DATA SHORTAGE IN AFRICA

Baisch Jürgen

Institute Water for Africa e. V., Wielandstr. 11c, D-71394 Kernen im Remstal, Germany, email: j.baisch@water-for-africa.org

Abstract: Africa isn't only suffering from water shortage but also from data shortage. The continent cannot fall back on a cross-country hydro-meteorological measuring net. Development cooperation organisations as planners often have the problem that no, or insufficient, hydro-meteorological data is available, even though these are of great importance for sustainable water resources management. Usable water deposits are often not recorded in quantity, quality or in spatial and temporal distribution. The negative effects of insufficient data can only be avoided on a long-term basis. One has to know where, when and how much precipitation, evaporation, run-off and groundwater recharge can be expected. This is the basis for sustainable planning in the field of water resources management, agriculture, hydropower generation, erosion control, etc. The answer is the "setting up of a cross-national hydro-meteorological measuring net for creating the preconditions of sustainable water resources management".

Keywords: water resources management, data shortage, water balance, sustainability, hydrology, network.

Hydrological cycle

Water is always on the move – it is in a cycle. In contrast to mineral resources, it is not finite and can be used again and again. The amount of water on earth and in the aerosphere is estimated at 1,383,844,700 km^3. The majority of the water (97.591 %) is in the oceans, the inland seas and the salt lakes. It is salt water. Only 2.408 % is fresh water. The majority of it (78 %) is stored in the polar regions and the glaciers. The remaining 22 % of fresh water is divided into surface water, ground water, ground humidity and water in the biomass. That is a volume of water of 7,326,700 km^3 in total or 0.529 % of the entire amount of water on earth and in the aerosphere. 0.001 % or 13,000 km^3 or rather 13 billion m^3 of water is in the aerosphere. [1]

The most important source for vegetation is precipitation from the atmosphere. The global average is 880 mm annually. The earth has a surface of 510 billion m^2. Consequently the total, global precipitation has a volume of 448.8 billion m^3. That is many times that of which is in the aerosphere. That is why the water in the aerosphere renews itself every 10.6 days. [1]

Some of the precipitation evaporates, some seeps away into the soil and becomes ground water. The part that does not seep away or become ground water runs off the surface in brooks and rivers which flow into lakes or the sea. The distribution of precipitation on the earth is variable. Where there is much precipitation much water can evaporate, become ground water or flow away. During short terms the precipitation in dry areas is lower than the evaporation. During this period of time water shortage and droughts can be caused and therefore bring about failures of harvest and therefore famines.

Hydrological Balance

The components of the hydrologic balance, precipitation, runoff and evaporation interact with each other. The thermal seasons (summer and winter) as well as the hydrological seasons (dry season and rainy season) influence their size. They vary in every area. The interactions of precipitation, runoff and evaporation are examined on the basis of the analysis of the hydrologic balance of an area. In addition to natural influences there are also human influences such as construction of dams, deforestation, irrigation, extraction of ground water and so on.

In large parts of Africa clean water is already a scarce commodity. Based on statistics for expected population development, the population will grow. The requirement of food will increase and therefore the requirement of water. To minimize the negative consequences for the environment through over-extraction of ground water as much as possible, it is necessary to know the numbers of hydrologic balance precipitation, runoff, evaporation, retention and operating capacity in its chronological and spatial distribution.

Actual state

Compared with the western world, African countries cannot fall back on cross-country hydro-meteorological measuring nets, covering all needs and supplying them with data for a lasting management of water resources, water supply, agriculture, generation of energy and protection against erosion. Where data is entered, it is often not centrally stored, made accessible or analysed. Data is also available only on a completely insufficient scale, i.e. there does not exist any sufficiently long term measurement series for safe planning. Entered data is not always comparable, since it is often measured in different ways.

Sometimes it is only available in units that do not belong to SI-units. In order to make use of this data, it will have to be converted into internationally acknowledged units.

Inadequate data often has many of negative effects:

- Wells are drying up when too much water is withdrawn.
- Ground water levels are reducing due to unknown ground water recharge, evaporation, precipitation, run-off and geology, resulting from too greater water withdrawal.
- Dying vegetation is resulting in harvest losses and increasing desertification, since the depth of groundwater is rising due to sinking ground water levels.
- Slums and streets are flooding due to bad planning caused by lacking precipitation data.
- Reliable precipitation data for the planning of dams, e.g. in irrigation projects, is missing.

All this could be avoided in the long-term, but it requires responsible water resources management. If water projects are going to have long-term successes, one has to know where, when and how much precipitation is to be expected and how much water will be available. It is imperative, that reliable data is measured, analysed und made available over long periods of time.

Until now this has not been the case in Africa. In comparison to the western world, African countries cannot rely on a measuring net delivering this data. So the basis for a long term plan in the field of water management, agriculture, generation of energy, erosion control and road construction is lacking, as well as the basis for reaching the millennium development goals.

