WORLD HYDROLOGICAL CYCLE OBSERVING SYSTEM

HYCOS AFRICA
A COMPONENT OF WHYCOS

Project document prepared by the World

Meteorological Organisation

for

the World Bank

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HYCOS AFRICA A COMPONENT OF WHYCOS

1. Statement of the problem

Sustainable water resources development and environmental evaluation are both dependent on the collection and dissemination of good quality hydrological data. However, in Africa, where water resources assessment and development is most vital, monitoring of the aquatic environment is currently severely limited by the widespread lack of up-to-date, quality-controlled hydrological data.

Water resources assessment

Water resources assessment is the determination of the sources, extent, dependability and quality of water resources, on which is based an evaluation of the possibilities for their utilization and control. It is the basis of sustainable development and the effective management of the world's and a nation's water resources. Water resources assessment relies on access to a timely, high quality data base of hydrological, environmental, and water use data.

Water resources development

Development schemes based on short records, or data from unrepresentative periods, may be significantly over- or under-designed, resulting either in unnecessary expense or missed design targets, and hence a waste of valuable resources. River flows in the Sahel region, for example, were far lower in the 1980s than in the 1970s. Consequently, schemes based on data from the 1970s would not have met their design targets in the 1980s, and it would be naive to base future schemes on information from the 1970s. Sustainable water resources developments require up-to-date, high quality data.

Management of international river basins

Over 50 major basins are shared between two or more African countries. Effective management of water resources and safeguarding the environment in these international basins requires international exchange of data. Whilst there are some examples of international cooperation (such as in the Niger, Senegal, Gambia and Zambesi basins), there are many other examples where water resources development would be improved by the timely exchange of recent, quality-controlled, hydrometeorological data.

Environmental evaluation

African water resources are facing a number of very significant changes. Population increases and economic developments mean that the *demand for water* - for public supply, industry and agriculture - will increase. *Changes in land use*, such as deforestation and

urbanisation, can have very large impacts upon river flows, water quality and groundwater recharge. A *change in climate* might, if it were to occur as predicted, affect significantly water availability. Up to date information on river flows and other hydrometeorological variables is needed to monitor environmental changes, both as part of a global environmental evaluation effort and in order to initiate mitigating actions. Some of these mitigating actions may have very long lead times, so early warning of change is essential. Unfortunately, up-to-date, quality-controlled data are rarely available in Africa.

Operational monitoring

Timely information on river flows is also valuable for short-term operational purposes. Flood forecasting is an obvious example, but data showing the current status of a catchment are also very important for forecasting and identifying drought problems and planning drought mitigation measures. Again, such data are rarely available.

Information on the global hydrological cycle

The hydrological cycle is a fundamental element in the global climate system. Improved understanding of the global climate system is essential for the improved simulation of climate and the impacts of climate change, and this understanding must be based on a high quality data base. The Dublin International Conference on Water and the Environment[1] urged the participation of all countries in global monitoring of the global hydrological environment.

Good quality data on the hydrological cycle are available from some regions, but few data are available from large parts of the world. There is a particular gap in Africa, and this lack has implications for the simulation of the *global* as well as the African climate system.

Unfortunately, recent surveys under the Sub-Saharan Hydrological Assessment Project[2] and for the WMO/UNESCO report on Water Resources Assessment[3] have found a serious decline in

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[1]WMO (1992) The Dublin Statement and report of the International Conference on Water and the Environment : Development issues for the 21st century. January 1992, Dublin, Ireland

[2]Executed by the World Bank in collaboration with the African Development Bank, CEE, the Governement of France and other UN agencies

[3]WMO/UNESCO (1991) Water Resources Assessment. Progress in the Implementation of the Mar del Plata Action Plan and a Strategy for the 1990s.

hydrometeorological data collection and management in many African countries. This is largely due to severe financial problems, which result in shortages of staff, vehicles and equipment for data collection and data processing. Measuring stations are being abandoned, the quality of hydrometric work is declining, little is being done to safeguard historical data, and data dissemination is limited. Very little data on river water quality are being collected. The hydrological services which undertake this work are generally in a poor state, a state which it continuing to worsen.

