WATER RESOURCES ASSESSMENT AND DEVELOPMENT PROGRAMME IN THE SUDAN (WADS)

PROGRESS REPORT

Period : 1 January 1986 - 1 June 1987

Purpose : Mid-term review

Prepared : Directorate General of International Co-operation (DGIS), The Hague

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Royal Netherlands Embassy, Khartoum

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1. INTRODUCTION

1.1 Project background

The 'Water Resources Assessment and Development Project in the Sudan' (WADS) started in January 1986 as a follow-up to the co-operation programme, under way since 1979, between the Sudanese National Corporation for Rural Water Development (NCRWD) and the Netherlands Institute of Applied Geoscience, TNO. The executing authorities of the project are the Sudanese Ministry of Energy and Mining and the Directorate General for International Co-operation of The Netherlands Ministry of Foreign Affairs.

Until 1986, the programme mainly involved water resources assessment aimed at rational development and adequate management of (ground)-water resources. During that year a Plan of Operations was prepared for the execution of a project in which emphasis will be placed on activities that directly support village water supply, complemented by support to the development of national and regional water resources management. The work will be done largely in Southern Darfur (nearly 75% of the budget), and in Khartoum and Kassala. Project duration is two years: 1987 and 1988.

1.2 Project Objectives

The co-operation between the NCRWD and TNO has developed into a water resources assessment and development programme which has contributed to the general awareness of the need for adequate management and rational utilization of Sudan's limited water resources.

The projects executed under this programme have been aimed at gradually establishing a national water policy, water resources management, training and, lately, rural water supply.

The objectives of the present WADS project can be specified as follows:

Rural Water Supply

- to develop practical guidelines for the planning, preparation and implementation of village water supply programmes and projects in Southern Darfur Province (SDP);

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Rural Water Supply

- to develop practical guidelines for the planning, preparation and implementation of village water supply programmes and projects in Southern Darfur Province (SDP);
- to implement a phased village water supply programme in SDP;
- to contribute to the development of a sustainable maintenance system for village water supply facilities (not including water-yard system);
- to study the feasibility of utilizing village water supply systems for irrigated gardening.

Water Resources Management

- to contribute to the draft of a plan for water resources management in SDP;
- to contribute to the draft of a national water exploration and development programme;
- to support and further develop the activities of the "Technical Committees" in Kassala, Nyala and Geneina;
- to establish an information centre on water resources data, including completing the setting-up of a database on water resources.

Training

- to develop a system of training as an integrated part of the project activities through on-the-job training and short courses.

2. ACTIVITIES IN SOUTHERN DARFUR

2.1 Village Water Supply Programme

2.1.1 Concept

The project has adopted for the execution of the village water

supply programme the systems approach as outlined by the International Reference Centre for Community Water Supply and Sanitation (IRC, 1986). This approach adresses the maintenance of the rural water supply facilities from the planning stage onwards. It includes the following key elements:

- community participation;
- local resources assessment for technology selection;
- village-level operation and maintenance;
- cost recovery;
- training;
- institutional and financial provisions for maintenance.

The IRC systems approach involves adapting the solutions for village water supply improvement to the needs and resources at the village level.
A step-wise procedure was designed for the preparation and implementation of the water supply programme (Annex A).
An essential part of this procedure is the analysis of the financial and organizational capacities of the village communities, to enable the project to evaluate the needs of the village community and their capability to operate and maintain the water supply facility.
The village water supply programme was started in 1987 under a pilot phase, which is expected to continue until the end of 1987. The selected approach is new in this part of Sudan and therefore the project wants to obtain experience, before the final procedures are determined. This needs to be done in the beginning of 1988.

The socio-economical surveys are planned such that also village women will be able to express their opinion on desired improvement of the village water supply. This is achieved by also organising separate meetings with male and female representatives in the villages.
Nevertheless it should be understood that in the present situation it is very difficult for women to decide differently from the men.

The selection of the villages to participate in the water supply programme uses criteria as described in annex A. The criteria will be evaluated at the end of the pilot phase.

A condition for the villages to be considered for improvement of the water supply situation will be their participation in the entire process. The strategic means for the project in this respect are:

- official request from the village through the Rural Council
- contract with the village, demanding:
  1. contribution in cash and labour for well and water lifting device;
  2. formation of a village water committee and appointment of caretakers(s);
  3. responsibility for future operation and maintenance (O&M) of the system.

The villages are expected to assure full ownership for the water supply facilities and they will not automatically be assisted by the project for maintenance. However, they may require support in certain circumstances like falling watertables, clogging of wells etc.

A low level of technology has been adopted for the village water-supply systems to adjust closest to the O&M capability of the village community: open dug wells with a simple hand-operated windlass-system or incidentally a handpump (on boreholes mainly). The dug wells will be constructed by different methods depending on the local conditions:

1. the upper part of the well is lined with concrete bricks, the lower part below the groundwatertable is lined with concrete rings with smaller diameter (1.30 m inside)
2. the whole well is lined with concrete rings

A concrete platform is constructed around the well to prevent pollution of the well water. The windlass (or handpump) is operated by the caretaker, who pours the water into a simple concrete storage chamber.

The consumers fill their buckets from taps connected to the storage chamber.

The maintenance costs of the systems, which should be low, will be financed by the villages on the basis of credits and subsidies from a revolving fund for maintenance.

Until April contracts have been signed with 4 villages to improve their water supply while 2 villages in the Jebel Marra area were referred to the NCRWD-Nyda, to apply for a borehole from the lower Saxony Programme (section 2.5.4).
The construction activities were started with borrowed construction equipment, as the project equipment was not expected to arrive before June 1987. Due to this equipment problem the project constructed only 4 wells before the rains of 1987.

The extension work and surveys in the villages in Kas rural council included the following items:

1. Explanation of WADS activities in the village
2. Inventory of existing water problems
3. Explanation of contract
4. Discussion of responsibilities of village water committee
5. Discussion of technology choice
6. Siting of new well

Two teams were formed and trained to carry out the extension work in the village. For the construction activities foremen and builders were trained in the various expects of the well construction.

The cooperation with the villages during the construction has been very good.
The required number of labourers was always present without problems. The financial contribution by the village was received with the signed contract. The money will be saved by the project until the policy of the revolving fund for maintenance is established.

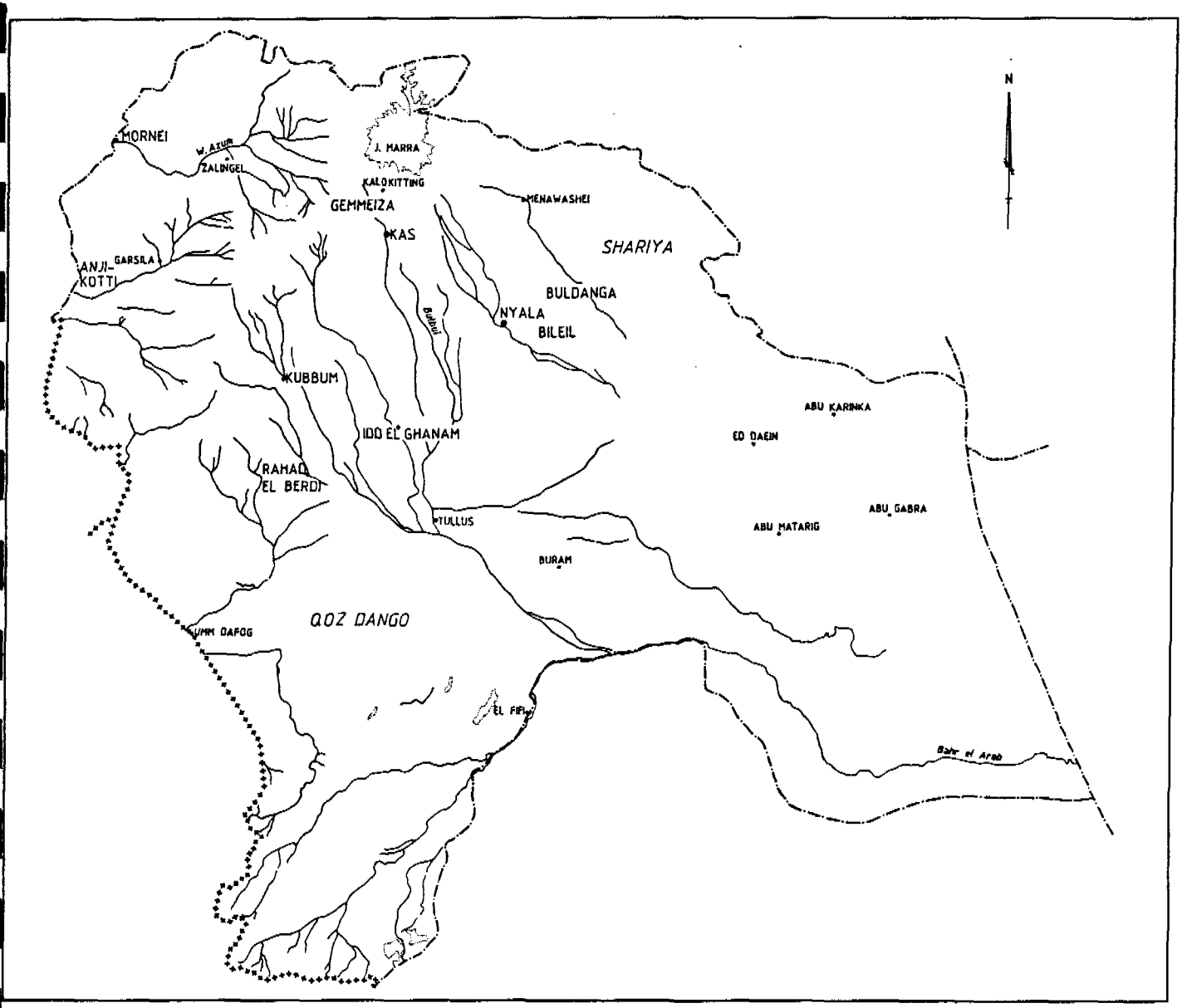


Figure 1 Map of Southern Darfur

Figure 1 Map of Southern Darfur

2.1.3 Planning

As the village supply programme will have a demonstration character, priority will be given to achieving success in terms of fully installed and running water supply systems and to developing villagelevel maintenance solutions. In particular during the pilot phase the project will emphasize the need for detailed and thorough preparation of the village projects. Success during this first phase will boost the villagers confidence and consolidate the working relations with all parties involved.

Therefore, from the technical point of view, the aim is to achieve a 100% success rate of wells constructed during this pilot phase. Priority may be given to villages where the prospects for achieving success are favourable. Therefore, during the pilot phase no more than 10 dug-well systems will be improved or constructed.

The function and use of the windlass-systems manufactured by the project's workshop, will be monitored. If the windlasses prove successful, they will continue to be installed in the next phase.

During the phase of extending the project the work will be increased and more village contracts will be prepared simultaneously. The number of systems to be constructed or improved will depend on the demand from villages in Kas and other rural councils, and on the project's ability to meet this demand. At present, it is estimated that a maximum of 120 facilities could be constructed or improved:

- 70 dug wells, equipped with a windlass;
- 10 boreholes with hand pumps (on a trial basis);
- improvement of 40 existing village water supply systems, including improvement or rehabilitation of water-lifting systems and/or wells.

These targets assume that a number of village projects started in 1988 may have to be completed early in 1989.

The village watersupply programme will be executed in six rural councils: Kas, Nyala (partially), Idd el Ghanam, Kubum, Rahad el Berdi and Shariya (see figure 1). It is planned that 20 wells can be constructed or improved in each rural council, doing one well in each selected village.

