invariantly linked to the challenges presently faced in general by the Region and in particular by various NHSs. The common challenges identified by NHSs were procedures for data quality assurance and enhancement, mostly techniques needed for filling in the gaps within hydrological records and identification of errors. Two techniques for infilling of gaps were proposed during presentations made at the Inception Workshop in May 2006; Multiple Linear Regression (MLR), a standard statistical tool which is well described in literature and a daily rainfall-runoff model, called SPLASH. The software of these two products was made available to NHSs.

The 2007/08 hydrological season was extremely wet resulting in flood events being experienced in a number of river basins. The Region realised that there was no mechanism or technique at hand to forecast and simulate (spatial and temporal impact) flood events. As a stop gap measure the Region identified the need and agreed to the

development of a regression model to estimate the travel time of rivers in flood. The development of the model by the Project commenced in the 1st quarter of 2008.

However, there were a number of challenges faced in the fulfilment of this component, although the Project had the capacity for development of products, it was realised that the implementation and useful application within the Region may not be achieved within the time-line for Phase II. The Region will only achieve readiness for applying such products once Components 1 and 2 of Phase II have been completed.

1.2.3.4 **Component 4 – Training and Awareness Building**

The outputs of this component were designed to include staff skilled in the operation and maintenance of the data collection and information management systems, as well as in data analysis and information presentation for decision making.

Another aspect of the component was the promotion of awareness activities for the general public, water agencies and decision-makers.

A training workshop on the operation and maintenance of DCPs was held in March 2008 and was attended by Technicians from all the Member States except Madagascar. Due to the long period between the training workshop and the installation programme, coupled with the need to train more staff, the training programme was extended to include on-site training. The Project also developed a number of manuals for in-house training at the NHSs.

A training workshop on database management was held in September 2008. Follow-up, on-the job, database training is planned to take place during the implementation of the database management system at each NHS.

The main challenge on this component has been the loss of trained staff.

The various workshops, including the Inception Workshop in May 2006, the Basin Workshop towards achieving the network design, survey activities and an improved cycle of Project Steering Committee meetings have all contributed greatly to regaining the Region's commitment to the Project and show cased the Project’s activities to the general public.

Links were also established with organisations which play a complimentary role to the Project namely; IHP HELP Symposium (through Implementing Agency's role as co-co-ordinator), IUCN (the World Conservation Union), GEF EPSMO Project, Waternet Programme and the UN office for Co-ordination of Humanitarian Affairs (OCHA) and some Basin Authorities in the Region.

2. CHALLENGES TO BE ADDRESSED AND PROJECT JUSTIFICATION FOR PHASE III

The SADC-HYCOS Phase II Project was subjected to many delays which impacted project implementation. These delays have implications on the completion of many activities which were supposed to be implemented in Phase II. As a result the entire purpose of the SADC-HYCOS programme will not be effective. A third Phase of the Project is justified to build on the accomplishments of Phases I and II and achieve the overall objectives of the programme. The major thrust of SADC-HYCOS Phase III will thus be focussed on achieving a fully functional and calibrated monitoring network and the strengthening of NHS capability to effectively manage their water resources.

2.1 SADC-HYCOS Network of gauging stations

The coverage of Phase I and II stations was supposed to enable Member States to reasonably and largely optimally undertake real-time monitoring of flooding and providing flood forecasts on the major rivers within the SADC Region. Data collected was also going to be useful for water resources assessment.

However, it has to be emphasised that the equipment provided by the SADC-HYCOS Project is not likely to address all the data needs at the national level. The SADC Region covers an area of 9.86 million km^2, and with 100 DCPs the network has a density of 98,600 km^2 per DCP which is still far below the WMO guideline of XX km^2 per gauging station.

An examination of the network shows that the Congo Basin with an area of about 3.2 million km^2 will have 12 SADC-HYCOS stations which are not adequate to cover all the hydrological data needs. This basin requires special attention aimed at expanding the hydrometric network. The planned Congo-HYCOS is an important WHYCOS project for addressing this need. Tributaries of the Zambezi River originating from Angola are not being monitored and yet they are important in terms of their contribution to the flows particularly when floods occur.

Although a network density analysis still requires a continued increase in the number of stations providing data in real-time for better flood management in particular, Phase III will focus on the consolidation (operationalisation of Phase I, installation and operationalisation of Phase II), of the defined Phases I and II networks rather than further expansion of the network.

Due to insufficient human and financial resources available to NHSs, proper maintenance of mechanical current meters was not possible and in some cases fixed cableway installations were vandalised and could not be replaced. It is thus possible that ratings at some stations might have changed due to scouring by extreme floods or the deposition of silt. Phase III will address this shortcoming through a two-pronged approach:

- The procurement of Acoustic Doppler Profilers and ancillary equipment to undertake regular streamflow gaugings and, in addition,

- The use of Slope-Area and backwater techniques to assist with calibration of river gauging stations.

Acoustic Doppler Profilers are costly and for use on wider or bigger rivers a boat with approximately 45 kW engine is required. For transport of the equipment a dedicated built trailer is ideally required. It is estimated that 20 to 30 Acoustic Doppler Profilers (ADPs) will be needed in the SADC NHSs. This is an additional module with a separate budget that is attached for the procurement of this equipment and complementary funding should be sourced.

An alternative method to introduce the ADPs into the SADC Region is the procurement of only 4 ADPs and the formation of 4 specialised teams to be trained in the use and application of this equipment. Each team will be equipped to undertake streamflow gaugings at the DCP gauging stations within the SADC Region. NHSs shall provide staff to accompany teams on missions to do streamflow gaugings and to undertake the necessary training and processing of data captured in the field. The training will therefore provide an opportunity to have more trained personnel who would augment the teams or/and replace some team members in the event of redeployment or wastage. The budget for this alternative is included in the main budget of Phase III.

2.2 Hydrological Information System and Data Exchange

2.2.1 HYDSTRA Hydrological Information System

During SADC-HYCOS Phase I the firm providing technical assistance to the Project installed the latest version of the HYDATA database within NHSs. This database, developed and supported by the Centre for Ecology and Hydrology (CEH) at Wallingford in the UK, was already widely used during implementation of the FRIEND Project prior to SADC-HYCOS Phase I implementation. Unfortunately CEH ceased support to the product and countries experienced difficulties to install and operate the system under the WINDOWS XP operating system. This required a new national database to be developed or procured as part of SADC-HYCOS Phase II.

Rather than to spend time developing a data repository (within the time available, a fully fledged database product could not be developed, debugged and implemented) the PMU resolved to investigate the availability of existing databases or hydrological information systems on the international market. The search eventually identified 4 different companies that complied with the technical requirement matrix. These companies were invited to attend and present the capabilities of their products to the member states at the 4th PSC meeting held in Namibia in November 2007. MS expressed their views on the products; although a few representatives raised concerns, consensus was reached that a new HIS was urgently required in all countries and based on presentations, an off-the-shelf option was an acceptable option in view of time.