2. The proposed solution

The proposed solution to the lack of good quality, up-to-date water data in Africa is to create a **network of key stations, linked by satellite, with an associated data base of quality-controlled historical data.** This network and data base constitutes **Hycos-Africa**, part of the World HYdrological Cycle Observing System. The network will complement existing national hydrometric networks, and the Hycos-Africa stations will be part of established networks wherever possible. The Hycos-Africa network will not only collect river flow data, but will also collect temperature, net radiation, humidity and windspeed (to allow the calculation of potential evaporation), several measures of the physico-chemical properties of the river water, turbidity, water temperature, and rainfall.

The use of modern data recording, transmission and processing technologies, however, will only overcome the severe practical problems currently faced by African hydrological services if it is **underpinned by long-term support** and is **seen by National Hydrological Services as an essential element in the rehabilitation and development of their hydrometric networks.**

The Hycos project will be run by WMO as executing agency, with the World Bank as fiscal agency mobilising and co-ordinating donor financial support. A small Hycos team will be created, based at WMO Headquarters in Geneva. This team will arrange for the implementation of the Hycos network, in collaboration with National Hydrological Services, and will manage and maintain the central Hycos data base. National Hydrological Services will maintain the Hycos network stations, with Hycos funding. Stage I of Hycos-Africa will take six years to develop.

The Hycos project takes advantage of the lessons learnt during the development and operation of several satellite-based hydrometric data collection networks currently in place in Africa and in other parts of the world.

3. Hycos-Africa objectives

The basic objective of Hycos-Africa Stage I, is to improve the availability and timeliness of hydrological and related data for planning and development purposes, and thus make a positive contribution to the rehabilitation and development of National

Hydrological Services in Africa. This will be approached through three major components :

i. The creation of a sustainable system for the operation and maintenance of a network of about 100 sites transmitting hydrometeorological data by satellite for national and international data centres. The data will include river levels (which will be processed into river flows), rainfall, climatic variables used to calculate potential evaporation, and indices describing the physico-chemical properties of river water.

ii. The creation of a sustainable procedure for managing the data collection network, validating the hydrometeorological data collected through the satellite-based system and maintaining an up-to-date data base of high quality, validated data.

iii. The establishment of a data base of historic and up-to-date data for the sites in the Hycos network, which will be available to data users: participating National Hydrological Services will have direct access to the data base.

If Hycos-Africa Stage I proves successful, Stage II will expand the network to give wider and more representative coverage of African catchments. The long term objective is to create a *global* hydrological cycle observing system.

4. Underlying principles

Several important principles underlie the Hycos project.

i. The project must be based on committed local participation; Hycos complements existing national data collection and processing activities, and should be seen as a part of the effort to rehabilitate and develop hydrometric networks.

ii. National Hydrological Services must get the full benefit from the Hycos data set.

iii. Hycos must be a long-term project. There are many examples in Africa of well-meaning attempts to improve data collection and processing which collapsed once the short-term funding finished.

iv. The Hycos network and concept must be sustainable. It must not risk technological obsolescence, must be maintainable using locally-available staff and resources, must be capable of upgrading, and must not rely on continued support of experts from outside Africa.

v. There must be free exchange of data collected by and for the Hycos project, subject to conditions attached by the Hycos-Africa Joint Planning Committee and the WMO.

vi. The monitoring sites must be carefully selected so that the

data are of the widest possible use. There are three potential types of catchments for Hycos Stage I:

a. Basins with identified water resources development potential;

b. Representative basins which can be the basis of procedures for extrapolating hydrological information from gauged to ungauged sites;

c. Benchmark sites with long, very high quality records, which will be of particular benefit for specific environmental monitoring purposes.

It is quite possible - and desirable, given limited resources - that a catchment will fall into two or more of these categories.