The project will prepare guidelines for planning, preparing and implementing of village water supply programmes based on:

- results of monitoring water supply facilities;
- exchanging experience and information with other projects in Southern Darfur or elsewhere in Sudan;
- the successes and set-backs of the ongoing village water supply programme;
- hydrogeological surveys, site investigations and the collection of hydrogeological data.

The draft guidelines will deal with the following topics:

- information required to plan facilities (needs, resources);
- environmental, hydrogeological and socio-economic criteria needed to determine technology options and service levels;
- procedures for planning, supervision and implementation;
- organization and financial principles;
- community participation procedures;
- human resource requirements;
- maintenance management.

The project will follow with interest the development of the water-supply policy by the authorities in Southern Darfur.
Several water supply programmes are being executed in Darfur at present and a better coordination with respect to project areas, choice of technology, etc. is urgently required between the agencies and government departments involved. The project has already started discussions with the regional representatives of the NCRWD and other regional authorities to find improvements to the situation.

2.4 Water Resources Management

2.4.1 Background

In relation with the nationwide compilation of water resources data by WADS, a framework for water resources management will be prepared at regional level.
This is executed by WADS in Darfur by making inventories of available hydrological and hydrogeological data, by determining the possibilities for water supply and the supply systems necessary, and

by estimating the costs of implementing the investigation and construction programmes.
These activities are planned to lead to the establishment of a Water Resources Management Plan.
The legal foundation for such a plan may be a regional water law. An example of such a law, based on the Water law adopted at Kassala Region, was submitted by WAPS-2 in 1985 to the regional authorities for their study and comments. However presently the central government is planning for a national Water law and regional efforts are being postponed.

2.4.2 Results

The establishment of a Water Resources Management Plan may be divided in three parts (Annex B):

1. Collection of information and data on water resources
2. Collection of information and data on water demand
3. Establishment of development and management guidelines

The activities related to the first two parts have included until present:

1. Collection of rainfall data. Many rainfall stations were established by the Sudan Meteorological Department or other organisations but many of these are not operating. An agreement was made between the Department, the Western Savannah Development Corporation and the WADS project each to supervise the operation of a selected number of stations in Southern Darfur.

2. Collection of groundwater data from deep boreholes in the Baggara Basin (waterlevels, electrical conductivity, temperature), which covers a large part of Southern Darfur.

3. Literature study on the geology and geohydrology of the Baggara Basin and collection of borehole data.

4. Geophysical fieldsurvey of the Qoz Dango, a remote sandy area in the south-west of Southern Darfur. The survey was executed on request of the Western Savannah Development Corporation.

5. Preparation of first draft of a hydrogeological map of Southern Darfur.

6. Execution of geohydrological studies in selected areas: Kas, Gemmeiza, Bileil, Bulbul, Buldanga (chapter 2.5).

7. Collection of data on population, health situation, water consumption, irrigation etc. from other organisations active in Southern Darfur.

The activities in part 1 and 2 are presently carried out simultaneously.
Part 3, the development and management guidelines, will be executed later (in 1988).

2.4.3 Planning

The data collection and analysis for the establishment of a Water Resources Management Plan will be recorded in Technical Reports, of which drafts will be ready on water resources in October 1987 and on water demand in December 1987. The first draft of the Management Plan will be prepared in the beginning of 1988.

The report on the water recources will be complemented with the hydrogeological map of Southern Darfur; the map will be designed from Landsat satellite imagery and hydrogeological data, collected by the project and will concur with the maps prepared for the nationwide compilation of hydrogeological data.
The analysis of water resources and water demand will have to rely very much on existing data. The amount of new data collected in the field is limited, because of the size of the area of Southern Darfur.
Therefore only preliminary development and management guidelines will be prepared in 1988. These will be discussed with the authorities, to decide on which future actions need to be taken.

2.5 Other activities

2.5.1 Hydrogeological studies

The project has carried out a large number of hydrogeological studies in Southern Darfur during 1986 and 1987:

- Kas Groundwater Resources Study; on the request of the regional authorities a survey was carried out near Kas (20,000 inhabitants) to assess the water availability for the town's watersupply (Annex C).
- Gemmeiza Groundwater Resources Study: on the request of NCRWD-Khartoum a survey was carried out in this area at 20 km from Kas, to assess its potentiality for watersupply to Kas (Annex D).
- Bileil Groundwater Resources Study: on the request of the regional authorities a survey was carried out in this area, located along Wadi Nyala, immediately downstream of the WAPS-2 project area, to assess the water resources for irrigation (Annex E).
- Bulbul Water Resources: on the request of the regional authorities a survey was carried out, mainly to assess the water resources for irrigation.
- Buldanga Water Resources: id.
- Many small (one-day) surveys were executed, usually on the request of a government department, a village or an aid-organisation, to determine sites for new wells or to check the productivity of existing wells or for other purposes.

2.5.2 Technical Committees

The Technical Committees of Nyala and Geneina, which were proposed by WAPS-2 to continue the monitoring activities at Wadi Nyala and at Wadi Kaja/Disa have not yet been established officially.
WADS considers the continuation of the data collection important and therefore the Technical Committees are working temporarily inside the project. More information on the activities is included in Annex F.

2.5.3 WADS/COR/UNHCR Water Project

The WAPS-2 and WADS projects have been assisting continuously the Sudanese and international refugee organisations, COR and UNHCR resp., in the watersupply of the refugee centres near the border with Chad. In the framework of this collaboration a water project has been started in 1987 to construct new wells at three centres.

The activities will continue until 1988 and are described in detail in Annex G.

2.5.4 Monitoring of Lower Saxony Handpump Program

The German state of Lower Saxony is executing a well construction programme in Northern and Southern Darfur. The wells are drilled with a down-the-hole hanner rig, mainly in the Basement Complex (hard rock) area, and are completed with a Kardia handpump. The WADS project has carried out fieldsurveys in some of the villages to enable a study of the socio-economical effects of the new well and of the operation and maintenance of the Kardia handpump,

2.5.5 Drilling

The WADS drilling rig has been drilling for the hydrogeological studies of the project, but also some boreholes were drilled for UNHCR, Roads and Bridges Public Corporation, Nyala Urban Water supply Corporation etc.

2.5.6 Evaluation of geophysical methods

The limitations of electrical resistivity and electro-magnetic survey techniques in Basement Complex areas and wadis were evaluated by the project, using new and old geophysical survey data (Annex H). The usefulness of the seismic refraction method and electrical resistivity method to locate the boundary of the Baggara Basin was also analysed, using the results of the Qoz Dango geophysical survey (Annex I).

2.5.7 Proposal for extension of the town water supply of Nyala and Geneina

The project prepared a proposal for the extension of the town watersupply distribution systems of Nyala and Geneina, on request of the regional authorities and the Royal Netherlands Embassy (Annex J).

The final design of the extensions was carried out by the National Urban Water Corporation with assistance from Euroconsult and construction activities are presently underway.

2.6 Training

2.6.1 Results

The training of project staff at Nyala was executed at three levels:

1. on-the-job training; this is a day to day activity
   - in the field when drilling, executing different geohydrological, hydrological and geophysical surveys, etc.
   - in the project workshop: car maintenance, mechanical work etc.
   - in the offices: data processing, analysis, report writing etc.
2. mini courses in the form of lectures, orientation talks etc. on various subjects: geophysics, data handling, groundwater models, slug tests etc.
3. short courses in the form of series of training sessions: well construction, extension work for village water supply, pumping tests etc.

One short course on remote sensing was given in Nairobi to six WADS staff-members. The course was a good orientation to utilize the remote sensing technique in groundwater applications.
One geologist has been in Vienna on a one-year course in isotope hydrology.

The project has also organized courses in the english language on beginners and advanced level for all project members.

2.6.2 Planning

The training of project staff will be executed in future more systematically. A preliminary job analysis was carried out of most of the project staff jobs, to determine the training requirements.
The final training programme will be made within a few months, especially after sufficient experience has been obtained with the village water supply programme.

At the village level selected villagers will be trained to do the maintenance of the provided facilities. Caretakers need to be trained in the operation of the waterlifting system, the maintenance

of well and structures, the hygienic use of the water, etc. The village water committees have to be aware of the above measures and they may have to be instructed about related matters, such as cost recovery.

The training at the village level can be executed systematically after the methods of the village water supply programme have been made sufficiently clear. This is expected before the next dry season of 1987-1988.

3. ACTIVITIES IN KHARTOUM

3.1 Database

3.1.1 Results

At the end of 1986 the following data had been stored in the computerised database:

- 1710 lithological descriptions
- 700 geo-electrical soundings
- 2500 chemical analyses

At the end of the year the database had been furnished with the following equipment:

- two micro-computers	APPLE-II	(64 Kb)
- one micro-computer	APPLE-IIe	(64 Kb)
- two micro-computers	IBM-AT	(640 Kb + 20 Mb hard disk)
- one micro-computer	IBM-PC	(640 Kb)
- one hard disk	CORVUS	(45 Mb)
- three printers	EPSON-RX 80,	FX 85 and MX 80
- two printers	OKIDATA-193	
- one plotter	HOUSTON-DMP 52	
- one stabilizer	IMUNELEC STAL-3 (3 KVA)	

The two IBM-AT's, the two OKIDATA-printers and the plotter have been supplied by the Nubian Sandstone Project, as it became clear that it was advisable to join efforts in data collection with the WADS-projects.

Unfortunately the screens of the two IBM's did not arrive before half 1987, which hampered the storage of the data of the Nubian Sandstone project into the database. The progress during the first one and a half year of the project has been low because of the following reasons:

- The collection of data from the regions did not start before 1 May 1987 because of managerial problems. In May 1987 a group of four employees has been formed, who will be sent to the regions to collect the available data and to instruct the personnel at the regional offices.

- During 1986 several employees left the databank which resulted in an evident lack of staff.
  Also the late arrival of the Dutch assistant expert (1 year and 4 months after the start of the project) has to be mentioned.
- The CORVUS hard disk did not work properly after its arrival in the beginning of 1986. It has been sent to the Netherlands twice for repair and at last (at the end of April 1987) it was working without any problem.
- In the third quarter of 1986 the database was severely hit by a short-cut in the electricity network, which resulted in the breakdown of three out of four power units of the micro-computers. The electricity network in the building has been completely renewed and power units have been ordered from the Netherlands.
- The amount of data entered into the database is low because the locations of many boreholes are not known in coordinates, so that only part of the available data can be entered.
  Efforts will be made to gather the data on coordinates from the regional offices or from the boreholes itself.

3.1.2 Planning

As mentioned before a group of four employees has been formed in order to collect data from the regional offices.
Furthermore a design has been made for the storage of and handling of data in Dbase-III. The processing of the data with Dbase-III can lead to a more easy dissemination of data to external users.

3.2 Information centre nationwide compilation

3.2.1 Results

- Nationwide compilation.
  The compilation includes the collection of nationwide hydrogeological data in order to provide the technical information for drafting a water resources management plan for the Sudan. The collected data and reports will be used by the information centre as a source for publishing bulletins and advising donors and other agencies.