With full knowledge of the Netherlands co-operating partner, SADC searched for an alternate co-funder to support the procurement of a new HIS. Unfortunately this did not

materialise and upon confirming that the selection process conformed to stipulated modalities the Netherlands approved the procurement of HYDSTRA, a product of the German firm Kisters Pty Ltd.

Following an introductory training course in the use and application of HYDSTRA the PMU data technologist undertook visits to most (75%) of the NHSs of participating countries to establish the status of data in digital form, types of data to be archived and its format. It became clear that a huge backlog to transform data from paper to digital format existed in some countries due to some digitising tables having become unserviceable or obsolete for use on the WINDOWS XP platform. Copies of the different kinds of data to be archived were obtained from MS for the purposes of developing specific scripts (in the PERL computer language) in order to import data into HYDSTRA. This requirement identified during the data census was an anticipated outcome in the implementation of the new HIS.

It needs to be pointed out that the migration of data to this system is not intended for SADC-HYCOS data only but is aimed at archiving all data captured and maintained by the NHS. This transcended the initial intention of the Project but the resultant benefit to the NHSs will be enormous. Training and follow up training on the operation, maintenance and use of this system is of great importance. It will be critical to successful implementation to employ a dedicated technical assistant (as an additional PMU staff member) for the implementation of an effective data management system including regular training on HYDSTRA (spanning from basic to advanced). The financial viability of temporary secondment of data management staff from NHSs to the PRC/PMU for digitisation of data and training on HYDSTRA will be investigated; this would enhance capacity development at NHSs and promote less dependence on Pretoria, and as a result, systems will be more sustainable.

2.2.2 Data exchange

Contrary to expectation the Internet services in most MS are still weak. This has a detrimental effect on data exchange. Most serious however, is the fact that some countries fail to download their own data from the DWAF hosted Regional Database and server. Use of the WMO Global Telecommunication System was considered to be a solution to this problem. Unfortunately the WMO GTS is:

(i) located within the Meteorological Services in MS which resides under a different ministry than the water and hydrological services with the result that access is once again problematic and

(ii) the GTS carries a large amount of meteorological data already – a software search will have to be done to locate the tiny pieces of hydrological data.

To address this data communication problem, a virtual server will be installed within the PMU. Special patented software will be installed on the PMU virtual server to access data from the Regional Database and/or satellite data receiving computer within the PRC to create a mirror image on the PMU virtual server. This is a very fast process, much faster than even downloading files via broadband Internet. Demonstration software is installed within the PMU and claims of fast data downloads have been verified. The same

software will also be installed on the new SADC-HYCOS desktop computers in the NHSs from where data downloads can be done from the PMU virtual server. Data exchange will be significantly enhanced which may render renewed impetus to this SADC-HYCOS objective. Funds required for the PMU virtual server and software are indicated in the budget.

2.3 Hydrological products

At the start of the SADC-HYCOS Phase II software was developed to assist with the infilling of gaps within records and/or historical extension of a time series. This software is based on multiple linear regression, a standard statistical technique.

A daily rainfall-runoff model (called SPLASH) was also made available. This model has application for infilling of daily gaps or historical extension in flow time series. This has application in water resources analysis studies for planning purposes or within flood routing studies for flood warning and prediction.

The call for the development of (undefined) hydrological products within Phases I and II was thus made on the assumption that river sections or gauging weirs are calibrated. The lack of calibration due to limited resources possibly gave rise to the poor response to identifying specific products.

Hydrological products to be developed should be better defined by users and developed according to their needs. This may also assist in identifying other HYCOS Projects where practical products were or are being developed.

2.4 Calibration of gauging stations

Through implementation of SADC-HYCOS Phases I and II it became evident that few calibration tables are available. Repeated requests for calibration tables were made to NHSs during Phases I and II with little or no response. Since the exchange of data has been agreed upon between countries and the PRC/PMU, the conclusion is that few streamflow gaugings are being undertaken (due to various reasons). If this assumption is correct, then a dire need exists to address this problem. Furthermore, most hydrological products need flow rate in m^3/s or volume 10^6 m^3 as input. Although river stage is archived in most databases, it does not constitute the final product of any hydrological services. River stage is always converted to a flow rate or volume via calibration tables, rating tables or mathematical relationships (applicable for certain time periods) for use within most hydrological products. Exceptions are river stage at a particular section for flood evacuation or large bodies of water such as natural lakes or dams.

3. SADC-HYCOS PHASE III : OBJECTIVES RESULTS AND ACTIVITIES

3.1 Project Purpose

The **purpose** of SADC-HYCOS is to contribute to regional socio-economic development through the provision of management tools necessary for sustainable and economical water resources development and management.

3.2 Project Objectives

The **overall objectives** of Phase III of the SADC-HYCOS Project are:

- The consolidation of Phase I and Phase II HYCOS installations to achieve a fully functional and calibrated hydrological monitoring network;
- The strengthening of NHSs capability to effectively use established hydrological databases, information systems and hydrological products developed by the project that provide users with the information they require, to the standards (including accuracy, timeliness, usability, etc.) they need, and that provide a secure repository of information for an indefinite future;
- To assist the participating countries through awareness building and promoting Project activities to strengthen institutional capacity to assess the status and trend of their national water resources on a continuing basis and to provide adequate warnings of water-related hazards.

3.3 Project Results

Specific result areas will be implemented to achieve the above objectives namely:

Result 1: HYCOS stations as installed under the Project, fully operational and maintained by NHS.
Result 2: River gauging stations calibrated.
Result 3: National and regional water resources management information systems strengthened and implemented.
Result 4: Hydrological products developed.
Result 5: Awareness building, capacity building and promotion of SADC-HYCOS Project activities.

A description of each result area is provided below. Details of the activities under each result, the expected outputs and corresponding means of verification indicators are included in the Logical Framework provided in **Annex 1** of the document.

3.3.1 **Result 1**: HYCOS stations as installed under the Project, fully operational and maintained by NHS

To obtain this result a set of activities will be carried out. The upgrading of Phase I stations and the final installation of all Phase II stations will achieve a fully functioning network with real-time data made available. Staff will be trained in the operation and

maintenance of equipment and NHSs will make appropriate operational budget available, fully demonstrating ownership of HYCOS installations. The following activities will be carried out to achieve these outputs:

- Upgrade Phase I software and convert from 3-hourly to hourly transmission time slots and frequencies
- Operationalise instrumentation and assist with installations of SADC-HYCOS DCPs
- Dispatch Data Loggers and accessories to NHS for installation at stations identified in the Network Design
- NHS to take ownership of HYCOS installations
- Training of staff in the installation, operation and maintenance of equipment.