The following three examples show that there is no such measuring net in existence.

“In some countries of Africa, most of the data is not in electronic media that can be easily accessed and manipulated. ... For most of the countries, meteorological and hydrological data are stored in various forms not readily compatible with modern archiving and processing facilities” [2].

The website of World Meteorological Organization with its Hydrological Referral Service (INFOHYDRO) shows that there is no metadata for African countries in the database besides Ivory Coast, Seychelles and Mauritius. The database INFOHYDRO does not contain or handle actual hydrological data [3].

The Global Runoff Data Centre (GRDC) in the Federal Institute of Hydrology (BfG) contains 6462 stations in 153 countries (888 stations in 44 African countries) where data products from 2784 stations can be downloaded. Many GRDC stations are not up to date because data acquisition is a tedious task and member states represented by their National Hydrological Service are often reluctant to provide data. The data acquisition activities of 2007 in WMO region 1-5 contained only three African countries (Central African Republic, Ghana and Namibia). GRDC has mostly collaborations and cooperartions with research groups from universities, not with organizations of development cooperation [4].

Demand

Experts in the field of water resources management point out again and again the difficulties in water management projects in their publications and lectures. There it is said that national and international organizations of development cooperation as planners often have the problem that no or insufficient hydrological or meteorological data is available for project areas. But these are of great importance for reliable calculations of water supply plants, the planning of irrigation plants, use of waterpower, flood protection and other water management tasks. Water deposits usable for these purposes are often not recorded in quantity, quality or in spatial and temporal distribution. When data is recorded there may be gaps. This is described in the reference book "Wasserwirtschaftliche Meß- und Auswerteverfahren in Trockengebieten" [2].

That this situation has not changed until today becomes clear through the report "Data shortage in Africa", by Volker Mrasek in "Deutschlandfunk" from 24.08.2005. The Swedish hydrologist and engineer Rikard Lidén says at a seminar at the World Water Week at Stockholm in 2005 that Africa is suffering not only from water shortage but also from data shortage. Sten Bergström, leader of the research group of the Swedish Weather and Water Service at Norrköping in Sweden is quoted with the following words: "Sometimes data is simply lacking because it was never measured. Sometimes gauging stations are destroyed in civil wars. But mostly water departments are only lacking money to employ people for measuring and maintaining the equipment. This is a real problem." Rikard Lidén says this is a growing problem, "since data quality is deteriorating and many measurement series are no longer continued. The engineer warns that water shortage in Africa can be still intensified, describing an example from the south eastern corner of the continent ..."

The question is if and how these gaps can be closed, e.g. by setting up separate gauging stations or by transferring data from comparable areas. Even if there is enough time before the start of the project to set up gauging stations and to carry them on during the project, raised data will not have the same statistical meaning as a series of measurements over many years. For water resources management planning needs measured values over 10 to 30 years. The longer the period of observation time the more convincing the results.

For planners, the initial question is where they can get data for their project area, since there currently exists no central authority for this data. A search in the country itself is highly time-consuming and besides it is not sure how reliable, representative or comparable this data is, as it is gathered by different organizations. The same measurement methods are not always applied or may not even be documented.

Aim

The states of Africa shall fall back on a sufficient covering cross-country hydro-meteorological measuring net, as is already used in Europe, supplying them with data for a sustainable management of water resources, water supply, agriculture, generation of hydropower and protection against erosion.

Relief organisations, organisations of development cooperation and their project partners as well as the involved states should have a central contact point that makes the necessary hydro-meteorological data and analysis available for sustainable planning.

At the same time cooperation with African countries is of great importance for us.

Method

Starting in Uganda, the current measuring net of weather stations will be extended, until its density is high enough to record all parts of the land hydrometeorologically. The World Meteorological Organization (WMO) recommends the following minimum density of precipitation gauging stations, depending on the type of the area [2]:

Table 1. Minimum density of precipitation gauging stations depending on the type of the area; recommendation of the WMO

Type of area	km^2 / station
Flat areas of temperate, Mediterranean or tropical zones	600 - 900
Mountainous areas of temperate, Mediterranean or tropical zones	100 - 250
Small mountainous isles with very irregular rainfalls, very narrow hydrographical net	25
Arid or polar areas	1.500 – 10.000

Meteorological gauging station

Meteorological gauging stations will have to consist of the following sensors at least, to measure parameters necessary for calculating water resources management quantities such as precipitation and evaporation:

- rain gauge (measuring of precipitation)
- pyranometer (measuring of global radiation)
- sunshine duration sensor (measuring of sunshine duration)
- wind speed sensor (measuring of wind speed)
- hygrometer (measuring of relative humidity)
- thermometer (measuring of air temperature)
- albedometer (measuring of reflexion radiation)

By employing solar panels and satellite transmitters, gauging stations can also be used in remote areas. Each station transmits the measured data to the satellite hourly, which transmits it to the destination station. From there the data can be transferred via the internet into the database in the office of the Institute Water for Africa.