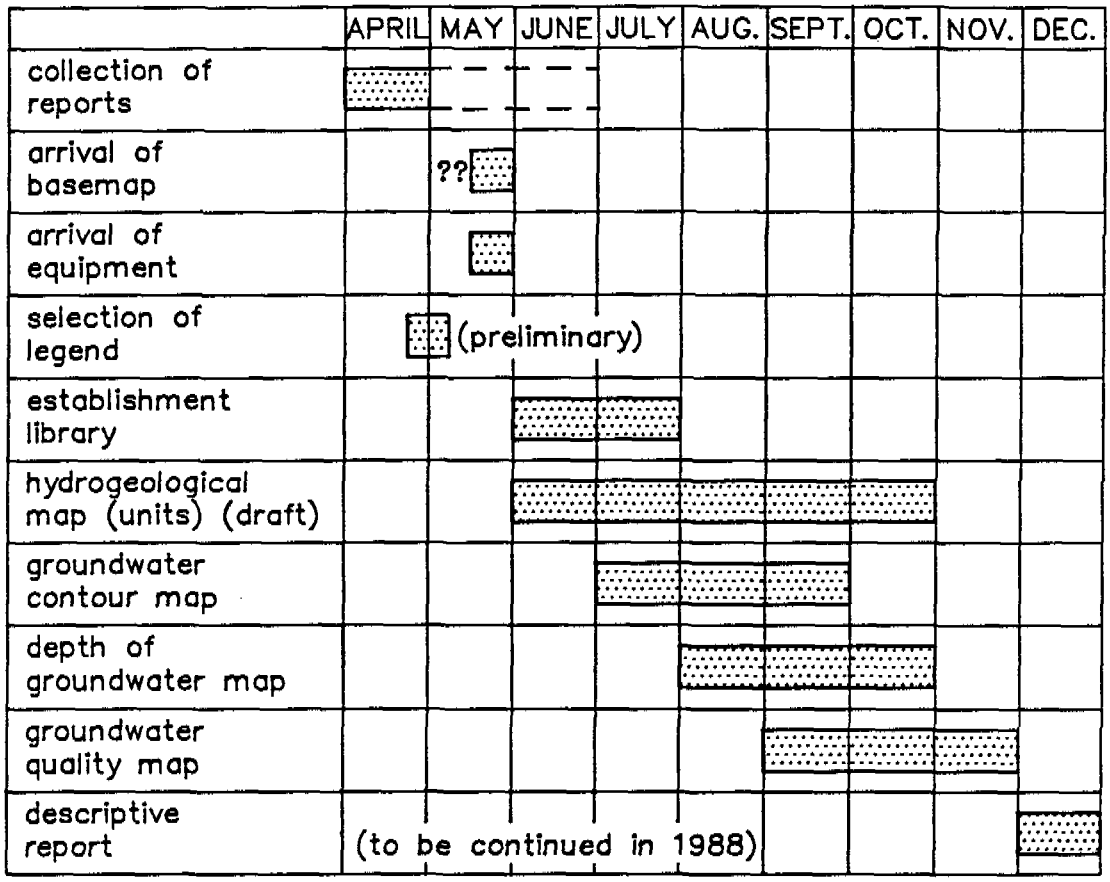


Table 1: Time schedule nationwide compilation

Because of lack of staff activities did not start before December 1986. In the following six months, the work for the nationwide compilation mainly consisted of collection of reports. Furthermore a map (in draft) has been prepared, which shows the project areas, as derived from reports.

A bibliography of the collected reports has been prepared (in draft), which will be entered into a personal computer. The bibliography will serve as basic information for a new library, which will be established in the second half of 1987.

- Information centre.

  Since the beginning of December 1986 the information centre has provided hydrogeological data, part of reports etc. to the following persons or organisations.

  * SREP (Sudan Renewable Energy Program)
  * Ministry of Public Works in ED Dueim, White Nile Province
  * WUSC (World University Service Canada)
  * UNICEF
  * Livestock routes project
  * University of Khartoum
  * Technical University of Berlin
  * Mare Drilling Company
  * FAO-project Dongola

A full description of the advice to or discussion with the above mentioned organisations can be found in Annex K.

3.2.2 Planning

As most of the available hydrogeological reports of Sudan have been collected, in June 1987 a start will be made with the draft of a hydrogeological map of Sudan on scale 1:2,000,000 (assuming sufficient staff, timely arrival of light table and base map).

At the end of 1987 a start has to be made with the water resources management plan for the Sudan. Co-operation will be sought with the UNDTCD-project, which has similar aims at the national level.

A time schedule for the nationwide compilation could be as shown in table 1.

3.3 Training

In June 1987 a course will be held in Khartoum on "Data collection and processing". The course is meant to train a selected number of NCRWD-employees how to set up and execute geohydrological investigations. Geohydrological concepts will be shortly reviewed and field techniques will be discussed. The course includes introductory training in the use of personal computers. Beside this training course of 3 weeks continuous attention is given to on-the-job training. For the database this includes training in computer programming and training in the management of the computer system and entered data. On-the-job training for the NCRWD-employes involved in the nationwide compilation consists of training in preparing maps, training in a set-up of a proper bibliography of collected reports and in writing of reports and articles.

4. ACTIVITIES IN KASSALA

4.1 Introduction

The National corporation for the Development of Rural Water Resources (NCDRWR) is responsible for the adequate management of water resources in the Sudan (except Nile waters). In the Gash Basin at Kassala the NCDRWR has carried out an assessment study, in co-operation with TNO-DGV in the framework of the bilateral aid programme of the Netherlands (phase 1 of the Water Resources Assessment Program in the Sudan, WAPS-1). As a follow-up to WAPS-1, a water management and utilization plan has to be established, as laid down in the 'Gash Basin Water Development and Utilization Act'.
The executing agencies legalized by this act are:

- a Water Council responsible for water management policy and for issuing licenses for wells.
- a Technical Committee (TC) for advising the Water Council.

The Technical Committee falls under the responsibility of NCDRWR and is supported by WADS. Besides this, NCDRWR has a Regional Administration for Water (RAW) in the Eastern Region of the Sudan, which is responsible for the rural water supply in that region. Gradually the Technical Committee will be incorporated in RAW, to prevent overlaps in tasks and duties and to carry out more scientific activities as geophysical prospecting, pumping tests and groundwater modelling. As a result of such a reorganization, the NCDRWR should operate more efficiently. The present Dutch foreign assistance programme is heavily involved in developing groundwater resources in the Gash Basin through the Kassala Area Development Activities (KADA) programme. The water-related activities of KADA are carried out in close co-operation with RAW. Hence the TC can act as an advisory body for water activities of KADA.

4.3 Results

The results of the activities in Kassala during 1986 and in the first half of 1987 are described below.

4.3.1 Monitoring Gash Basin

During 1986 runoff measurements of the Gash river have been carried out. In 1987 the quality of these measurement will be improved by the installation of a water level recorder on a still well.

Groundwater levels in numerous wells have been measured in order to monitor the Gash aquifer. In February 1987 a well inventory has been started in the Gash basin. The data collected from this inventory will be used to update the groundwater model of the Gash aquifer. This updating is necessary to predict future drawdowns and to manage the groundwater system.

4.3.2 Wad Sherifei study

A hydrogeological survey has been conducted for the drinking water supply of the refugee camp Wad Sherefei nearby Kassala. The study showed that the groundwater resources are limited, as since a few years a considerable drawdown of the groundwater levels has been observed. A summary of the report is given in Annex L.

The regional authorities concluded from the report that drilling of new wells in the area should be cancelled. To improve the water supply situation, it has been decided to reduce the camp population. From the estimated number of 170,000 inhabitants 25,000 were transfered to other camps, 100,000 probably settled in Kassala or returned to Eritrea, so that in July 1986 the population had been decreased to 45,000 people. The existing wells are sufficient to serve this number of inhabitants. Only the existing system of water tankers will be replaced by a piped water system.

4.3.3 Gash Delta rural water supply

On request of KADA a compilation of hydrogeological data of the Gash delta area has been carried out. The results have been laid down in a short report. As a follow up of this compilation a geo-electrical survey has been undertaken around some villages in the Gash Delta. The aim of the study was to investigate the possibility of artificial infiltration of Gash surface water into sandy layers in the subsoil. After preliminary interpretation of the geo-electrical soundings favourable drilling sites could be indicated and the subsequent drilled boreholes showed sandy layers of limited thickness. The areal extent of the layers is not known yet. Further geophysical work is necessary to determine the extent of the layers. A report on the study has been submitted to KADA.

4.3.4 Shukriyah survey

During the last week of February 1987 about 20 geo-electrical soundings have been performed along the West bank of the Atbara river and near the reservoir at Gashim Al Girba. These soundings from part of a larger study to improve the water supply in the area of the Shukriyah tribe, which dwells mainly west of the Atbara. The preliminary interpretation, laid down in a report, gives three recommended sites for production/exploration boreholes.
Any correlation with existing data was not possible, since no such information was available. The area is a while spot on the map.

4.3.5 Khor Sallum study (Port Sudan)

The Technical Committee received a request from the authorities of Port Sudan to carry out a preliminary study for water supply of the southern suburbs of the town, mainly populated by Eritrean refugees. The study had to be carried out within a development plan prepared by the University of Amsterdam on request of the town authorities of Port Sudan and Almere (the Netherlands). The latter two have a bilateral co-operation on city level.
Consequently the TC prepared a proposal which has been approved by all involved parties. The study is directly financed by DGIS, the Directorate General for International Co-operation of the Dutch Ministry of Foreign Affairs.
In the beginning of May 1987 the total amount of 68 geo-electrical soundings had already been carried out and preliminarly interpreted. Beside the geo-electrical survey a well inventory has taken place. The proposed drilling will probably start at the beginning of August 1987. The preliminary report will be submitted before the end of May 1987.

4.4 Planning

In the beginning of 1987 a planning board has been taken in use in the TC-office. Gradually it becomes clear to every member of the TC that the big number of activities not can be carried out well without a proper planning. For the Khor Sallum study consequently a thorough manpower planning and time schedule has been prepared by the head of the TC (see annex M).
Also an overall activity planning for the year 1987 has been outlined in annex N.

4.5 Training

Continuous on-the-job training is being done by the resident Dutch hydrogeologist in Kassala. Special attention is given to the evaluation of pumping tests, description of borehole samples and to the interpretation of geo-electrical soundings. The project co-ordinator planned to give two lectures on the last subject. One has been given on 16 February 1987 dealing with measuring errors, smoothing of field curves and interpretation with master curves. Interpretation by desk computer, equivalence problems etc. will be dealt with in a lecture to be given during the monthly visit of the project co-ordinator in June 1987.

The project supervisor delivered on 8 and 9 May 1987 a mini-course on pumping tests (total six lecture hours).

5. MANAGEMENT

5.1 Organisation

The WADS-project is one of the co-operation projects which resort under the Groundwater Department of the NCRWD.

Actually for the Khartoum and Nyala activities a separate project budget has been allocated by NCRWD. The expenditure of the TC-Kassala is covered by the regional office of NCRWD in Kassala.

After a preliminary organizational set-up in 1986 it became clear that because of the wide variety of activities in the project it would be better to appoint a separate Dutch project manager for Nyala (Chief Technical Adviser) and a project co-ordinator based in Khartoum responsible for general co-ordination and for the activities in Khartoum and Kassala.

At the end of 1986 the whole organizational structure of the Nyala team has been reorganized to serve better the activities for the village water supply. In the same period a logistical unit has been established at Khartoum to guarantee a smooth transport and handling of materials, goods and funds.

The project comprises Sudanese and Dutch team members. The project is run by the Project Director (Sudanese), the Project Co-ordinator (Dutch) and the Chief Technical Adviser at Nyala (Dutch).

The Netherlands team members are not employed by the NCRWD. They are supervised technically and administratively be TNO-DGV, Delft, the Netherlands. The project co-ordinator has to give direct account of the project's progress through the Netherlands Embassy to the Directorate General for International Co-operation of the Ministry of Foreign Affairs of the Netherlands.