3.3.2 **Result 2:** River gauging stations calibrated

The following activities will be essential to achieve this result. Gauging stations with completed surveys as well as trained NHS personnel competent to carry out continued gauging activities in order to develop calibration tables suitable for use on the Regional database and through the HYDSTRA data management system at each NHS will require the following:

- A Contractor must undertake field surveys of HYCOS DCP stations to fast track the calibration of gauging stations
- Procurement of specialized equipment such as Acoustic Doppler Profilers to facilitate the calibration of gauging stations
- Theory and Practical training on the use of ADPs for the calibration of stable river sections
- NHS staff to be trained in the utilisation of slope-area and backwater assessment techniques to undertake the calibration of gauging stations
- Develop calibration tables for HYCOS gauging stations.

3.3.3 **Result 3**: National and regional water resources management information systems strengthened and implemented

The outputs for Result 3 will be a fully functional database management system at each NHS (HYDSTRA) linked to the Regional database with verified hydrological data available on the Project website. A virtual database will also be established and populated with historical data sets from SADC-HYCOS stations. NHSs will be supplied with digitising hardware and software and technically assisted with the digitisation of charts. Staff will be trained in order to improve the outputs of NHS related to the database management system. Activities will be:

- Migrate existing data onto the new national HYDSTRA databases
- Using Internet and file transfer protocols develop and establish a virtual regional database to link national database management systems
- Expand the virtual regional database to include historical data sets from SADC-HYCOS stations

- Analyze and further develop the regional database management system to include transformation of stage into flow.
- Promote and facilitate the dissemination and use of hydrological information by ensuring that the SADC-HYCOS website is up-to-date with reliable data and relevant data analysis tools
- Implement tools for data exchange with national database management systems for data quality assurance and for dissemination of validated data on website
- Develop and establish data rescue techniques by providing or upgrading digitizing hardware and software
- Provide training to staff in use and maintenance of database management system, data exchange and data rescue techniques

3.3.4 **Result 4**: Hydrological products developed

During Phase II the following products were established as suitable to meet the possible needs of NHS. These products will be investigated and further developed during Phase III.

- Gross and Net Yield analyses for single reservoirs
- Reservoir Simulation and Reservoir Systems Analysis
- Low flow frequency analysis and its application in water demand management
- Flood frequency analysis.

3.3.5 **Result 5**: Awareness building and promotion of SADC-HYCOS activities

In the SADC sub-region, there is inadequate awareness of the state of water resources to include the economic, social, environmental and management implications in planning and represents a serious constraint to improved water resources management and development. Knowledge of water resource issues is largely confined to a small number of professionals and specialists in SADC member-states. Extending this understanding to all beneficiaries requires extensive awareness building among political leaders, decision-makers, professionals, academics, donors, NGOs and the public. Aside from public awareness, the human resource capacity necessary for comprehensive and sustainable water resources development and management is also lacking. Opportunities must therefore be sought, to attend various meetings and workshops convened in the water sector for the purposes of showcasing SADC-HYCOS activities and raising awareness of the role of NHSs. The PSC will also serve as an appropriate means to introduce techniques and tools that could enhance NHS ability to apply hydrological information and products to decision-making.

- Distribute programmes for deterministic daily and monthly rainfall-runoff models for infilling of missing data and historical time series extension
- Promote awareness at NHS in the use of statistical methods for infilling of missing data and historical time series extension
- Introduce Time Series Analysis and probabilistic water resources assessment techniques to NHS
- Raise awareness of impacts of catchment management on runoff

- Introduce techniques for the estimation of reservoir yield characteristics for catchments with inadequate data
- Introduce principles of flood routing for purposes of downstream flood warning
- Promote awareness on SADC-HYCOS activities at various levels (e.g. NHS, RBO, community level, decision makers etc)

4. PROJECT GOVERNANCE AND ORGANISATION

4.1 Description of the SADC Water Sector

The Southern African Development Co-ordination Conference (SADCC) was created in 1980 with an initial membership of nine continental States namely Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe. SADCC was transformed through a Treaty in 1992 from a Co-ordinating Conference to Southern African Development Community (SADC) to be a legally binding instrument that will promote deeper economic cooperation, development and integration in the South African Region. In the 1990s, the membership of SADC increased to fourteen with Namibia (1990), South Africa (1994), Mauritius (1995) Seychelles (1997 though later with drew and rejoined in 2008) and the Democratic Republic of Congo (1997). The membership now stands at fifteen with Madagascar as the last to join the membership in **2007**. The 1992 Treaty, which officially created SADC, places a priority on a regional approach to sustainable development within the broad themes of poverty alleviation, food security, and industrial development. The overriding objective of SADC is the attainment of an integrated regional economy on the basis of balance, equity and mutual benefits for all Member States.

The continental SADC Region has a total land area of nearly 6.8 million km² with 15 large river basins dissecting the region. Regional estimates place the annual average renewable freshwater resources at 650 billion m^3, distributed in rivers, lakes and groundwater bodies. All of the continental SADC countries share these water resources with two or more neighbouring countries. Both seasonal and annual rainfall varies considerably within the region, leaving some areas with an abundance of water and others under severe water stress. The Region's water resources are used for a variety of purposes, including hydroelectric power generation, navigation, fishing, tourism, irrigation and livestock watering, domestic and industrial supplies, as well as the maintenance of the ecosystems.

In 1995, recognizing the importance of water resources in the region, the SADC Ministers responsible for water resources mandated the SADC WSCU (now Water Division) and the SADC Secretariat to support/facilitate the Sector and develop a Regional Strategic Action Plan for integrated water resources development and management. Parallel to the development of the Water Sector Strategy, SADC signed the "SADC Protocol on Shared Water Course Systems" in 1995 and ratified it in September 1998. The Protocol was subsequently revised for purposes of aligning it to the United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses that was adopted in April 1997. The Revised Protocol "Revised Protocol on Shared Water Courses in SADC" was signed in 2000 and ratified in September 2003. The main objective of the Protocol is to foster closer cooperation for judicious, sustainable and coordinated management, protection and utilisation of shared watercourses and advance the SADC agenda of regional integration and poverty alleviation. In November 1998, the Regional Strategic Action Plan for Integrated Water

Resources Development and Management in the SADC Region (1999 - 2004) was presented to the international community at a Roundtable Conference.

The strategy reaffirmed the importance of the region's water resources and its influence on all aspects of the region's economic and social performance. The strategy identified seven major areas requiring intervention.

i) Legal and Regulatory Framework - National water legislation in most SADC countries is inadequate and weakly enforced. To address the legal and regulatory aspects of transboundary and shared river systems, country specific laws pertaining to the use of these waters need to be consistent with widely accepted international water principles.

ii) Institutional Strengthening - Lack of integrated plans has been recognized as one of the major constraints in promoting sustainable development and equitable sharing of water resources in the SADC region.

iii) Sustainable Development Policies - Legislation, policies and economic instruments need to be improved to encourage the conservation and sustainable use of the region's water resources.

iv) Information Acquisition, Management and Dissemination - Integrated water management is dependent on having appropriate information, managing this information, and making it available to a large and diverse number of end users. Regional and national capacities and data and information systems need to be improved and strengthened through better technology, trained human resources, and access to capital.

v) Awareness Building, Education and Training - There is a lack of awareness among the general public about the state of the region's water resources as well as the economic, social, environmental and political issues. Decision makers need to develop specific skills in negotiation, dispute resolution and integrated resource management.

vi) Public Participation - The challenge for the region is to involve all stakeholders more fully in policy formulation, Project design, implementation, operation and maintenance.

vii) Infrastructure – Most of the infrastructure is inadequate or has outgrown its design life and cannot accommodate the growing demand for multipurpose use.