Hydrological gauging station

As ground water levels are dependent on time and place they will be analysed for problems which demand examination with regard to time and space.
Ground water levels are fluctuating throughout the year as they are influenced for example by water levels of stretch of waters above ground, tapping of ground water and rainfall. These connections can be examined, but it requires the setting up of ground water gauging stations.

A ground water gauging station consists of a ground water data-logger with capacitive measuring cell. Additionally it has a solar panel and a satellite transmitter to be able to operate the gauging stations in remote accessible areas.

Water level gauging station

Water level at rivers is measured with a water level gauge. From the water level an individual discharge curve can be calculated for the outflow.

In dry seasons, when the level of rivers is low, discharge in rivers corresponds to the ground water outflow. When there is rainfall, the water rises and feeds the ground water. The outflow in rivers can influence ground water levels or be influenced by it. For this reason discharge is an additional quantity in hydrological balance. In our project existing data of water levels will be examined if they are correct and included in the database.

New gauging stations can be built on the same modular principle as meteorological weather stations and ground water gauging stations or be installed together with them. This data will also be transferred via satellite and stored in the database for the future.

Sustainability

If precise knowledge about water resources is available, negative consequences for the environment through ignorance and mismanagement can be avoided in future project plans. Sinking ground water levels, the dying of vegetation and the extension of deserts are only a few of many examples.

On the other hand it is possible to return the fertility to salted infertile soil through leaching water if evaporation becomes known. For new technologies like Alpha-Spring-technology, described under [7], favourable positions for water extraction in dry regions can be found on the basis of the collected data. This water can be used for desalination of over salted soils, irrigation of fields or water supply for the population. Through water extraction by means of Alpha-Spring, ground water levels will rise again in the area in question. Such projects will have no negative effects on nature or ecology. Rather, it enables a lasting management of water resources.

In the case of reliable hydro-meteorological data, active planning is possible. Lasting management of water deposits can permanently preserve areas used agriculturally. It is possible to counteract to sinking ground water levels so that these areas will recover again. Salinization also can be avoided by sufficient irrigation. Well-directed resources and careful irrigation technology will increase the yield.

An active agricultural economy helps avoid malnutrition and incorrect feeding as well as resulting illnesses.

Availability of sufficiently clean water is more importantly responsible for a reduction in the occurrence of illnesses caused by poor hygiene. All of this reduces child mortality and improves productivity of the population. This again increases economic productivity, which is important for the country as a whole. If the construction of wells is based on secured parameters of water balance, women and children will above all profit from it in the long term. Then it will be unlikely that wells dry up. Long journeys to reach the next well will no longer be an issue. Less time will need to be spent fetching water, which can be a laborious or even dangerous task. This means that especially girls and women will have more time for schooling. This creates more educational opportunities for them. Education is the country's capital, for it improves productivity and national economy will also profit from it.

In the case of ground water recharge in the area of wells owing to measured values it is possible to limit water consumption within an ecologically defendable frame or to keep it under surveillance. In some places water kiosks or water meters have proved to be meaningful. In this way the population is made aware that water is valuable and has to be protected since it is not available infinitely.

Figure 1. Water kiosk in Birnin Gwari, Nigeria; photo: Jürgen Baisch

Gauging stations do not mean that the population will get water, e.g. people do not derive direct visible benefits from it. Nevertheless these stations are suited to support responsible handling of water resources and environmental esteem.

Conclusions

The Project requires constant work over years. Collection of data of at least five, or preferably ten years have to be analyzed to give convincing results which can be made available. The statistical confidence increases year by year.

In a world of fast success it is the more urgent that this work can begin immediately.

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References

[1] Achtnich W. *Bewässerungslandbau*. Ulmer: Stuttgart, 1980; 94-96.

[2] WMO. 2001. Report of the International Data Rescue Meeting (Geneva, Sept 2001). WMO – TD No. 1128, Annex 5

[3] http://www.wmo.ch/pages/prog/hwrp/INFOHYDRO/infohydro_index.html Access date: 15.04.2008

[4] http://grdc.bafg.de
Access date: 15.04.2008

[5] Deutscher Verband für Wasserwirtschaft und Kulturbau e.V. (DVWK). DVWK Schriften 96 "Wasserwirtschaftliche Meß- und Auswerteverfahren in Trockengebieten". Paul Parey: Berlin, 1991, 5.

[6] http://www.dradio.de/dlf/sendungen/forschak/410357 Access date: 23.01.2008

[7] http://www.alpha-spring.com Access date: 23.01.2008