5.2 Personnel

Annex O present a list of the personnel employed in the WADS-project for both the Sudanese and Netherlands team members.

5.2.1 Sudanese team members

In the plan of operations for 1987 and 1988 the required Sudanese staff has been specified. When checking this list, it becomes clear that most of the proposed staff has been employed. Some staff for the village water supply activities in Nyala still has to be enrolled, as well as some personnel for the information centre in

1. chief technical adviser
2. technical manager/workshop instr.
3. hydrogeologist Nyala
4. economist (assistant expert)
5. civil/agr. engineer (assistant expert)
6. project co-ordinator
7. databank expert (assistant expert)
8. hydrogeologist Kassala

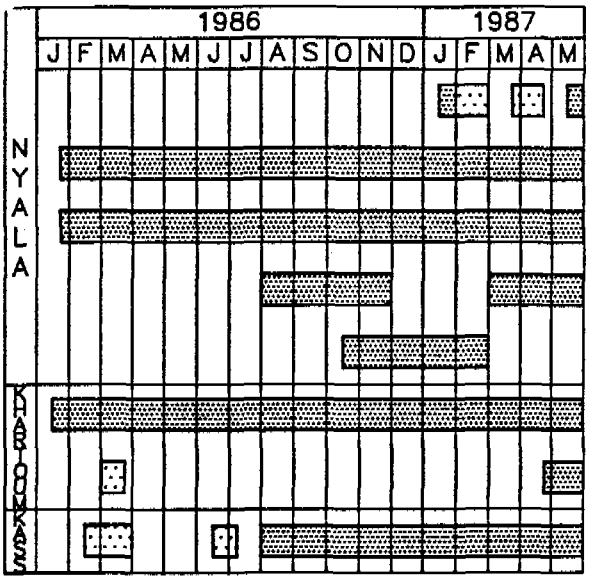


Fig. 2a: Personal situation Dutch staff during 1-1-'86 to 1-6-'87

present except home leave

interim support

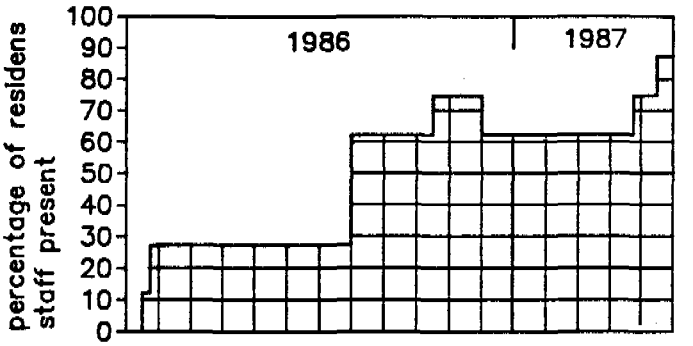


Fig. 2b: Presence of proposed staff in percentage

Khartoum. (2 to 3 programmers at the database and one experienced hydrogeologist for the nationwide compilation).

5.2.2 Netherlands team members

At the end of April 1987 the Dutch staff was complete. It consists of 4 employees of TNO-DGV, 1 employee of IWACO and three assistant-experts. According to the plans of operation for 1986 and 1987/1988 this number would stand for ca. 24 manyears, but because of delayed arrival of the proposed staff this figure will be less. The assistant-experts employed by DGIS arrived 8 to 16 months later than foreseen. The TNO-employee for Kassala arrived eight months later than planned, but in February/March and June/July 1986 interim support has been given by an experienced hydrogeologist.

A geophysicist of TNO-DGV joined the project in Nyala during five months to give support in geophysical matters (May - September 1986).

Figure 2 gives a clear picture of the Dutch staff situation during January 1986 up to June 1987.

The total number of manyears Sudanese staff is 372; the ratio Dutch staff/Sudanese staff is ca. 1:15.

During the first 17 months of the project 21 short missions have taken place. A list of persons and activities of the missions is given in Annex P.

5.3 FINANCIAL ASPECTS

5.3.1 Sudanese Contribution

The Sudanese contribution, according to the Budgets from the Plans of Operation is as follows (in LS 1000):

		Period 1986	Period 1987/88	Total
1.	Personnel	451	1728	2179
2.	Equipment	65	570	635
3.	Operational Costs	895	1585	2480
4.	Buildings	275	250	525
5.	Inflation Correction	335	910	1245
6.	Contingencies	160	257	417
	Total	2181	5300	7481

Details as to the realization are under preparation.

Lately, some delays are being reported with regard to the purchase of equipment, fuel and accessories, due to the non-availability of funds. Applications have been made to obtain finance for these project expenditures from the so-calles Countervalue Funds. Up till now, however, no funds have been received from this source.

5.3.2 Netherlands Contribution

General Review

The Netherlands contribution to the WADS-project amounts to Dfl. 9,9 mlns. (period 1986-1988), covering the cost of five resident experts in the Sudan, as well as visiting experts, equipment, transport and housing for the Dutch team-members. Additionally to this budget the Netherlands Government is providing the cost of three associate expatriate experts.

(Further details in preparation)

Cost of equipment

The table gives an analisis of the equipment expenditures of WADS up till mid 1987 from the Netherlands contribution to the project. Actual expenditures, including items pending, amount to f. 1,276,000.- for the WADS-Nyala activities and f. 285,000.- for WADS-Khartoum/Kassala. As against the total budget this leaves f. 563,000.- for future equipment purchases in Nyala (of which f 170,000.- is already earmarked) and f 125,000 for the activities in Khartoum/Kassala.

ANALISIS EQUIPMENT EXPENDITURES WADS (Netherlands Contribution)

	BUDGET			REALIZATION					BALANCE
	86	87&88	Total	86	mid 87	pending	earmark	Total	mid 87
WADS Nyala	a	b	c	d	e	f	g	h	i
General	109	110	219	102	46			148	71
Hydrological Equipm	98		98	41				41	57
Hydrogeol/geophys equipm	66	65	131	62	33	20	20	115	16
Equipm socio-econ.unit	35	100	135	30	84			114	21
Drilling equipm	226	100	325	240	2		100	342	-17
Workshops	60	305	365	59	71	48	20	178	187
Well construction		250	250		184		30	214	36
Techn Comittees	76		76	31				31	45
Transport + Conting.		200	200	63	10	150		223	-23
TOTAL WADS Nyala	670	1130	1799	628	430	218	170	1406	393
WADS Khartoum/Kassala									
General Khartoum	62	30	92	54	34			88	4
Information Centre Kh.	22	60	85	38	6			44	41
Instrument workshop	3		3	9				9	-6
General TC Kassala	59	62	121	73	26			99	22
Hydrol. equipm	15		15	8				8	7
Hydrogeol/ equipm	46		46	12				12	34
Geophys equipm	10		10	5				5	5
Transport + Conting.		38	38	20				20	18
TOTAL WADS Kh./Kass.	217	190	410	219	66			285	125

Annexes Q and R give a detailed breakdown of the purchases made during 1986 and in 1987, respectively.

Nyala-based activities

A major item in the equipment expenditures is formed by the drilling equipment, which (as per mid 1987) accounts for approx. 25 % of total equipment (incl. a provision for an additional rig). The actual utilization of this equipment for the project-activities is still sub-optimal; before acquiring a small drilling rig a cost-benefit analysis of the drilling equipment will have to be made. There are no major discrepancies between equipment budgeted and actually purchased.

Khartoum/Kassala-based activities

Budget and realization for Khartoum and Kassala equipment together are in line. In Khartoum an extra investment had to be done for the purchase of a voltage stabilizer for the Database. These extra costs were offset in Kassala, where pumptest equipment was lent from KADA instead of purchased by the project.

5.4 Logistics

The equipment for the project arrived in several shipments during 1986 and in the first half of 1987. Because of the new planops for 1987 and 1988 a new purchase round had to be made in the Netherlands. It is expected that all the necessary equipment will have arrived on the working locations at the end of August 1987. The fuel supply (paid from the Sudanese budget) went smoothly during the first one and a half year of the project.

Building activities have been undertaken in Nyala (two new offices) and will start in Kassala (new guesthouse).

The purchase of materials and goods in the local market, which need authorization of NCRWD, is extremely difficult, because either funds are not available or tender/procedures take much time. Hopefully this problem can be solved after July 1987, when money from the countervalue funds can be derived and purchasing can be done autonomously.

5.5 Equipment

Annexes Q and R, indicating the costs of investments, also present a general picture of the purchased equipment uptil June 1987. It is shown in which kind of equipment the available budget has been invested.

Annex S gives the list of equipment in use in Kassala at 1 May 1987 (new equipment 1987 not included). Annex T presents, a list for Khartoum. Also the new equipment is not included.

A list of the Nyala equipment has been given in the yearly report 1986 (cars, furniture, instruments, spare parts). As most of the new equipment was still in customs during the finishing of this report, making a new list did not seem useful at the moment.

A complete inventory list for the Nyala equipment will be prepared for the yearly report 1987 after the arrival of the new equipment.

More attention should be given to the well logging equipment, which is in bad repair at the moment. Support from the Netherlands through training of electronic engineers in maintenance and repair is advisable.

6. CONCLUSIONS

6.1 Progress in relation to scheduled activities

- Kassala

The progress in Kassala is normal, although the activities for the water resources management plan have not yet started. The Technical Committee has been requested by many donors/organisations to carry out surveys.

- Khartoum

In 1986 the progress of the information centre was low. The database had a lot of problems with the computer equipment and was understaffed. The activities for the nationwide compilation did not start before December 1986 because of lack of staff.

- Nyala

In 1986 a lot of small projects and surveys have been carried out. At the end of 1986 it became clear in which direction the Nyala-part of the project had to develop, namely being the village water supply, especially the installation of dug wells with windlasses. All this led to a planops for 1987 and 1988.
In the first half of 1987 the progress in the village water supply programme has been considerable. The completing of some wells however has been delayed because of the late arrival of equipment from the Netherlands (spate pump).
The activities of the water resources management plan for South-Darfur are on schedule.

6.2 Constraints

- General

* Releasing money from the Sudanese budget for the local purchase of building materials, types and care spare parts is a constant point of concern. In the beginning of June 1987 part of the vehicles in Nyala could not be used anymore, because tyres could not be supplied by the NCRWD. Hopefully this situation will change when after 1 July 1987 the countervalue funds will become available and can be used to purchase the above mentioned terms.

* The clearance and transport of goods is extremely time consuming. A solution for this problem is not obvious, because the delay is built up by many factors.
  Equipment from the Netherlands, specified in the planops for 1987 and 1988, will take about half a year to arrive in Nyala. This is due to time consuming procedures in the Netherlands (e.g. delivery time) and in Sudan (clearance and transport).

- Nyala
  * Delayed employment of supervisor for WADS/COR/UNHCR-project
  * not enough drivers
  * well logging in bad repair
  * lack of car tyres

- Khartoum
  * Still additional staff needed for database and nationwide compilation
  * Electronic workshop is too small and not dust free

- Kassala
  * In near future probably lack of staff

7. RECOMMENDATIONS

7.1 Kassala

- To incorporate the most recent knowledge in an evaluation of available groundwater resources. The data gathered can serve as basic information for a groundwater model, which will be used to predict future draw downs and to manage the groundwater system.
- Enrolment of experienced staff in order to be able to carry out the growing amount of projects and surveys.