5. Benefits and beneficiaries of the project

There are several major benefits of the Hycos project. These benefits will be enjoyed directly by National Hydrological Services and those in allied fields, planners of water development schemes, development aid donors and environmental change scientists, and indirectly by the local communities likely to benefit from development schemes and affected by a changing environment.

Improved data bases for water resource development activities
Improved data bases will lead to more efficient design of water resource development schemes, which will reduce the chance of over-design (which wastes resources) and under-design (which results in missed targets and lower than anticipated benefits). It will be possible to base schemes on up-to-date data which have been subject to rigorous quality control. The high quality, up-to-date Hycos data can be used to develop and validate procedures for estimating hydrological characteristics at sites with no gauged data. Finally, the Hycos data set will provide a context against which short-term records collected for specific project purposes can be evaluated.

Practical benefits of a satellite-based data collection system
There are two major practical benefits of a satellite-based data collection system. First, the system takes advantage of computer data processing techniques; these are faster, more efficient and less prone to error than manual procedures. Second, continual monitoring by satellite means that problems at the measuring site can be quickly identified and rapidly resolved, thus minimising periods of missing data.

A catalyst for further improvements in National Hydrological Services
The support provided through Hycos to National Hydrological Services will do more than enable them to undertake HYCOS tasks. The technical training and field equipment provided, and the

ability to collect and analyse data soon after they are recorded, will all act as catalysts to improvements in hydrometric networks in general. This is most likely to occur if national Hycos components are planned around the recommendations of the Sub-Saharan Hydrological Assessments and the identified needs of the individual National Hydrological Services.

Water resources development in international river basins
Efficient management of water resources in international basins requires the international exchange of hydrometeorological data. The Hycos data base provides a framework for such an exchange.

Up-to-date data for monitoring and operational purposes
Hycos data will be very useful for operational purposes - particularly for monitoring the hydrological aspects of drought -and for monitoring environmental change.

Contributions to national and international meteorological data bases
Although the primary aim of Hycos is to collect hydrometeorological data for hydrological purposes, the meteorological data collected (rainfall, temperature, windspeed, humidity and radiation) will be of value to National Meteorological Services. The Hycos network will therefore augment the existing network of meteorological stations providing data both to national services and, through the World Weather Watch, to the international meteorological community.

Improved data bases for global change science
Better and more reliable data from Africa will contribute considerably to the understanding and simulation of global climate processes; improved climate modelling benefits predictions of short-term weather and longer-term climate change, which in turn have benefits for the use and management of water resources.

Trained human resources in modern computer and satellite technology
A very important benefit of Hycos, and one which will contribute to the sustainability of the concept and the general development of hydrometric networks in Africa, is the enhancement of skills in modern computer and satellite technology.

6. Potential risks

The Hycos project faces two types of potential risk.

Technological failure
The Hycos project uses modern computer and satellite technology (as presented in detail in Part B). Whilst some of the technology to be involved is very new, most of the components are well tested in the field and have successfully been used for a number of years. The risk of the project failing for technical reasons to meet its objective of providing a working, sustainable satellite-based data collection system is therefore small.

Institutional failure
The Hycos project relies on the active participation of National Hydrological Services, using funds supplied from the project. However, the withdrawal or non-participation of a small number of countries does not jeopardise the success of Hycos as a whole; it merely means that those countries will not be able to enjoy the benefits of Hycos, and that data from those countries will not be available through Hycos.

The Hycos data base is intended to be available to all bona fide researchers and development projects. Some countries, however, may be unwilling to release hydrometric data to third parties. It is proposed that countries can only participate in Hycos if they are willing to make their data available to third parties or other countries, under conditions discussed with the Hycos Joint Planning Committee.