Based on the 44 projects in the strategy, the Roundtable Conference assisted the SADC Water Sector and identified 31 actions, interventions and priority projects for the region. In April 1999, a panel of consultants produced Project Concept Notes (PCN) for each of 31 projects that had been identified through the Regional Strategic Action Plan. The PCNs were presented to the Cooperating Partners who in turn were requested to identify projects of interest.

It was anticipated that the Cooperating Partners would assist with the further elaboration of the PCNs into full project proposals. The objective of the further elaboration was to identify the full scope, design and budget for the project. Once completed, the elaborated project proposal would contain all the necessary information for the Cooperating Partners to make a decision on support for the project in the context of the Cooperating Partners strategic investment areas.

Project Concept Note 15 was prepared for the expansion of the SADC Hydrological Cycle Observation System (SADC-HYCOS) under the information acquisition and management theme of the Regional Strategic Action Plan. The SADC Member Countries have identified the need for realtime information for water resources management and the associated capacity to collect and disseminate the information. The Member Countries recognize the importance of readily accessible water resource information to regional economic and social development, to regional disaster mitigation and to regional environmental protection.

4.2 Management Arrangements

The Project will be implemented with technical support provided by international and national institutions.

A Project Management Committee (PMC) was constituted under Phase II of the SADC-HYCOS Project. This PMC must be maintained under Phase III to oversee Project policy, strategy and implementation. The PMC will meet more regularly to take appropriate decisions for the good running of the Project and the PSC that would meet less often will be appraised of such decisions for purposes of information and concurrence. The PMC will be the highest executive authority of the Project. The members of the PMC will consist of representatives of the SADC Water Division, Cooperating partner(s), and in addition, a troika consisting of 3 SADC member states, (in accordance with the SADC system of one new member of the troika per annum i.e. current chairperson, incoming and outgoing member), WMO (upon invitation depending on specific issues), Implementing Agency and SADC-HYCOS Project Manager. Travel expenses are to be kept to a minimum and cost effective scheduling and conducting of meetings will be done.

The Project Steering Committee (PSC) as constituted in Phases I and II will be maintained and the NHSs will be represented at appropriately senior positions capable and empowered to take key strategic decisions The PSC will however, be re-focussed in Phase III, to concentrate more on aspects of project implementation. The PSC will play an advisory role on the governance and administration of the Project and have more focus on the formulation of strategies and frameworks for the project's key result areas. The PSC will also concentrate on awareness and capacity building on a wide range of hydrological and water resources analysis topics while at the same time serve as a necessary communication and liaison channel between members of NHSs, PRC and the PMU. Members of the PMC will be at liberty to attend the PSC meetings at any time or may be called upon specifically to attend. The PSC will meet at least once a year, for at least two days; the first day being devoted to the meeting and the following day to a

workshop where the envisaged strategies will be developed and assessed as the project progresses. The Project will fund the attendance of one member from each NHS while countries will be encouraged to send more officials who could benefit from attendance. The venue for PSC meetings will be centrally located within the SADC Region to minimise costs.

SADC WD is already stretched to capacity with the implementation of the overall SADC Water Sector Programme. RSA through DWAF will continue as the Implementing Agency (IA) of SADC-HYCOS Phase III. The IA established a PMU during Phase II which works in close collaboration with the PRC with SADC providing a supervision oversight. These structures should remain in place for Phase III implementation and take advantage of the experience and institutional memory already gained. Staffing is detailed below. WMO will continue providing technical backstopping and assistance to the SADC Secretariat (SADC WD), Member States and the Project Management Unit on technical issues related to Project implementation.

The PMU will be headed by a Project Manager who will be responsible for ensuring that the Project objectives and outputs are achieved, and for all communication with the stakeholders of the Project. The Project Manager will be assisted by a Project Assistant, a Hydrologist and a Data Technologist. Project implementation and management will be guided by an Implementation Plan and Annual Business Plans, against which the PMU will report progress to the PSC, PMC and Co-operating partner(s) bi-annually or when ever it would be found necessary.

The wide range of expertise needed for the Project is likely to demand several providers, working under sub-contracting arrangements. Subject to successful capacity building, Project activities progressively will be transferred to participating countries, principally their NHSs. At the same time, a regional technical support facility for instrumentation, data transmission, and regional database management will be available at the PRC. Given the participating countries' preference for in-country, hands-on training, PRC/PMU staff will need to spend significant time in each country.

4.3 Responsibilities of Stakeholders

The responsibilities of stakeholders in the Project are outlined in the following sections.

4.3.1 SADC Water Division (SADC WD)

The SADC Water Division will execute and facilitate the Project implementation through negotiations with co-operating partners and SADC Secretariat will sign project funding agreements on behalf of SADC Member States. It will facilitate the participation of member countries and co-ordinate their contributions. SADC Water Division will also mobilise resources for some critical emerging Project support components through co-funding arrangements. It will co-ordinate the project activities with the IA. It will be a member of the PMC and PSC and will ensure that SADC decisions are reflected at the Project implementation level.

Summary responsibilities of SADC

- Seek Project funding, negotiate with the co-operating partners and sign the funding agreement on behalf of SADC
- Facilitate and co-ordinate participation and contributions from participating countries
- Co-ordinate and supervise the activities with the implementing agency to ensure timely submission of reports
- Organise and participate in PMC and PSC meetings/activities
- Report progress to WRTC and higher SADC bodies
- Ensure that SADC decisions are reflected at the Project implementation level

4.3.2 Project Management Committee (PMC)

The PMC will oversee Project management policy, strategy and implementation. The PMC will be the highest executive authority of the Project.

Summary of the Project Management Committee responsibilities

- Determine Project management policies and conclude policies developed by the PSC
- Manage conflicts or disagreements among participating countries
- Endorse the Project implementation plan
- Endorse annual work plans and budget
- Monitor Project implementation
- Approve any changes to the Project document
- Assess Project progress and success
- Provide a communication channel with regional bodies and other interests
- Troika acts as a link to participating countries to keep them informed

4.3.3 Project Steering Committee (PSC)

The PSC will play an advisory role on the governance and administration of the Project while mainly focussing on the formulation of strategies and frameworks for achievement of the project's key result areas. The PSC will pay special attention to the achievement of awareness and capacity building on a wide range of hydrological and water resources analysis topics while at the same time serving as a necessary communication and liaison channel between members of NHSs, PRC and the PMU.