7.2 Khartoum

- Nationwide compilation

* To improve the access to existing data.
* To set up a library and catalogue
* To elaborate summaries of all available reports
* To edit Technical Bulletins
* To prepare a hydrogeological map of Sudan, scale 1:2,000,000
* To co-ordinate activities with UNDTCD-project.

- Database

* To complete the technical set-up of the computer network
* To establish a data collection system, especially with reference to data stored in the regional offices
* To set up a proper training system for personnel of the database
* To recruit additional personnel i.c. two geologists/programmers

- Electronic workshop

* To improve building facilities
* To set up a maintenance system for all the geophysical equipment in the WADS-project.

7.3 Nyala

- Village Water Supply

* To make a complete and comprehensive planning of tasks, necessary manpower and transport for the Village Project Section, including all its activities as monitoring Kardia handpumps, selection of new villages, extension work in selected villages etc.
* To employ still some additional staff
* To complete five dug wells before the rainy season 1987
* To select a second rural council soon

- Water resources management plan

* The Technical Report on water resources should be ready in draft in the beginning of September 1987. It will contain an assessment of the available groundwater and surface water resources.
* The Village Project section will prepare a Technical Report on actual and future water demand, which will be finished at the end of 1987.
* A Technical Report with development and management guidelines, confronting resources with actual and future demand, will have to appear in April 1988.

- Groundwater exploration section

* In siting of wells aerial photographs should be used as standard procedure. Application of geophysical techniques should be considered in case the hydrogeological situation does not allow easy answers.
* The well logging equipment has to be repaired and stored in a dust free place.
* The seismic refraction experiment with a falling weight should be carried out as soon as possible (before the end of June 1987).
* In order to achieve a thorough training of the project geophysicists a short mission of a geophysicist from the Netherlands is recommended.
* To finish the Technical Reports of Baggara Basin, Bileil and Buldanga. Also the annual reports of the TC's and the note on the Hydrological map should be finished soon.

- General

* To encourage that report writing is fully executed by the Sudanese staff. This should be considered as part of the WADS on-the-job training activities.

8. FUTURE DEVELOPMENTS

There are three basic steps in providing water to the people:

(a) Assessment of water resources
(b) Planning
(c) Implementation.

In the past in the co-operation between the, then, National Water Corporation and TNO great emphasis has been laid on the Assessment aspect(A), in particular during WAPS I (Water resources Assessment Project in the Sudan). The follow-up during WAPS II was also mainly geared towards (ground)water assessment studies, but it already contained several elements of Planning(B), e.g. the start of a data-base at K 10 and the establishment of a Water Act in Kassala; these elements, however, were not yet integrated in the overall set-up of the project activities.
The present project, WADS, contains a great deal of Implementation (C), in particular in the Village Water Supply Programme in S. Darfur, and also a more specific orientation towards planning through increased support to the database (information centre) and through the activities with regard to the nation-wide compilation of data on water resources.

It is felt, however, that for the future a more systematic approach towards planning and management of national (ground)water exploration and development is of the utmost importance.
The National Corporation for Rural Water Development has, therefore, started discussions with some parties as to the ways and means to strengthen the institutional structure of NCRWD. With UNDP some preliminary proposals have been formulated, which are still under discussion. The policy guidelines of the Netherlands Government also mention the strenghtening of institutional infrastructure as a priority area.

There is one strategic approach in particular which is considered to present a solid basis for future development.This is manpower development through systematic training at management and operational level, aiming at integration of the elements mentioned above, i.e. assessment, planning and implementation. Direct application of this approach could be considered with respect to the present activities now undertaken under WADS, as well as to other fields, preferably in co-ordination with other donor agencies.

Annex A

1. Procedure

The procedure which was selected for the pilot phase for the stepwise preparation of the village water supply programme can be summarized as follows (reference is made to page 8 of the Plan of Operations 1987/1988):

1. Villagers informed at village council level through headquarters rural council. Information sheet of the WADS programme is handed to the village.

2. Village submits request to rural council headquarters.

3. Verification and selection of suitable requests by WADS-project (reconnaissance surveys):
   - socio-economical survey;
   - hydrogeological survey.

4. Priority selection by WADS.

5. Approval of the priority selection by Steering Committee.

6. Preparation of Village Well Contract signed by WADS-project and the village.
   The village is required to pay:
   - for the surveys: Ls 250,-
   - 50% of the costs of the materials (cement, steel, bricks), which is estimated at Ls 750,- for each well.

7. Definite location of well is determined by detailed hydrogeological survey.

8. Well construction starts after:
   - payment has been received;

- village water committee is established (committee should be formed before signing of the contract).
  The village is required to make 12 labourers available daily during construction.

9. Construction and hand-over of the well, waterlifting system and tanks.
   -a certificate of ownership is handed to the village after all activities have been completed.

The selection procedure is designed to suit the project objectives during the pilot phase. In this phase villages are selected mainly on criteria according water quantity and water quality conditions. It will be necessary to change the procedure later to fit the long-term objectives of the WADS project, which is to select villages on their willingness to participate in the programme and on their capability to maintain properly the well and waterlifting system. The final procedure is expected to be ready at the end of the pilot phase (end 1987).

2. Selection Criteria and Priority Ranking

The priority ranking is determined, according selection criteria, which are based on the data from both the hydrological and socio-economical surveys. Therefore the surveys need to be executed, before the requests are considered by the Steering Committee.

For the pilot phase it is proposed to use as selection criteria:

1. The water quantity condition, as expressed by the time needed to collect a tin of water at the end of the dry season.
2. The water quality condition, as observed at the water source during the dry season.
3. The willingness of the villages to contribute with money and labour to the construction of the well.
4. The hydrogeological conditons.

The experience obtained during the pilot phase will enable the project to improve the assessment of the willingness of each village to contribute. The "willingness" criterium will then get a greater importance in the selection procedure.

3.2.1 The water quantity conditions

The availability of the water and the difficulties to collect water can be expressed by the total time which a women needs, to collect on foot one tin of water to her house in the village.
This time consists of transport time and waiting at the well.

If a big quantity of water is available at the well than normally the transport time is decisive. If a small quantity of water is available than waiting times at the well may also be considerable and can be longer than the transport time.

The total time is classified as: Less than 1 hour
1 to 2 hours
2 to 4 hours
more than 4 hours.

3.2.2 The water quality conditions

The water quality observed at the water source(s) which is used for drinking water during the dry season, can be described in terms of colour, smell, taste etc.
The following classification is used:

1. good : colour = clear, odour = no, taste = good
2. inferior: colour = yellow, odour = no, taste = good
3. unsafe : colour = brown, odour = yes, taste = bad

A better analysis of the water quality may be possible if data on the chemical and/or bacteriological quality of the water is available.

3.2.3 Water supply conditions

The combination of the water quantity and the water quality classifications is expressed in an priority ranking matrix, representing the water supply conditions.

		Quantity			
		<1	1 - 2	2 - 4	>4
Quality	Good	4	3	2	1
	Inferior	3	2	1	1
	Unsafe	2	1	1	1

3.2.4 Other Selection Criteria

The final priority ranking is determined by considering the willingness of the villagers to contribute to the construction of a new well by considering the hydrogeological conditions.

At locations where hydrogeological conditions are favourable for a new well, the chances for the project to have success are good. At such locations the priority ranking of the village need to be upgraded.
Because the project is better served by succesful projects to start with, locations with bad hydrogeological conditions will be downgraded in priority ranking.

3.2.5 Priority Ranking

The described selection criteria will give a priority ranking from 1 to 4 for each village request.
Those villages with priority 1 should be started with.
The ranking of these villages will be determined by WADS. Villages with priority ranking 2 or even 3 could be helped if the number of priority 1 villages is less than 20 in one rural council.

The system permits other villages to submit their requests after the priority ranking has been carried out. If the request receives a priority 1, than it should be added to the selected villages.

Annex B

Framework for Water Resources Management Southern Darfur.

The activities are divided in three parts:

1. Water Resources

Contains an assessment of the available groundwater and surface water resources, based mainly on literature and estimates of lacking parameters.
Activities:

- inventory of available hydro(geo)logical data, complemented with data from satellite imagery, aerial photography and fieldwork if necessary;
- distribution or discretization of South Darfur into hydrogeological units or typical relevant (in view of future development potential, technology, other natural resources; possibly the planning units of the Indicative Land Use Plan of WSDC) areas;
- estimation of the water development potential of each unit or area;
- cost estimate for the construction and maintenance of the most feasible water supply systems for each unit or area;
- evaluation of lacking data, accuracy of results obtained, recommendations on short term and long term actions;
- reporting.

2. Actual and future water demand

Contains a description of actual water use, population (sedentary and nomads), livestock, irrigation, etc.
However difficult it will have to make the best guess as to future development and trends of number of water users and water use.

Activities:

- inventory of actual water supply conditions, (type of systems, quantities of water), type of use (domestic, irrigation, livestock), annual fluctations in behaviour;
- estimate of actual population;
- estimate of actual use;
- discussion of possible growth scenarios for the future 10 to 15 years of population, cattle and water use;
- evaluation of lacking data, accuracy of data and results, recommendations;
- reporting.

3. Development and management guidelines

Confronts resources and actual and future demand, as from the previously mentioned parts. It will comment on possible actual deficiency compared to national and international standards and recommendations on supply levels, and on the experience of the project and the others in South Darfur.

It will make an extrapolation of the water demand over 10 to 15 years.

It will make estimates of the manpower and cost required to remend the actual deficiencies and provide the future demands.

It will recommend priorities for:

- investigations;
- manpower development;
- water resources development;
- water resources management;

in South Darfur.

Annex C

Abstract of Kas Groundwater Resources Study

Upon request of the regional authorities the WADS project carried out a hydrogeological study to estimate the amount of ground water available for a water supply system in Kas. The Kingdom of Jordan would be ready to finance its construction. Kas is situated approximately 90 km NW of Nyala and has 15.000 inhabitants. The town is dissected by Wadi Gendi and Wadi Garaa, which meet in Kas.

The geology of the area consists of Precambrian granites and gneisses, which are overlain by Alluvial Deposits, built up of fluvially reworked volcanics, sandy clays and clays, and sands and gravels.

Geophysical work combined with hand-augering revealed that the subsurface topography of the Basement Complex is very irregular and that frequent lateral and vertical changes occur in the composition of the Alluvial Deposits. The most promising aquifers are the coarse-grained sediments in and around the wadi beds.

Hydrogeological investigations showed that the recharge of the Alluvial Deposits takes place by infiltration of wadi waters during the rainly season. It was noticed that the drop in ground water levels during the rainy season in Wadi Garaa was very low (2 m), as compared with the rest of the area (up to 7 m). This is caused by recharge of the wadi sediments through a major E-W striking fault underlying wadi Garaa.

Two pumping tests in existing boreholes and grainsize analysis on samples of the four boreholes the project drilled, indicated that the permeability of the coarse-grained Alluvial Deposits is about 50-70 m/day. The saturated thickness of the aquifer was less than 4 m at the end of the dry season. Water quality was good.

The drafting of a rough ground water balance made it clear that the present annual ground water extractions for domestic use of about 0.07 Mm^3 can be doubled without too many problems, by drilling or digging at least five new wells in or near the wadi beds.

Care must be taken to prevent organic contamination of the ground water, and to restrict the influx of people to Kas, as ground water resources are not unlimited.

Annex D

Gemmeiza area study

Upon request of the NCRWD a hydrogeological study of the area around the village of Gemmeiza (20 km north of Kas) has been conducted. Gemmeiza is a village upstream of Wadi Gendi on the asphalt road. This study meant to supply Kas with potable water because the investigations done by WADS proved the low potentiality of the KAS area.