7. Relationship to other programmes

Global Climate Observing System (GCOS)
The Second World Climate Conference in 1990 called for the creation of a Global Climate Observing System (GCOS), which would provide up-to-date data on all aspects of the climate system and climate change. GCOS will incorporate current climate observing systems, develop new components, and provide a means for the storage and exchange of climate data. A Joint Scientific and Technical Committee (JSTC) for GCOS has been established by WMO, the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the United Nations Environment Programme (UNEP) and the International Council of Scientific Unions (ICSU), and this committee is currently determining the GCOS concept and scope.

The GCOS project recognises that the hydrological cycle has a high priority in studies of global climate change, and is at present considering how best to accelerate the up-to-date collection of river flow data. The Hycos-Africa project can be seen as a regional contribution to GCOS, and as a model for the later global-scale network.

Many of the data which will be acquired as part of GCOS will also be directly relevant to Hycos and users of Hycos data. In particular, Hycos will benefit from the collection under GCOS of up-to-date *climatic* data (such as rainfall and temperature), *spatial hydrometeorological* data (such as soil moisture status and evaporation), and *vegetation and land surface property* data.

Global Runoff Data Centre (GRDC)
The Global Runoff Data Centre is operated by the Bundesanstalt für Gewässerkunde in Koblenz (Germany) under the auspices of WMO, with support from the German government. It collects data on river discharges from basins around the world, and by June 1992 it held data from over 1300 catchments. Most of the data consist of daily flows over the period 1978 to 1985 (although very few data sets cover this entire period), but the GRDC also holds on computer the

long records of monthly flow collected by UNESCO for its publications on the discharge of selected rivers of the world.

The GRDC is an historical archive, and is not at present set up to collect regularly up-to-date flow data. However, it does provide a means for collating the past flow records for the Hycos network, and data collected through Hycos will be passed annually to the GRDC.

World Hydrological Cycle Observing System - Latin American and Caribbean (LACHycos)

LACHycos is a proposed project to create a satellite-based hydrometric monitoring network in Latin America and the Caribbean. The project will be carried out by a group of executing agencies led by the World Bank, WMO, UNESCO and external support agencies. The project has a similar set of objectives to Hycos-Africa, and it is anticipated that the two projects will co-operate closely together, particularly in the creation of data bases. This co-operation is essential given the long term objective of creating a global hydrological cycle observing system.

As a first step it is currently planned to establish under LACHycos a sub-regional project (Argentina, Brazil, Paraguay and Uruguay) for flood forecasting and warning in the La Plata basin.

GEMS/WATER

The Global Environment Monitoring System (GEMS) is a collaborative effort to acquire, through monitoring and assessment, the data and information needed for the rational management of the environment. The GEMS/WATER programme has the particular objective of collecting data on global water quality. GEMS/WATER is jointly implemented by WHO, WMO, UNESCO and UNEP. Phase two of GEMS/WATER began in 1991, and will involve the collection of water quality data from a network of *baseline stations* in undisturbed areas (at first 10, rising to between 40 and 50), *trend stations* in areas subject to deteriorating water quality (100 at first, increasing to 300 to 400 sites) and *global river flux stations* (between 60 and 70). Samples are to be taken manually from each site, and the samples analysed in the laboratory to determine values of a very wide range of water quality determinands.

The determinands measured in GEMS/WATER are far more comprehensive than those which will be assessed automatically under Hycos, but Hycos will be taking its measurements with a much higher frequency. The GEMS/WATER network, like the Hycos network, is currently under development, and it would be essential for both programmes to compare proposed monitoring sites in Africa at an early stage. The data collected through Hycos will supplement GEMS/WATER data; Hycos flow data may be particularly heplful in determining annual balances in the GEMS/WATER global river flux stations.