Summary of the Project Steering Committee responsibilities

- Develop Project implementation policies
- Develop strategies/frameworks for the Project implementation plan
- Develop a program on capacity building and awareness building

- Select members to be seconded to the PMC
- Review, evaluate and advise on the project implementation process
- Evaluate progress by MS against self-determined implementation strategies
- Develop and oversee implementation of mechanisms of project ownership by MS viz a viz Project Sustainability
- Identify regional bodies and other interest groups for possible collaboration with the Project

4.3.4 Implementing Agency and Project Management Unit

The respective roles and responsibilities of the IA and PMU are outlined below. The essential characteristics of the Implementing Agency and existing PMU are demonstrated project management capabilities and wide acceptability to project participating countries, co-operating partners and stakeholders.

Summary of responsibilities of the Implementing Agency

- Delegate project specific authority to the PM, subject to the rules and regulations of SADC for the purposes of managing the PMU, appointment of staff and procurement of goods
- Advise DWAF SA corporate managers of high-level DWAF SA approval allowing for fast-tracked implementation of the Project
- Co-ordinate other water-related projects in the region with SADC-HYCOS activities
- Host and maintain the Project Regional Centre (human resources, Data Receiving System, Regional Database with Integrated SADC-HYCOS Website, Training, etc.)

Summary of Responsibilities of the Project Management Unit

- Obtain, co-ordinate and administer implementation funding from SADC and/or Cooperating Partner
- Manage a Project Specific Bank account for the Project
- Prepare a draft Project implementation plan
- Manage the implementation of the Project
- Provide administrative control and reporting on the Project
- Manage the provision of services, service contracts and the procurement of materials and equipment under the individual Project activities subject to SADC procedures and donor modalities
- Appoint PMU staff and where appropriate renew contracts of existing staff members and direct their activities
- Appoint sub-contractors and direct their activities
- Foster regional technical and scientific co-operation in the fields of water resources assessment, monitoring and management

- Provide a forum for exchange of expertise and knowledge
- Collaborate with the PRC to ensure successful Project implementation
- Manage the installation support of field and IT equipment in participating countries and required technical support and training with the PRC
- Act as a focal point to co-ordinate the Project activities implemented in and by the participating countries
- Co-ordinate the Project activities with other water-related projects in the region
- Report to the IA, SADC, Co-operating partner(s), and PSC on the progress of the project in one standard format

Staffing of the Project Management Unit

Considering that Phase III is to a large extent the consolidation of Phase I and II activities, the present PMU staff will be maintained to ensure continuity and avoid further delays. Moreover, additional staffing is required to effectively support project implementation. A technical assistant is required to assist with the implementation and training on HYDSTRA as well as improved data management techniques and procedures. A technician is required to assist NHSs with installation of field equipment, training on operation and maintenance of the instrumentation and for technical backup in cases which cannot be resolved by NHSs.

4.3.5 Participating Countries

The participating countries will have a number of responsibilities for Project implementation. The SADC Council of Ministers approved the implementation of SADC-HYCOS Phase I and II. This approval thus obviates the need for any other Memoranda of Understanding between participating countries and the Implementing Agency. The partner countries have by implication already committed themselves to provide the real-time data generated under the Project as well as historical data essential for the expansion of the Regional Database, the operation and maintenance of instrumentation and the calibration of gauging stations. Partner countries will also be required to release and support NHS staff to participate in Project activities.

Summary of Responsibilities of the participating countries

- Provide support to missions by staff from the PRC, PMU and contractors
- Provide appropriately qualified staff to participate in Project activities, (PMC meetings, PSC meetings, training, etc.)
- Manage any impediments to successful Project implementation (e.g. land access, custom clearance)
- Carry out installation and other work required with assistance, where needed, from the PRC, PMU and contractors
- Undertake streamflow measurements and associated surveying to ensure successful calibration of gauging stations

- Perform ongoing, routine activities related to operational water resources assessment and monitoring, and related to the operation and maintenance of Project installations for which budgetary provision should be made within and beyond the project duration
- Disseminate validated data and information to users as well as the PRC/PMU for archiving on the Regional database
- Provide calibration tables of SADC-HYCOS gauging stations to the PRC/PMU
- Provide monthly progress and status reports to the PMU
- Provide information about the Project to national interests and the public
- Commit to the spirit of Regional co-operation

4.3.6 Project Regional Centre (PRC)

The Project Regional Centre (PRC) is the dedicated structure of the Implementing Agency to receive data from DCPs and Data Loggers (DL). Validated data as well as calibration tables should be forwarded to the PRC to be archived on the Regional Database. Unverified data will be published on the SADC-HYCOS website soon after receipt. This will ensure that all participating countries have access to river responses due to heavy rainfall and resultant floods. The PRC will foster regional cooperation in the fields of water resources assessment, monitoring and management, and provide a forum for exchange of expertise. The PMU will work closely with the PRC in support of Project initiatives.

Summary responsibilities of the Project Regional Centre

- Monitor DCPs and forward data to NHSs that do not have direct access to satellite data.
- In collaboration with the PMU, manage a regional database and associated functions (data dissemination etc.).
- Provide all services (training, on-going assistance and advice etc) which are not provided under other contracts.
- Provide technical support to participating countries with site preparation, installation of equipment and calibration of gauging stations.
- Foster regional technical and scientific co-operation in the fields of water resources assessment, monitoring and management.
- Provide a forum for exchange of expertise and knowledge.

4.3.7 World Meteorological Organisation (WMO)

The WMO will oversee and facilitate the Project implementation and provide technical and scientific backstopping. WMO as the custodian of the WHYCOS will provide critical technical service to guide the SADC Water Sector, Member States and PMU on the implementation of the Project, ensuring that the Project takes maximum benefits from lessons learned in implementing other HYCOS projects and ensuring its linkage with on-

going or planned HYCOS components and with the global WHYCOS programme. As such, WMO shall be represented on the PMC and provide technical assistance where and when required. WMO will also be represented and participate in the PSC and provide the necessary technical support.

Summary responsibilities of WMO

- Assist in seeking Project funding
- Facilitate Project implementation
- Support the Implementing Agency by advising on technical standards
- Advise on the preparation and evaluation of tenders for equipment and services
- Provide the link with the meteorological community (NMS and EUMETSAT) to facilitate the use of Geostationary Meteorological Satellite(s) and exchange of data through the GTS and Internet
- Interact with the Project, through regular missions and participation in the PSC and PMC activities
- Coordinate the implementation and standards of different HYCOSs through the World HYCOS International Advisory Committee (WIAG)

4.4 Contracting and Procurement

Procurement of goods and services will conform to donor modalities while SADC regulations and procedures will be observed.

4.5 Timing and Phasing

Due to the overspill of some Phase II activities into Phase III, it is necessary that continuity be retained to ensure attainment of goals. SADC-HYCOS Phase III will thus commence immediately after Phase II terminates to avoid any potential gaps. Successful implementation of Phase III activities and building of capacity within NHSs requires a minimum project duration of 4 years.