The study consisted of reconnaissance geological surveying, land-sat interpretation, some resistivity measurements and well inventory on a relatively small area of 20 km^2. A borehole was drilled according to the recommendations of the study.
A pumping test has been performed.

A final report has been drafted. The study shows an estimated 3 million cubic metres of good water available. This can be piped down to Kas. The study refers to the high cost of the pipeline.

Annex E

Bileil area (Wadi Nyala)

Bileil area (downstream along Wadi Nyala) has a potential for small scale irrigation schemes, and has been recommended in (WAPS 2) report to be studied. Later 8 of Bileil farmers have requested a study. A team has been formed to make a well inventory, and a hydrogeological survey. Topography survey also started as well as geoelectrical soundings. The data collected have been analysed and processed and a technical report is under preparation.

Annex F

Technical Committees Nyala and Geneina

The data collection in the WAPS-2 project areas at Nyala and Geneina has been continued by WADS.
The activities include rainfall and evaporation measurements, groundwaterlevel measurements, wadi discharge observations, water-sample analysis and small hydrogeological investigations and studies.

Annex G

WADS/COR/UNHCR Water Project

The activities are carried out at five refugee centres:

a. Asernei
   Construction of three new boreholes
b. Anjikotti
   Construction of five dug wells with windlasses
c. Habila
   Improvement of five existing wells with windlasses
d. Romalia
   Construction of three new boreholes with Kardia handpumps
e. Mornei
   Construction of two boreholes with Kardia handpumps.

The maintenance of wells and waterlifting systems will carried out by the NCRWD-Nyala.

Annex H

The Evaluation of geophysical methods in S.Darfur

At the end of April (1986) a geophysicist of (TNO-DGV) joined the project to reinforce temporary (5 months) the geophysical activities in the projects. He supervised a check programme of the applicability of the (EM-34) and resistivity meters for well siting studies in the Basement Complex areas and in the wadi fills. The EM-34 device has been tested in siting a well in the Basement rocks near TARLY, a village approx. 50 km north of Nyala. At the site determined by the study a very succesful borehole has been drilled by the Lower Saxony project. A report has been prepared with the title "The electrical method in Wadi - studies". The report comments on the problems encountered in the interpretation of geo-electrical soundings executed in wadi-fills. The report highlights the effects of equivalence and anisotropy. The report says, "If the lithology does not change too rapidly laterally, borehole data may be used to calibrate some soundings. This may help in establishing an unambiguous interpretation of other soundings. But this method can not be applied to wadi studies, because lithology and depth to the basement vary too rapidly".

Annex I

Qoz Dango study

Due to a request from WSDC a hydrogeological study to delineate the southern and northern boundaries of Qoz Dango aquifer, has been carried out. WSDC is going to establish settlements within Qoz Dango.

In Qoz Dango there are about 700.000 to 1.000.000 hectares of very light soil receiving yearly about 600 mm to 1000 mm of rain. The limited factor for the development of this area of high potential for crop production is the lack of drinking water facilities.

Hence 17 spreads of seismic (refraction method) have been conducted during March, as well as 17 vertical electrical soundings. The data from the two methods were processed, analysed and interpreted.
The results of the two methods were in agreement, although the refraction method is more reliable, but costly. The northern and southern boundaries of the aquifer have been outlined. The technical report has been drafted, finished and submitted to WSDC.

Annex J

Extension of water supply at Nyala and El Geneina

A previous report was prepared for improvement of the Nyala town water supply (Humphrey's 1983). The outlined cost at that time was estimated to be 34 millions dutch guilders for a complete new system for Nyala.
Difficulties were raised in making the above sum of money available. A mission was sent to work with WADS to reconsider the network. A study for modification of the existing network was conducted. A report was prepared as well. The report includes recommendations for the extension of the network in the poor parts of the town by establishing kiosks; and no private connection is recommended. The report recommends that the work should be executed by a team from the regional Ministry of Housing and Public Utilities. It may be assisted for one year by a dutch expert. The total foreign costs were estimated at 2.3 million guilders.

For El Geneina town the report sketches the proposal for the extension of the network using the Disa wells together with the wells already drilled by WAPS 2. The report, also comments on the materials of the pipes e.g. Asbestos-cement pipes are recommended in areas where pipe laying is easy and horizontal. While Ductile-Iron pipes are required in areas where traffic is crossing and in sloping terrain. The Topographic set up in El Geneina requires Ductile-Iron using. The proposed routes in El Geneina network are put in maps. All the lines were surveyed by WADS.

Kiosks are planned in such a way that every 2000 peoples are served by one kiosk. The capacities of the pipes were calculated in such a way that the average consumption is 18 L/C/day. Capacity for watering livestock was not included. At any water kiosk a small tank (5 or 10 m^3) was proposed to be installed to secure a more reliable supply. These tanks were not included in the budget. They are left to be financed from the money collected from the local people. These tanks can be made locally.

The exact quantities of bends, T-pieces, reducers, air valves etc were not determinded in the calculation of the report.

The aim of any improvement of water supply at Nyala must be to increase the number of people served by the water distribution system and to obtain a situation where prices paid for the water become more equal. Hence this is a proposed trial to achieve this aim by extension to the area where at present no connections exist. It is expected that about 40000 to 50000 inhabitants will benefit from this.

Annex K

1. The Sudan Renewable Energy Program contacted the information centre/data base for information concerning the quality of the shallow groundwater in the Khartoum area, as they are planning locations for windmills, which will pump groundwater for irrigation.

2. The Ministry of Public Works in Ed Dueim contacted the information centre for data on groundwater quality in the White Nile Province.

3. WUSC (World University Service Canada)
   The first contact with WUSC took place in Nyala at the end of 1985. Mid 1986 the contacts were intensified and advice was given to Charly Earle, hydrologist of WUSC. After that, WUSC prepared a proposal for a program in Northern Darfur (area south of El Fasher). The proposal has not been discussed with the WADS-staff or on a national level with Abdul Razig. The former director-general of the Ministry of Housing and Public utilities approved the proposal and the intention was to start with the program in early 1987. In January 1987 WUSC contacted the information centre and Abdul Razig. Reading their program it became clear that the execution of the foreseen works was impossible. E.g. the installation of handpumps in the Nubian sandstone aquifer with static waterlevels of 80 to 120 m. below ground level seems rather unrealistic. Moh. Kheir Saleh wrote a four-page comment on the WUSC-program. The comments have been discussed with the representatives of WUSC and thereafter they have decided to rewrite the whole program.
   This example shows moreover that co-ordination and appraisal of programs and proposals on a national level is of utmost importance, in order to avoid mistakes and failures.

4. UNICEF
   UNICEF is carrying out an extensive drilling program in Northern Kordofan. The field co-ordinator of this program visited the information centre to discuss the hydrogeological situation in Northern Kordofan. He is interested in the application of geo-

physical methods to detect suitable locations for drilling in the area, where the basement is overlain by so called sandy Qoz layers of several tens of meters.
UNICEF is also interested in information about the physical properties of the Basement Complex. E.g. which type of rock contains in general more water and which types are more faulted and fractured, so as to determine drilling locations.
However, from the discussions it became clear that the data and knowledge of the Basement Complex gathered by UNICEF probably are unique in Sudan. UNICEF drilled a few thousand boreholes in the Basement Complex, mainly in Bahr El Gazal and Equatoria Province. The WADS-project has written a letter to UNICEF with the request to supply the information centre (+ databank) with the data of these boreholes. Consequently WADS has been invited to come to Wau to see the amount of data available there (about 1000 log descriptions).

5. Livestock routes project

The World bank is sponsoring a project to improve the livestock routes from the west (Nyala) and South-Kordofan (Kadugli). The idea is to establish a number of wateryards along these routes, combined with animal health centres. The operation of the wateryards will not be given to NCRWD but will be in the hands of operators and engineers of the Livestock and Meat Marketing Corporation. The pumps and engines will not be of the same type, as those used in the wateryards of NCRWD, which will make exchange of spareparts impossible. The project puts little emphasis on follow-up and maintenance. Both contractor (Preussag) and consultant (Mascott, England) visited the information centre and made hundreds of copies of maps and reports.
The contractor will use several geophysical methods for locating the boreholes to be drilled: seismic refraction, geo-electrical soundings and the VLF-electromagnetic method.

6. University of Khartoum

Prof. Ayed, lecturer in geophysics at the University requested from the information centre copies of several reports. He is planning to carry out an investigation near Gedaref to determine

the extent and depth of the Gedaref sandstone (comparable with the Nubian Sandstone) in order to find out if this formation can be an alternative groundwater source for the drinking water supply of Gedaref.

7. Technical University of Berlin

The TUB is carrying out an academic research in Egypt and Sudan. Publications on this research can be found in the " Berliner Geowissenschaftliche Abhandlungen". A full series will be received by the information centre in exchange of a complete set of the WAPS-2 reports. One of the aims of the TUB (according to Mr. Reynolds who visited the information centre) is to produce an improved structural map (geology) of Sudan. The Tub has for this purpose, permission to see the data, gathered by the Oil companies, SUNOIL and CHEVRON.

Furthermore the research of the TUB revealed marine deposits in the northern part of Northern Darfur and it has been discovered that in between Basement Complex and Nubian Sandstone also Silurian and Triassic deposits are present. Mr. Reynolds also collected data upon the depth to Basement Complex and copied several geophysical well logs of boreholes around Dongola.

8. MARE drilling company

Engineer Brandoli of the Mare drilling company visited the information centre in order to collect data about the formations to be encountered in the area west of En Nahud (North Kordofan). He copied the structural-hydrogeological map produced by STROJ-EXPORT in 1976. Furthermore he asked if WADS could possible carry out caliper logs in the boreholes to be drilled.

9. FAO-project Dongola

Together with the Forestry Department, FAO is intending to create some shelterbelts of trees on the east side of the Nile, north of Dongola in order to protect the agricultural area there against sand which is blown in by north-eastern winds from the desert. Mr. Bert Wessemius, short term consultant for drilling operations, visited the information centre to collect data on formations present in the area.

The main aquifer in the area is formed by the Nubian Sandstone.

Annex L

SUMMARY

The Wad Sherifei Refugee Camp and Reception Centre is located approximately 20 km south of Kassala near the Gash River.
The camp currently has 120.000 - 175.000 inhabitants and the water supply is restricted to 5 - 9 L/capita per day.
This assessment study was done at the request of KADA, to improve the water supply and to facilitate water distribution. It is concluded that the aquifer is restricted to a south - north oriented buried channel that passes below the "old camp" and camp sections A, B, C, E and O. Four wells exploit this aquifer to supply water to the camp. The static water levels in the pumping centres have dropped by 2 m since 1981/1982. This must be the result of pumping, because despite the drought years the static water levels of the wells in the garden area along the Gash on the northwestern side of the camp do not show such a decline. The drop is not alarming but requires watching, and new boreholes or groups of boreholes should be spaced 1000 m apart. The "Technical Committee Kassala" will monitor the variations in groundwater level in a number of selected wells.
Four sites for testproduction wells are indicated on the appended map (plate 1).

Annex M

Plan for Khor Sallom Hydrogeological Survey

* Aerial photographs have first to be interpreted before we can contact people of the Geological Survey Department in Port Sudan, otherwise two geologists of TC can work on that with the help of aerial photographs.

* Surveying and levelling
  This work will start together with geophysics
  - with the help of aerial photographs a map of Khor Sallom area should be drawn with a certain scale.
  - trying to locate the existing boreholes & wells in that map + profiles
  - Make levellings for waterpoints & soundings
  - all this work will be done in the field

In the office they draw the maps and sections related to the study.

for this work we need actually
* a surveyer
* a draughtsman
* 2 labourers
* a car for work.