8. Satellite Telemetered Hydrological Networks and Development

Several examples can be given of the ability of satellite based data transmission systems to support development projects in Africa.

i. *The Onchocerciasis Control Project (OCP)*, which started in 1975, following a World Bank initiative to create a trust fund to support this Project entered its fourth phase (1992-1997) this year. This project is a considerable success in the fight against river blindness, a tropical disease, within an area of about 764.000 square km in West Africa. For the control and eradication of this disease it is necessary to receive a continuous flow of information about the discharges of the rivers which provide the habitat for the larvae of the biting blackfly, called simulie, which is the transmission vector. Aerial spraying of insecticide on the blackfly breeding sites from helicopters will destroy, in-situ, these larvae, but because of the use of insecticide it is necessary to be precise about the dosage to prevent entomological resistance of the vector to the insecticides used, and to limit its environmental impact on the rivers and riverbanks of the Programme area. This information will also allow optimization of the use of helicopters and of expenditure.

   In 1985 a pilot study was conducted on the KARA riverbasin (North Togo).This study demonstrated that the cost-effectiveness and the efficiency of the OCP would be improved by the use of a satellite monitored network of modern automatic level recorders.

   Based on to these results, in 1986 the OCP began the installation of a large network of satellite monitored hydrometric stations using the ARGOS transmission system. This network, which is still in operation, contains more than 100 stations and decicated software, (PERLES). It is used to forecast the discharges at all the stations of the OCP network, from the water level data transmitted in real-time by satellite to the Air Operation Base in ODIENNE. This system, the satellite monitored network and the data base handled by the PERLES software, gives the OCP teams the necessary information for efficient and cost-effective management of the spraying of the insecticide.

ii. ***The Benin National Hydrometric Network*** is equipped with about 20 telemetered stations acquired and installed as part of a hydrometric network rehabilitation contract funded by FAC (France). This network was installed after an economic analysis, conducted in 1986, to find a way to improve the efficiency and cost-effectiveness of the traditional one.

   After comparing the running costs (excluding the personnel costs) for the classic network and for the satellite monitored one, it was found that the use of the latter would cut down the field expenses by more than 50%. Of course, investment

costs are high and the payback period much longer than for the OCP.

In this case, the cost-effectiveness of a satellite monitored network seems to have been proved, taking into account the results from the first three years of the new modern network. Moreover, according to the national report prepared for the Sub-Saharan African Hydrological Assessment Project, this network is still operating, only one telemetered station being out of action while the **hydrological data base is regularly up-dated, a situation which is not so frequent in Africa today.**

Other *"psychological"* benefits may be credited to this type of telemetered network, such as the fact that the managers can see the network functioning in real-time and are more easily able to answer immediately the enquiries from their administrative or political leaders.

Last but not least, the *time saved* from the routine tasks can be used by the team *to contact users* of the information produced by the network and to prepare the *products* they are really asking for, based on the data stored in the data base.

iii. *The SONEL hydrometeorological network*. SONEL, which is a private company for electrical power production in Cameroon, has installed a hydroelectric plant at EDEA, on the lower section of the SANAGA river, the largest river basin of this country, (133.000 square km, or 25% of the total area of the country.) This plant is a run-of-river system and to increase the energy yield through an increase of the guaranteed discharge during the low flow period, several regulating dams and storage reservoirs have been constructed in the Sanaga river basin.

These developments provide a minimum guaranteed discharge exceeding 600 m3/s at EDEA, (it is of interest to note that even during the 1970s, a period with below average flow conditions, an increase in the energy yield was possible during the low-flow season). But in order to increase the productivity even more SONEL decided during the 1980s, to install within the Sanaga basin a network of forty satellite monitored hydrometeorological stations using the METEOSAT data transmission system, with its own ground receiving station.

Nine of these DCPs are equipped with sensors for water level, rainfall and relative humidity, the remaining thirty-one stations being equipped either for rainfall and relative humidity measurement, or for only one of these two variables.