Apart from the first year for Phase III when equipment is procured, Phase III activities will be undertaken in such a way to have approximately the same annual expenditure in years 2 to 4. Timing and phasing is tabulated in **Annex 2.**

4.6 Reporting and Auditing

The implementation plan for the duration of Phase III will be drawn up by the PMU at the start of the Project. The implementation plan will guide the process for constructing annual business plans. The PSC will approve the implementation and business plans of the Project.

The PMU will report twice a year to the PSC on achievements, successes and failures to implement, as expounded in the implementation schedule and relevant business plans. Reports will contain detailed financial information as required to request project funds for drawdown from the co-operating partner(s). Major implementation deviations, if any, should be reported (with reason) to the PSC.

Annual financial audits will be performed in accordance with the rules and regulations of the Co-operating partner(s). SADC will be the contracting agency.

It is the prerogative of the co-operating partner(s) to decide if and when Phase III implementation and achievements will be evaluated.

5. BUDGET PROPOSAL

The budget for SADC-HYCOS Phase III consists of 2 core budgets which address the major needs of the project; one core budget does not include a budget for ADPs, operational cost and training, whilst the Core 2 budget provides for the procurement of a maximum of 4 ADPs. An additional budget module is available and hopefully would attract the attention of an additional co-operating partner in collaboration with either one of the Core budgets.

Core 1: Budget summary for SADC-HYCOS Phase III

Cost Item	year 1	year 2	year 3	year 4	TOTAL(Euro)
Personnel	323,000	340,200	358,776	378,838	1,400,814
Operational Costs	53000	19000	29000	28000	129000
Travel and DSA	140000	150000	140000	135000	565000
Subcontracting	0	45000	80000	25000	150000
Equipment	55000	80000	30000	15000	180000
Training and Capacity Building	50000	60000	50000	40000	200000
Contingencies				80186	80186
WMO		50000	50000	50000	150000
Annual Total	**621,000**	**744,200**	**737,776**	**752,024**	**2,855,000**

Core 2: Budget summary for SADC-HYCOS Phase III (includes 4 ADPs)

Cost Item	year 1	year 2	year 3	year 4	TOTAL(Euro)
Personnel	323,000	340,200	358,776	378,838	1,400,814
Operational Costs	53000	19000	29000	28000	129000
Travel and DSA	140000	160000	150000	140000	590000
Subcontracting	0	45000	80000	25000	150000
Equipment	197500	50000	30000	0	277500
Training and Capacity Building	50000	70000	62000	40000	222000
Contingencies				80686	80686
WMO	55000	40000	10000	45000	150000
Annual Total	**818,500**	**724,200**	**719,776**	**737,524**	**3,000,000**

Module 1: Additional Budget summary for SADC-HYCOS Phase III (25 ADP's)

Cost Item	year 1	year 2	year 3	year 4	Total (Euro)
Equipment: 25 ADP's	600000				600000
Equipment: Boats	140000				140000
Equipment: Engines	140000				140000
Equipment: Trailers	60000				60000
Equipment: Laptops	23000				23000
Travel and DSA of Gauging Teams	50000	55000	52000	50000	207000
Training: Theory and Practical	20000		20000		40000
Annual Total	**1033000**	**55000**	**72000**	**50000**	**1210000**

The IA and the PRC provide extremely valuable support to the SADC-HYCOS Project in terms of technical assistance, data receipt, archiving, web hosting and training. Most of this support is in kind and seldom is the financial commitment appreciated. The budget reflected in the table below provides an estimate of the financial commitment of DWAF SA.

IA and PRC Budget (EUROs) for SADC-HYCOS Phase III support

Cost Item	year 1	year 2	year 3	year 4	Total (Euro)
Personnel	53700	57996	62636	67647	241979
Operational Costs	14500	15660	16913	18266	65339
Subcontracting	20235	21854	23602	25490	91181
Equipment	16000	17280	18662	20155	72097
Training &Cap. Building	8000	8640	9331	10078	36049
Annual Total in EURO	**112435**	**121430**	**131144**	**141636**	**506645**

6. SUSTAINABILITY

Without a clear sustainability strategy the lag time experienced between Phase I and Phase II, which nearly led to a collapse of the regional information system, illustrates the need for a properly implemented sustainable approach during and after Phase III. A range of factors which may negatively affect the sustenance of the project identified during the course of Phase I and II are:

- The frequent loss of key staff to death or turnover
- Little recognition in some governments of the importance of the water sector
- Government and/or Departmental restructuring
- Inadequate or no financial provision for ongoing operation and maintenance
- Vandalism of gauging station equipment
- Difficulty of obtaining spares timeously in member states which is aggravated by non standardisation of equipment
- Lack of validation of data

Generally, projects are more likely to be maintained if they clearly meet the needs of the government and when the governments are aware of the projects. Sensitisation of decision makers and the public is thus important. Phase I and II have managed with relative success to have the Project included in the respective government budget lines. For sustainability the Phase III must encourage the governments to continue funding the operational activities after the project lifespan. The budgetary allocation under public awareness can also be used to sensitise different interest groups (RBO, international organisations etc). This will encourage collaboration, co-ordination and co-operation which will greatly enhance sustainability.

Currently, the IA is DWAF SA which is providing the necessary support to the project such as data receiver, internet facilities and human resources. It is important for SADC to look critically at supporting the IA beyond the life of the project.

A key thrust of the Project is to maximize participation and technical capacity in the participating country's NHSs and supporting regional organisations, so that they are willing and able to continue hydrological data collection and archiving after project funding terminates. Without this, data collection is likely to decline in many of the partner countries at the end of the Project and the available data series will still be too short for hydrological analysis and product development.

During Phase I and II training sessions on instrumentation and database management were held during too early during the Phases respectively, which resulted in attrition of knowledge. Phase III must address this through a more continuous, dedicated training approach e.g. on-site, hands-on training at NHSs.

Phase I experienced exceptionally high incidences of vandalism at stations. In an effort to combat the vandalism problem Phase II procured and installed field equipment in some locations, which utilises the GPRS data communication protocol. It is a compact low

energy consumption product which operates from batteries. The equipment is unobtrusive and functions satisfactorily. Phase III should assess the migration to this type of technology.

Apart from the key strategies identified above, the following strategies may also be considered to ensure the sustainability of the SADC-HYCOS Project in the Region:

- Use appropriate technology for Southern African climate and circumstances
- Integration of SADC-HYCOS into NHS national programmes and/or River Basin Organisations
- Ensure appropriate motivation of staff in the water sector through appropriate training/capacity building and delegation of responsibility for solving national hydrological problems
- High staff turnover require succession planning to retain skills and knowledge
- Member states should ensure security of the equipment by one or more of the following measures
    - Appropriate public awareness and involvement of local communities in SADC-HYCOS activities
    - Involvement of existing structures such village committees, water user associations and District Development committees to ensure security of equipment and installations
    - Hardening of installations through proper structures, fencing and/or appointment of observers to guard installations
- Member States should ensure proper maintenance of hydrological equipment
- MS should utilize technical expertise within the region to combat dependency on outsiders.