* Geophysics
  Resistivity survey 85 VES
  In the first phase 70 soundings distributed along six north-south sections.
  After analysis of the soundings the remaining 15 made in places where additional information is needed.
  Needs:
  * one technical engineer/geophysicist
  * one hydrogeologist
  * 3 labourers
  * a car.

Test boreholes:

- On the basis of the results of the above mentioned activities sites for 5 test production wells will be selected.
- After completion pumping tests will be conducted

Needs:

* a drilling crew fully equipped, that will be organized with DG of NCDRWR as well as the pumping test unit.
  Proposal is to conduct the drilling with a rig from RWC Port Sudan and also pumping test if there is a pumping test unit available; if not other alternative is KADA.

* Hydrogeological investigation
  Collection and analysis of all available data for Khor Sallom

  The 2 geologists working with aerial photographs can also help in the collection of data.

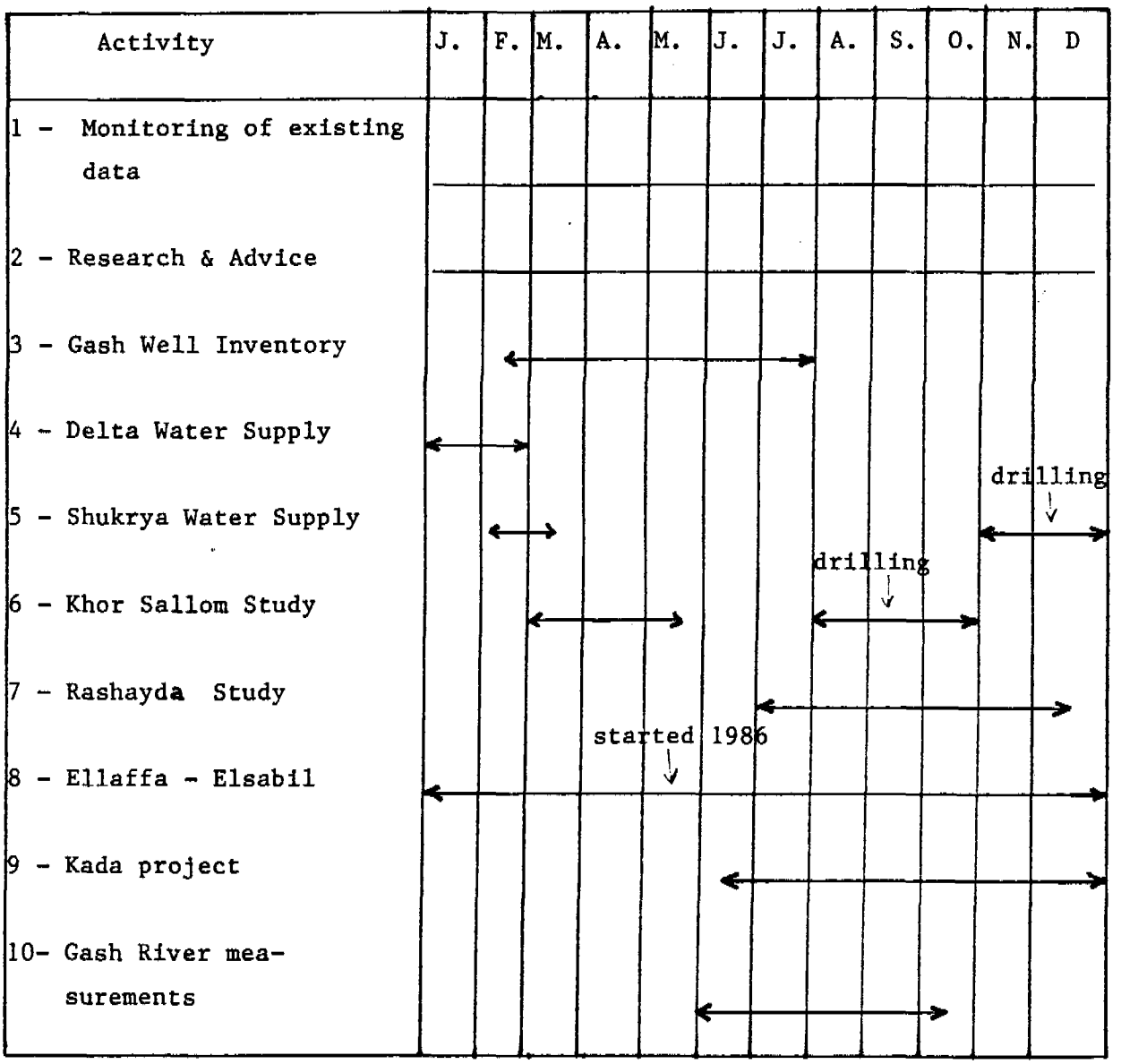
* Conducting the work:
  Alternatives
  1 - Camping in an hotel in Port Sudan
  2 - Camping in the Guest house of RWC in Port Sudan
  3 - Camping in Sallum Village

* The first alternative is expensive and we have to drive daily 40 kms going and coming in addition to the problem of storing the equipment and doing some office work.
* The second alternative is good if the of NCDRWR agrees; questions are:
  - driving distance
  - other services (beds, food etc); will they be given by RWC or not, if not we need a lorry for transporting those things.

Third alternative seems to be the best if we found a place to camp in or we found camping facilities, for camping facilities we can ask DG of NCDRWR, but we still need a lorry for carrying camping facilities.

activity	month	1st week	2nd week	3rd week	4th week
- Data Collection & geology	March	←	→		
- Surveying & levelling	87	←			→
- Geophysics		←			→
One month days for completion of interpretation (April)					
activity	month	1st week	2nd week	3rd week	4th week
Drilling & Litho-logic	May	←			→
data collection	87				
Pumping test	May 87		←		

Annex N


Activity
J.
F.
M.
A.
M.
J.
J.
A.
S.
O.
N.
D
1 - Monitoring of existing data
2 - Research & Advice
3 - Gash Well Inventory
4 - Delta Water Supply
5 - Shukrya Water Supply
6 - Khor Sallom Study
7 - Rashayda Study
8 - Ellaffa - Elsabil
9 - Kada project
10- Gash River measurements
drilling
drilling
started 1986

Annex O

Sudan Team

Project Director	Moh. Kheir Salih

Nyala

Management and Administration

Project manager	Abdallah Mohamed Kheir
Accountant	Ali Fatouh
Accountant	Mohamed El Dein
Administrator	Ibrahim El Agab
Typist	Atima Eissa
Typist	Sayda Ibrahim
Clerk	Moh. Suleiman
Office boy	Adam Burma

Village Project Section

Environmental engineer	Saleh
Agronomist	Abdu Rahim Moh.
Community development worker	Magda
Community development worker	Yahia
Community development worker	Ahmed

Systems Maintenance & Technology

Civil engineer	Sidiq Omer
Foreman	El Tayeb Moh.
Foreman	Moh. Abdul Rahman Lutfi
Foreman	Dudain
Foreman	Adoma Adam
Technician	Ibrahim
Builder	Ismail

Groundwater exploration

Geologist	Wasila Ahmed
Geologist	Osman mahgoub
Geologist	Hamdan Mastour
Geologist	Mahmoud Abdalla
Geologist	Moh. Abdalla

Drivers (continued)

Bushara Hajar
Ibrahim El Safi
A/Halim Mahgoub
Ed Doma Adam
Bakhit Ahmed
Haran Adam
Ibrahim Maki
Babiker

Labourers (continued)

Ahmed Abdalla
Moh. Ahmed Naser
Moh. Hussein
Adam Yussif
Asha Eissa

Guards

El Haj Bushara
Ismail Al Bakz
Yussif Yagoub
Hussein Nagmous
Hasein A/Razul
Ibrahim Hilon
Isaq Ibrahim
Ali Abbo Arabi

Kassala (Technical Committee)

1.	Elsary Kamal Eldein	Head TC	Hydrogeologist
2.	Eltayeb Mohd. Musa		Technical Engineer
3.	Abdulghaffar Mohd. A/Alla		Technical Engineer
4.	Osman Mohd. Idris		Technical Engineer
5.	Mohd. Abdel Hafiz		Draughtsman
6.	Isam Ibrahim Mohd.		Geologist
7.	Mohd. Ahmed Mohd. Medani		Geologist
8.	Fatah El Rahman Ahmed Ali		Geologist
9.	Ismail Mohd. Ahmed		Technician
10.	Khalifa Mohd. El Hassan		Electronic Engineer
11.	Omer Hag Rahama		Clerk
12.	Asha El Hassan Ahmed		Typist

+

three drivers
four labourers
two guards
one office boy
casual labourers

Technical assistant	Mohamed Ahmed
Technical assistant	Omar Adam
Technical assistant	Idris Mohammed
Electronic engineer	Moh. Abdalla Salih

Survey drawing section

Surveyor	Radi Abu El Kheir
Surveyor/draughtsman	El Tom El Sheikh
Surveyor/draughtsman	Adam Said

Drilling section

Drilling engineer	Abdulla Gorashi
Foreman	Faulo Peter
Skilled labourer	Ibrahim
Labourer	Mahmoud Ahmed
Mechanic	Aboud Abdul Gabar

Technical Committees

Groundwater technician	Mohamed Salih
Geologist	Ahmed Hussein

Workshop

Chief mechanic	Osman Ali
Steel worker	Yahia Ali
Mechanic	Mohamed Abdalla
Mechanic	Abdul Gadir
Assistant mechanic	Fadul Fodail
Assistant mechanic	Abdul Moneim
Labourer	Ali Idris
Labourer	Adil Ahmed
Storekeeper	Ahmed Adam
Assistant store keeper	Moh. M'deen

Drivers	Labourers
Moh. Adam	Hussein Ahmed
Abdalla Said	Subah El Kheir
Rashid Yagoub	Naser El Din
Bahar Hussein	Abdul Gadir Omer

Khartoum

- logistical unit

Ali Abdul Hafiz	Head
Tigani Abdul Karim	Purchasing/clearance
Mohamed Sadiq	Account/personel
Halima Saad	Typist
Samira Bakr	Typist

- database

Sir El Khatim Hamid	Manager
Osman Mustafa	Geologist
Rabia Mohamed	Typist
Ismahan Ali	Typist
Samia Ibrahim	Typist
Batoul Ahmed	Typist

- Nationwide compilation

Amal Mahgoub Hamid	Geologist
Seif El Dowla	Geologist
Aba El Maali	Geologist

Netherlands team

Khartoum

Project co-ordinator	W. Senden
Ass. expert (database)	E. Holleman

Kassala

Hydrogeologist	A. van der Meer

Nyala

Chief technical adviser	B. Blankwaardt
Hydrogeologist	T. van Ellen
Technical manager	L. Kootstra
Ass. expert (socio-economist)	I. de Beij
Ass. expert (engineer)	F. Jaspers