The network is used to very carefully manage the regulating system of regulating reservoirs upstream of EDEA. No figures are available to give an idea of the cost-effectiveness of this network but since it works and SONEL has to pay for it,

in particular for the annual transmission fees within their contract with EUMETSAT, it can be assumed that its cost-effectiveness and efficiency have been demonstrated.

iv. *The OMVS Telemetered Network* comprises nine satellite (ARGOS) monitored hydrological stations. This network allows the OMVS forecasting centre to manage, in real-time, the MANANTALI and DIAMA dams respectively located in the upper and lower parts of the so-called Senegal "Valley". With this system, it has been possible to obtain, during the last three years, an artificial flood in this area, which guarantees the flood recession harvest, while at the same time providing savings in the inter-annual reserves of the MANANTALI reservoir. In the near future it is anticipated that a much more complex management system will be used for which computer programmes have already been developed, installed on PCs and checked in practice. The complete system, the telemetered network and the management programmes allow the OMVS to choose amongst ten different levels of priority in the use of the water releases from MANANTALI. As an example, it is possible to replace the cultivation schedule for corn by the one for sorghum. It is also possible, since it is one of the priority levelswhich has been defined, to take into account the electrical power production capacity for a given scenario.

In addition to these actual "*success stories*" it is necessary to point out that these satellite monitored hydrometeorological networks could also be invaluable to a number of development related projects, such as to strengthen existing systems or to establish new ones for the real-time analysis of climate risk for agriculture. Even if the situation for meteorological networks is generally better than for the hydrological ones, the results of the Sub-Saharan African Hydrological Assessment Project indicated that a number of agrometeorological stations were not working well and that in certain cases, the data were transmitted with such delays that they could not be used for operational agricultural purposes.

The data collected through multisensored DCPs and transmitted in real-time could also be used for the ground-truthing of the satellite remotely sensed data, to calibrate the algorythms both for research and operational purposes, for example, in rainfall estimation (METEOSAT) or for the calculation of the vegetation index NDVI (NOAA). They can also be used coupled with remote sensing data for the crop yield estimates.

9. The use of Hydrological Data for Development.

There is also the use of the data collected to consider, how it is transmitted and generally stored in data bases. As an example, the HYDRONIGER network is the first satellite monitored hydrological network installed in Africa. It comprises sixty-five stations within eight countries and has been developed for flood forecasting and management, for agriculture, flood protection, navigation and

electric power production. The telemetry component has always worked remarkably well, with a success rate of over 95%.

But in this case it seems evident that the products, which are made available through the system, are not tailored to the needs of potential users. Therefore, the HYDRONIGER system, including the telemetered network could be in decline since the participating countries are not interested enough in it to pay for its maintenance and operation. Recent information indicates that the HYDRONIGER project should be completely re-thought, starting from the results of a survey on the real needs of the potential users. In response to this survey, the hydrological network could be restructured with a limited number of key stations satellite monitored to allow the use, on PCs, of two types of hydrological models. The first one would be a rainfall-runoff model for the upper part of the NIGER basin, to increase the lead time for the forecast of the inputs. The second model, a propagation one, will be used for the downstream reaches of the river.

Several studies have assessed the financial justification for hydrological data collection. It is possible to anticipate that the benefit-cost ratio for most of the developing countries would be higher than those found for networks in Australia (6/3) and Canada (9/3). But it is also clear that this can only be true if efficient use is made of the data collected. It is obvious that this is not always reality and that a lot of work has to be done in this particular field.

Assuming that the data bases contain all the necessary primary data, also assuming that these data have been checked and that the operational tools to handle them exist, the products to be issued have to be defined to meet the needs of the different potential users. A hydrological yearbook, a monograph, an areal intensity duration frequency curve, a flow duration curve, a flood warning, a drought forecast are different products which can all be issued from data collected through hydrometeorological networks. But they have to be used for different purposes and to be adapted to different levels of responsibility and authority.

Although this is not the place to enter into more details concerning all the African development projects based on hydrometeorological data collected through networks, it should be emphasized that the relationship betweeen hydrological data and development has to be based on a two-pronged approach.

1. the rationalization of the networks making them more efficient and cost-effective, in particular through the installation of multisensor satellite monitored stations, such as that proposed for Hycos-Africa,

2. the development of "user-friendly" products adapted to different purposes and different levels of decision making in a form which is easily applicable in terms of user needs, knowledge and capabilities.