Adopting the above strategies will help to foster a greater sense of ownership by participating countries. Phase III needs to entrench the responsibilities of participating countries ensuring that the understanding of the project objectives goes beyond the mindset of a Regionally focussed project making it clear that participating countries directly benefit from maintaining the outputs of the Project.

7. RISKS AND MITIGATING STATEGIES

Risk 1: Bureaucratic delays as experienced during the implementation of Phase II is considered to be a low risk should Phase III follow on immediately after Phase II;

Mitigating Strategy: Secure financing for Phase III as soon as possible but not later than end of August 2009, retain the existing PMU staff and confirm the current PMU office accommodation.

Risk 2: Lack of co-operation between any two or more persons or parties involved with Phase III is considered to be a low to medium risk;

Mitigating Strategy: The roles and responsibilities of all parties should be clearly defined and understood (refer to Chapter 4). SADC WD shall act as honest broker and seek to resolve misunderstandings, disagreements and disputes in an amicable way.

Risk 3: Lack of interest in implementation of Phase III in any one or more SADC NHSs is considered to be a low risk;

Mitigating Strategy: The NHSs have demonstrated the desire to work cooperatively under SADC-HYCOS Phases I and II. The PMC will address issues brought to its attention. If these matters cannot be resolved SADC WD will intervene towards reaching a solution.

Risk 4: Due to high staff turnover for various reasons, NHSs/PRC/PMU/IA may lose scarce technical expertise (medium to high risk);

Mitigating Strategy: Deficiencies should be identified and ameliorative measures put in place at national level. Training activities such as short courses at Technikons or Universities within the SADC Region should be utilised to strengthen capacity. The Project will strive towards standardisation of instrumentation and data management. Appropriate training material on instrumentation and data management will be developed and distributed.

Risk 5: Funds available for procurement of new, replacement and damaged equipment due to vandalism or natural disasters such as floods may not be timely or sufficient (medium risk);

Mitigating Strategy: The principle of ownership should be instilled within NHSs. Ownership, amongst others, implies that NHSs should budget for eventualities timeously. The Project will work with the NHSs to ensure contact with suppliers. In case of losses due to *'Force Majeure'* the Project will evaluate each request for replacement assistance on its own merit.

Risk 6: Resistance by the NHSs to share access to data and information (low to medium risk);

Mitigating Strategy: A general understanding of the PRC/PMU policy regarding publication of unverified data on the SADC-HYCOS website is necessary: data as received at the PRC for the last 30 days will be published on the SADC-HYCOS website and should be available to all participating countries. Data is user and password protected. Where access to data is requested by national or international

organisations for purposes of flood information, warning or collaboration with any government or institution regarding limiting loss of life and/or damage to property, it is recommended that access to the data/information on the website be provided to such organisations. Any requests for data for purposes of planning, research or any other reason should be directed to the respective NHSs who will supply such data/information at their own discretion or policy framework. It is expected that water data and information for non-HYCOS sites and networks (such as FRIEND) will be made available by NHSs to the PRC for archiving on the RDB

Risk 7: Overlap, duplication and divergent bilateral projects may confuse the development and implementation of the Project activities (low risk);

Mitigating Strategy: The existence of the SADC Water Division minimizes the potential for overlap, duplication or divergence projects. The Unit has a strong and recognised mandate to coordinate the water sector activities in the region and has established good working relations through an open dialogue with the Cooperating Partners in the region.

Risk 8: NHSs staff and the staff resources of the SADC WD may be overburdened and have limited time to participate in the Project design and implementation due to other commitments and bilateral projects (low risk);

Mitigating Strategy: The Project directly involves the senior officials of the NHSs of each participating country, who are aware of staff commitments and other on-going and potential projects. Furthermore, SADC-HYCOS implementation should be accorded a high priority within each NHS.

Risk 9: NHSs may not be able to immediately pay for HYDSTRA licenses due to budgetary constraints;

Mitigating Strategy: The SADC-HYCOS Project will pay the license fees for HYDSTRA for the duration of Phase III; NHSs must include the license fees within their budgets from 2014 onwards.

ANNEX 1 : LOGICAL FRAMEWORK

Log Framework Result 1	Activities	Verification Indicator	Means of Verification	Assumptions
HYCOS stations as installed under the Project, fully operational and maintained by NHS	Upgrade Phase I software and convert from 3-hourly to hourly transmission time slots and frequencies	Number of stations upgraded and fully operational	Country inspection visits	
	Operationalise instrumentation and assist with installations of SADC-HYCOS DCPs	Number of stations installed and fully operational	Country inspection visits	
	Dispatch Data Loggers and accessories to NHS for installation at stations identified in the Network Design	Number of stations installed and fully operational and real-time data made available	Country inspection visits	
	NHS to take ownership of HYCOS installations	Operational budgetary provisions by NHS	Review outputs of NHS	
	Training of staff in the installation, operation and maintenance of equipment	Number of staff trained and level of performance	Contact with NHS	NHS to release appropriate staff for training missions

Log Framework Result 2	Activities	Verification Indicator	Means of Verification	Assumptions
River gauging stations calibrated	Contractor to undertake field surveys of HYCOS DCP stations to fast track the calibration of gauging stations	Number of gauging stations with complete surveys	Survey reports	NHS to release appropriate staff to accompany missions
	Procure specialized equipment such as Acoustic Doppler Profilers to facilitate the calibration of gauging stations	Equipment delivered	Contact with supplier	
	Theory and Practical training on the use of ADPs for the calibration of stable river sections	Number of stream flow guagings undertaken	Stream flow gauging reports	NHS to release appropriate staff for training
	Train NHS staff in the utilisation of slope-area and backwater assessment techniques to undertake the calibration of gauging stations	Number of gauging stations with complete surveys	Survey reports	NHS to release appropriate staff for training missions
	Develop calibration tables for HYCOS gauging stations	Number of completed rating tables	Accessibility on Regional database and HYDSTRA data management system at NHS	NHS to process stream flow gauging and survey reports

Log Framework Result 3	Activities	Verification Indicator	Means of Verification	Assumptions
National and regional water resources management information systems strengthened and implemented	Migrate existing data onto the new national HYDSTRA databases	HYDSTRA fully functional	Review outputs of NHS	NHS to release appropriate staff to accompany PMU missions
	Using Internet and file transfer protocols develop and establish a virtual regional database to link national database management systems	Regional and national data management systems linked	??	
	Expand the virtual regional database to include historical data sets from SADC-HYCOS stations	Virtual Regional Database populated	??	
	Analyze and further develop the regional database management system to include transformation of stage into flow.	Flow disseminated on Project website	??	NHS to supply calibration tables
	Promote and facilitate the dissemination and use of hydrological information by ensuring that the SADC-HYCOS website is up-to-date with reliable data and relevant data analysis tools	Availability of hydrological data on Project website	Clearly demonstrated ability by NHS to apply information to decision-making	
	Implement tools for data exchange with national database management systems for data quality assurance and for dissemination of validated data on website	Verified data published	Evaluation of published data	NHS to provide validated data
	Develop and establish data rescue techniques by providing or upgrading digitizing hardware and software	Number of stations digitally converted	Review outputs of NHS	
	Provide training to staff in use and maintenance of database management system, data exchange and data rescue techniques	Improved performance of staff in activities carried out by NHS and quality of outputs	Review outputs of NHS	