Annex P

Short missions during the period 1/1/86 - 1/6/87

NAME	PERIOD		PURPOSE
Kruseman	15/2 - 27/3		interim hydrogeologist Kassala
V.d. Linden	19/2 - 27/3		preparation plan for water supply Nyala/Geneina
Van Kuijk	22/2 - 27/3		geophysical expedition Qoz Dango
Swenker	26/2 - 20/3	1	support databank Khartoum
Spreij (ILRI)	14/3 - 4/4		preparation base line survey South-Darfur
Verhoeven	14/3 - 4/4		general supervision/base line survey South-Darfur
Meekes	26/4 - 26/9	9	interim geophysicist/hydrogeologist Nyala
Verhoeven	14/6 - 2/7		general supervision
Kruseman	16/6 - 7/7		interim hydrogeologist Kassala
Kruseman	2/8 - 11/8	8	introduction hydrogeologist Kassala
Vos (ILRI)	30/8 - 5/10		preparation planops 1987/1988
Bastemeijer (IRC)	30/8 - 15/9		preparation planops 1987/1988
Schoute	10/9 - 5/10		technical supervision
Bastemeijer(IRC)	30/10-12/11	6	preparation planops 1987/1988
Verhoeven	30/10-21/11		preparation planops 1987/1988
V.d. Linden	6/12-12/2		lecture at conference Khartoum
Blankwaardt(IWACO)	22/1-30/1	1	preparation for assignment as CTA Nyala
V.d. Linden	22/ -27/2	9	interim CTA Nyala
Rolf	10/3-17/3		support databank Khartoum
V.d. Linden	23/3-17/4	8	interim CTA Nyala
Schoute	6/5-22/5	7	technical supervision

Annex Q

EQUIPMENT KHARTOUM ACTIVITIES (1986)

GENERAL MANAGEMENT AND LOGISTICS	budget	realised
spare parts Corolla and Hizux	4	5.0
Toyota, HI-Lux	18	17.5
office equipment	5	3.5
aircoolers	20	12.6
word processor + printer	10	10.9
miscellaneous	5	4.4
WATER RESOURCES INFORMATION CENTRE		
2 photocopiers	5	2.9
office equipment	10	5.8
overhead projector	2	1.0
slide projector	1	0.3
sereen	1	0.4
furniture	0	10.0
reference books, publ.recentific journals	3	0.0
Imunelec voltage stabilizer	0	17.2
INSTRUMENT WORKSHOP		
additional tools, spare parts	3	1.9
10 water level indicators (on request of NWC)	0	7.3
Total	87	100.7

EQUIPMENT DARFUR SURVEY (1986)

GENERAL	budget	realised
Hilux Toyota Twin cabin + spare parts	30	26.5
2 field radio sets	10	13.6
2 copy machines	10	5.8
stereoscopes	4	4.0
camping equipment	10	0.4

	budget	realised
1 generator	10	9.4
8 air coolers	20	12.6
office furniture	0	10.1
office equipment	5	2.2
office requirements	5	2.3
miscellaneous	5	5.0
1 generator 10 KVA (Jaspers) + spares	0	9.6
	109	101.5

HYDROLOGICAL/IRRIGATION EQUIPMENT

1 generator 1.5 KVA	2	1.4
2 conductivity meters	5	0.0
5 water level recorders (SSWR)	30	0.0
1 meteostation outfit	15	0.0
spares stream flow outfit	4	0.0
1 Toyota station + spares	35	32.1
miscellaneous (+ spares LR)	7	7,6
	98	41.1

HYDROGEOLOGICAL EQUIPMENT

2 leveling units	10	8.8
2 conductivity meters	1	0.0
1 Toyota landcruiser (+ spares)	35	32.5
5 water level indicators	2	4.0
miscellaneous	5	6.1
	53	51,4

GEOPHYSICAL EQUIPMENT	budget	realised
2 generators 1.5 KVA	3	0.0
spare parts landrovers	5	5.0
spare parts geophysical equipment	5	5.7
Total	13	10.7

DRILLING EQUIPMENT	budget	realised
spare parts drilling rig	65	54.8
1 new truck + tank + lift installation	140	144,9
spare parts landrover	10	13.6
handaugers	1	4.7
pvc casing + screens	0	18.9
miscellaneous	10	3.1
Total	226	240.0
MAINTENANCE WORKSHOP		
Toyota pick-up + spares	35	25.8
toolsets	15	29.0
miscellaneous	10	4.0
Total	60	58.8
SOCIO-ECONOMIC BASE LINESURVEY		
Toyota, station + spares	35	30.0
TECHNICAL COMMITTEES NYALA/GENEINA		
office equipment	10	11.0
miscellaneous hydrological equipment	10	0.0
miscellaneous hydrogeological equipment	10	4.0
4 conductivity meters	10	0.0
10 calculators	2	1.0
2 downhole samples	4	0.0
spares landrovers	10	10.0
3 water level indicators	5	0.0
1 hydrochemical + bact. field kit	10	5.0
miscellaneous geophysical equipment	5	0.0
	76	31.0
DARFUR GRAND TOTAL	670	564.5

KASSALA TECHNICAL COMMITTEE (1986)		budget	realised
GENERAL			
1 Toyota (budget) became Landrover (110)+ spares		35	50.4
1 generator		10	9.4
2 air conditioners		4	3.2
1 photocopier		5	2.9
office equipment + furniture		0	5.0
miscellaneous		5	2.2
	Total	59	72.9
HYDROLOGICAL EQUIPMENT			
2 rainfall recorders		8	7.7
15 raingauges		2	0.0
miscellaneous		5	0.7
	Total	15	8.4
HYDROGEOLOGICAL EQUIPMENT			
3 water level indicators		5	2.8
1 bacteriological kit		5	2.7
1 leveling unit		3	4.4
2 conductivity meters		5	0.0
5 calculators		1	0.5
1 downhole sampler		2	0.0
1 pumptest equipment		20	0.0
miscellaneous		5	1.1
	Total	46	11.5
GEOPHYSICAL EQUIPMENT			
spares landrover		5	5.0
miscellaneous		5	0.0
	Total	10	5.0
KASSALA GRAND TOTAL		130	97.8

EQUIPMENT NEEDED FOR ACTIVITIES IN DARFUR

	Quantity (in brackets) and cost				
	Sudan contr. in LS 1000	Netherl. contr. in Dfl. 1000		spent	rest
General					
Camping equipment	5		10	6	+4
Navigation system			10	6	+4
Satellite images (SPOT)			20	0	+20
Office furniture	5		15	12	+3
Office equipment			10	5	+5
Stationery			30	9	+21
Miscellaneous	2		15	8	+7
Total	12		110	46	+64
Hydrogeological/Geophysical Equipment					
Bailer rig		(1)	18	19	-1
Additional seismic equipment	5		5	0	+5
Flame photometer		(1)	5	6	-1
Bacteriological analyzer		(1)	2	0	+2
Pumptest equipment		(1)	20	0	+20
Miscellaneous	3		15	8	+7
Total	8		65	33	+32
Equipment Socio-economic activities					
Toyota Landcruiser pick-up twin cabin		(2)	80	84	-4
Field equipment			5	0	+5
Miscellaneous			15	0	+15
Total			100	84	+16
Workshops					
Spare parts Landrovers			50	28	+22
Spare parts Toyotas			65	41	+24
Tools mechanical workshop			50	0	+50
Tyres	10		20	0	+20
Spare parts lorries			50	2	+48
Hand pumps			30	0	+30
Other lifting devices	15				
Miscellaneous	5		40	0	+40
Total	30		305	71	+234

EQUIPMENT NEEDED FOR ACTIVITIES IN DARFUR (CONT'D)

	Quantity (in brackets) and cost				
	Sudan contr. in LS 1000	Netherl. contr. in Dfl. 1000		spent	rest
Well construction					
Toyota ~~Landcruiser single cabin pick up~~ 4,24x		(1)	40	29	+11
Welding equipment		(2)	10	8	+2
Tools			15	15	0
Moulds for concrete rings			20	22	-2
Generator 20 kVA			10	10	0
Pumps			15	38	-23
Construction materials	400		100	62	+38
Miscellaneous	20		40	0	+40
Total	420		250	184	+66
Drilling					
Provision for percussion rig			100	2	+98
Transport and contingencies	30		200	10	+190
Summary					
General	12		110	46	+64
Hydrogeological/geophysical equipment	8		65	33	+32
Socio-economic work			100	84	+16
Workshops	30		305	71	+234
Well construction	420		250	184	+66
Drilling			100	2	+98
Transport and contingencies	30		200	10	+190
	500		1130	430	+700

EQUIPMENT NEEDED FOR ACTIVITIES IN KHARTOUM AND KASSALA

	Quantity (in brackets) and cost				
	Sudan contr. in LS 1000		Netherl. contr. in Dfl. 1000		
				spent	rest
KHARTOUM					
Reference books etc.			13	1	+12
Software			20	11	+9
Booster stabilizer			15	17	-2
Drawing and light table			7	5	+2
Furniture	5		20	5	+15
Furniture training centre	5		5	0	+5
Miscellaneous	5		10	1	+9
Transport and handling			20	0	+20
Total	15		120	40	70
KASSALA					
Off-the-road motorbikes		(2)	10	8	+2
Drawing table		(1)	5	4	+1
Chemicals			1	0	+1
Navigation system		(1)	10	6	+4
Altimeter/planimeter		(2)	5	13	-8
Compasses		(4)	1	1	0
Furniture	5		5	0	+5
Cables and reels			5	7	-2
Miscellaneous			10	5	+5
Aerial photographs	50				
Transport and handling			18	0	+18
Total	55		70	44	+26

Annex S

EQUIPMENT KASSALA (furniture not included)

Survey section

Administration and management

1 Typewriter Arabic
1 Typewriter English
1 Typewriter English portable
1 Canon Copymachine PC25

1 Hach kit chemical analysis
1 Hach kit for bacteriological analysis
15 Topographical maps 1:100,000
1 Geological map 1:2,000,000
aerial photographs different areas

Transport	Condition
Landrover pick-up	weak
Landrover pick-up	weak
Landrover hard top 109	weak
Landrover 110	good
Motorbike Yamaha 175	good

Survey section

2 Staedtler pens	2,0 mm	0,5 mm
2 Staedtler pens	1,4 mm	0,35 mm
2 Staedtler pens	1,0 mm	0,25 mm
2 Staedtler pens	0,7 mm	0,18 mm

2 Rotring Schablones	0,25 mm
2 Rotring Schablones	0,18 mm
2 Rotring Schablones	0,35 mm
2 Rotring Schablones	0,50 mm
2 Rotring Schablones	0,70 mm

Survey section (continued)

2 T squares
4 50 cm rulers
3 Triangles 45°/30°
2 Staffs
1 Wild level
1 Zeiss level Ni2
2 tapes 100 m/50 m
1 Océ blueprint machine
1 Pantograph (wood)

Hydrology and Geophysics section

2 water level indicators
3 water level indicators (out of order)
1 current meter
3 Ec. meter Hach
5 Stop watches
1 pH. meter
1 resistivity meter GEA-76
1 resistivity meter GEA-76 (in repair)
3 water level recorders
2 water level recorders (out of order)
1 auger set
1 compass Wilkie
5 raingauges (steel)
1 box standard curves
1 micro computer HP 9815 A
1 plotter HP 9862 A
1 first aid kit
1 soiltest sieving set (mechanical)
10 rechargeable batteries
2 battery chargers
3 thermometers
6 calculators olympia
1 wild steroscope
1 pocket stereoscope wild

Annex T

EQUIPMENT KHARTOUM

The equipment of the database has been already specified in par 3.1.1 (computers etc.).

The rest of the equipment consists of:

1 overhead projector
1 slide projector
1 projection screen
1 binding machine
2 typing machines (one arabic, one english)
8 water level indicators
2 spare air conditioners
1 generator 20 KVA
1 compressor
1 CANON pc-25 copier
1 Toyota Corolla
1 Toyota HILUX
1 landrover 109
furniture

New equipment will arive at the end of June 1987 and will be specified in the yearly report 1987.