It is only if the second approach is conducted simultaneously with the first, that the consistency of the system is assured, and the necessary investment for the data collection system justified.

If the technical problems related to the establishment of these modern networks are all solved, programmes would have to be launched to develop those "user-friendly" products which are interfacing technology, science and operational needs.

10. Hycos- Africa - A Product for the Development Market

It must be evident that Hycos-Africa alone is not able to solve all the problems related to the poor status of the hydrological networks identified in the Sub-Saharan Africa Hydrological Assesment and the Water Resources Assessment Project.

Hycos-Africa is only one tool proposed amongst the different national and regional projects whose beneficiaries and benefits have already been listed in this report.

Should it be necessary to be more explicit on the reasons why Hycos-Africa is really a product for the development market, some additional comments can be provided.

i. It has been ably demonstrated by the Hydrological Assessment Project that "among the West African countries a significant part of the expenditure on data collection is undertaken on specific project studies". This is also true for other parts of the African continent. At the same time it is important to stress that the information collected during a short study (e.g. for feasability and/or design) does not and cannot replace a basic network. It is only supplementary to it. The Hycos-Africa objective is to create a network of key stations satellite monitored, with an associated data base of quality-controlled historical data. Only this kind of system will secure the long term records which are needed to:

1- sample the extremes of rainfalls, floods and droughts,
2- provide data to improve the statistics for the long term mean and the different statistical distributions, and
3- detect the effects of changes in land use,
4- monitor long term trends in climate
5- characterise the aquatic environment.

In fact, Hycos-Africa can provide a context against which records collected for specific project purposes could be evaluated.

ii. The concept of Hycos is based on a completely open system, one which allows each of the participating countries to have free access to all the data collected within this system. This is the only way to assure regional co-operation and collaboration

between the riparian countries of international basins, to provide for the integrated and therefore the sustainable development of these basins.

iii. Hycos-Africa will act as a catalyst for further improvements to National Hydrological Services since their active participation will be required and made possible through adequate equipment, support and tailored training activities.

iv. A recent meeting of the WMO/UNESCO/UNEP/ICSU Global Climate Observing System (GCOS) JSTC task group on land surface processes has identified the variables to be measured which are of key importance for this System. Several of these variables such as precipitation, evapotranspiration, surface temperature, air temperature, humidity, radiation and surface water runoff are proposed to be measured by, and collected through the Hycos-Africa system.

At the same time these experts recognized that measurements of runoff on a regional basis were of crucial importance for the establishment of the heat and water balance, and that records of runoff coupled with land use studies offer a new indicator for climate change detection, because runoff integrates over an area. But they also noted that, in particular, runoff was inadequately measured throughout the world and especially in developing countries, such as those of Africa. They also faced the problem of the exchange of hydrological data and of the need for the development of comprehensive data banks fed with reliable data and regularly updated.

It seems therefore that the implementation of a major tool like Hycos-Africa would contribute to the major tasks to which GCOS is dedicated:

- Prediction of global climate;
- monitoring of global climate;
- detection of global climate change;
- monitoring the effects of climate change, especially on terrestial ecosystems, and
- planning and decision-making for economic development.

This list shows that GCOS is not only a system devoted to improving the knowledge and understanding of global climate change but that it is also directly related to development, since particularly in very sensitive zones such as the inter-tropical zone of Africa, the socio-economic and biosphere balances are precarious. Therefore even very small modifications of one of the components of those balances, such as the climate, could lead to disastrous situations.

Consequently if Hycos-Africa is to be a tool for GCOS, it must also be considered that GCOS is a tool for development.

A project like Hycos-Africa must be given high priority by the international community, on the assumption that it will be a cost-effective tool for major short, medium and long term development projects. Without it, there is little chance of

ensuring sustainable development, lacking the tools to monitor the general trends of the water cycle at national, regional and global levels. *Hycos-Africa would be one of these tools, and one of the most important, if not the most important.*