Log Framework Result 4	Activities	Verification Indicator	Means of Verification	Assumptions
Hydrological products developed	Gross and Net Yield analyses for single reservoirs	Software developed and manual compiled	Clearly demonstrated ability by NHS to apply information to decision-making	
	Reservoir Simulation and Reservoir Systems Analysis	Software developed and manual compiled	Clearly demonstrated ability by NHS to apply information to decision-making	
	Low flow frequency analysis and its application in demand management	Technical report compiled	Accessible on Project website	
	Flood frequency analysis	Technical report compiled	Accessible on Project website	

Log Framework Result 5	Activities	Verification Indicator	Means of Verification	Assumptions
Awareness building and promotion of SADC-HYCOS Project activities	Distribute programmes for deterministic daily and monthly rainfall-runoff models for infilling of missing data and historical time series extension	Improved performance of staff in activities carried out by NHS	Review outputs of NHS	
	Promote awareness at NHS in the use of statistical methods for infilling of missing data and historical time series extension			
	Introduce Time Series Analysis and probabilistic water resources assessment techniques to NHS			
	Raise awareness of impacts of catchment management on runoff			
	Introduce techniques for the estimation of			

	reservoir yield characteristics for catchments with inadequate data			
	Introduce principles of flood routing for purposes of downstream flood warning			NHS to provide significant cross sectional data and calibrations of sections as well as data on extreme floods
	Promote awareness on SADC-HYCOS activities at various levels (e.g. NHS, RBO, community level)	Number of workshops held, press releases and information brochures produced on the role and services of NHS	Interviews with water agencies and decision-makers	

ANNEX 2 : Project Phasing and Milestones

	Year 1	Year 2	Year 3	Year 4
Consolidation of Phase I and II installations	Upgrade Phase I software and convert from 3-hourly to hourly transmission time slots and frequencies Operationalise instrumentation and assist with installations of SADC-HYCOS DCPs Dispatch Data Loggers and accessories to NHS for installation at stations identified in the Network Design Train NHS staff in the installation, operation and maintenance of equipment	install DCPs in the participating countries Continue to train more NHS staff in the installation, operation and maintenance of equipment, preferably practical on-site training	Regional roll-out to NHS to take ownership of HYCOS installations Evaluate the regional network and performance of the installed equipment Foster collaboration with the River basins organizations in the region, on the area of operation and maintenance of DCPs Evaluate the capacity building programme	Integrate the network with the national systems in member states and the systems of the various River basin organizations in the region. Develop manuals on the operation and maintenance of DCPs Develop strategies and manuals for continued and sustainable in - house training of staff by the NHS
Stations calibration	Design of calibration programme Select Survey Contractor support teams Assembly streamflow	Contractor undertakes field surveys of HYCOS DCP stations to fast track the calibration of gauging stations train NHS staff	Calibrate stations using survey results continue training of NHS staff on the use of	Evaluate the training programs and develop a framework for a continuous training program. Integrate the

	gauging teams Procure ADP equipment Train gauging teams on the use of ADPs for the calibration of stable river sections of gauging teams Train NHS staff in the utilisation of slope-area and backwater assessment techniques to undertake the calibration of gauging stations	on the use of ADPs by assembled gauging teams. Regional roll-out of streamflow gaugings on stations Develop rating tables for HYCOS stations using streamflow gauging results	ADPs by assembled gauging teams. Continued roll-out of streamflow gaugings on stations Verify the developed rating tables.	streamflow gauging exercises and rating tables development with the national systems and systems of river basins organizations in the region. Evaluation and gap filling of streamflow gauging exercise rating tables of all HYCOS stations developed using the two methods
Water Resources Information Management Systems	Migrate existing data onto the new national HYDSTRA databases Using Internet and file transfer protocols develop and establish a virtual regional database to link national database management systems Promote and facilitate the dissemination and use of hydrological	Analyze and further develop the regional database management system to include transformation of stage into flow. Continue to promote and facilitate the dissemination and use of hydrological information by ensuring that the SADC-HYCOS website is up-to-date with reliable data and	Continued dissemination of reliable hydrological information and analysis tools on the website Continued training and support to staff in use and maintenance of database management system Continued training and support to staff in use of HYDSTRA for digitizing charts Continued update	Improved dissemination of reliable hydrological information and analysis tools on the website Improved training and support to staff in use and maintenance of database management system Updated virtual regional database with data sets from SADC HYCOS

	information by ensuring that the SADC-HYCOS website is up-to-date with reliable data and relevant data analysis tools Expand the virtual regional database to include historical data sets from SADC-HYCOS stations Implement tools for data exchange with national database management systems for data quality assurance and for dissemination of validated data on website Provide training and support to staff in use and maintenance of database management system	relevant data analysis tools Continued training and support to staff in use and maintenance of database management system Regional roll out of digitizing hardware and software Provide training and support to staff in use of HYDSTRA for digitizing charts Establish data quality checks, and procedures to disseminate validated data on website Update virtual regional database with data sets from SADC HYCOS stations	of virtual regional database with data sets from SADC HYCOS stations Continued data quality checks, and dissemination of validated data on website	stations Improved data quality procedures established and validated data disseminated on the website Populated virtual regional database
Hydrological Products	Review the already developed products and assess the shortcomings and level of acceptability Identify other products which	Develop the hydrological products. Identify, adopt and implement relevant products produced by other HYCOS projects or	Deploy the products to the NHS Train the NHS staff on the use of the hydrological products Assess the level of utilization of the	Follow-up monitoring and evaluation of the products

	will address challenges faced by NHS.	initiated by collaborating agencies such as WMO	hydrological products by NHS	
Awareness Building and Promotion	Introduce and distribute programmes on Hydrological analysis such as rainfall-runoff models, reservoir yield and flood forecasting techniques to NHS Develop a framework for promoting awareness on SADC-HYCOS activities Develop information brochures and materials about the project	Assist NHS with the application of the Techniques and Programmes Conduct workshops on awareness programme. Identify Project activities which require collaboration or cooperation with relevant international organizations Distribute the brochures and materials to interested groups	Assess the level of utilization of the various techniques and programmes. Conduct awareness campaigns with the local communities Foster collaboration and co operation with other relevant international organizations	Develop a framework for further awareness campaigns by NHS Follow-up monitoring and evaluation of the techniques and programmes.