

Evaluation Report
of

North and South Kordofan
Water Sanitation and Health
Education Projects

for
Government of Sudan
and
UNICEF

Khartoum/Sudan
December 1989

OUTLINE OF DRAFT REPORT

Table of Contents

1.0 Introduction

- 1.1 Scope and nature of task
- 1.2 Objective of Evaluation
- 1.3 Plan of work and field visit
 - 1.3.1 Programme for WES Evaluation Team in North Kordofan
 - 1.3.2 Kadugli Water and Environmental Sanitation Project Programme for Evaluation Team
- 1.4 Data Collection Procedures

2.0 Background

- 2.1.1 Population of Sudan
- 2.1.2 Population of Kordofan
- 2.1.3 Climate of Sudan
- 2.1.4 Family Life in Rural Kordofan

- 2.2 Health and Nutritional Status
 - 2.2.1 The Health System in Sudan
 - 2.2.2 Patterns of Diseases in Sudan
 - 2.2.3 Remarks on Nutritional Status of the Population of Sudan

- 2.3 Availability of Water in Sudan and Kordofan

3.0 Government Water and Health Strategy Guidelines

- 3.1 A Review of Past Strategies and Policies
- 3.2 Water Supply and Sanitation coverage and Investments
- 3.3 Objectives, Strategies and policies
- 3.4 Conclusion

4.0 Technical Aspects

- 4.1 Overview of Water Supply in Sudan
 - 4.1.1 Kordofan Background
 - 4.1.2 UNICEF Water Sanitation and Health Education Project
 - 4.1.2.1 Programme Re-Orientation
 - 4.1.2.2 Borehole Drilling and Site Selection

- 4.2 Water Availability and Quality
 - 4.2.1 Water Resources
 - 4.2.2 Geological Setting

- 4.2.3 Water Basins
- 4.2.4 Water Quality
- 4.3 Drilling Operation
 - 4.3.1 Borehole Drilling
 - 4.3.2 Well Construction
 - 4.3.3 Low Cost Borehole Design
 - 4.3.4 Well Development
 - 4.3.5 Platform Construction and Handpump Installation
- 4.4 Handpumps
 - 4.4.1 Handpump Selection
 - 4.4.2 Local Manufacturing of Handpump Potentials
- 4.5 Maintenance of Handpumps
 - 4.5.1 North Kordofan
 - 4.5.2 South Kordofan
 - 4.5.3 Constrains and Maintenance Problems
- 4.6 Performance
- 4.7 Transport and Equipment
- 4.8 Project Management
- 5.0 Sanitation and Health Education
 - 5.1 History of the Programme
 - 5.2 Methodologies used and Appropriateness - Environmental Sanitation
 - 5.2.1 Latrine Design
 - 5.2.2 Procedure of household latrine construction
 - 5.2.3 Household Latrine Promotion
 - 5.2.4 Guinea Worm
 - 5.2.5 Health Education
 - 5.2.5 Fencing of handpumps and disposal of waste water and animal faeces
 - 5.2.6 Content and Procedure
 - 5.2.7 Institutional set-up
 - 5.2.8 Performance
 - 5.2.9 Cost and Cost-sharing
- 6.0 Linkages of UNICEF-assisted Water Supply, Sanitation and Health Education Project (WES) with Other Child Survival and Development Activities
 - 6.1 Introduction
 - 6.2 Activities in South Kordofan Project
 - 6.2.1 Health Activities
 - 6.2.2 Education Activities
 - 6.2.3 Agricultural Activities
 - 6.3 Activities in North Kordofan Project
 - 6.3.1 Health Activities
 - 6.3.2 Educational Activities
 - 6.3.3 Agricultural Activities

| | |
|-------------|--|
| 6.4 | Conclusion |
| 6.5 | Monitoring |
| 7.0 | Environmental and Socio-economic Impact |
| 7.1 | Introduction |
| 7.2 | Water Programme |
| 7.3 | Sanitation and Health Education |
| 7.4 | Conclusion |
| 8.0 | Sustainability |
| 8.1 | Definition |
| 8.2 | Provision of Water Supply |
| 8.3 | Provision of Sanitation |
| 8.4 | Community Mobilization |
| 9.0 | Cost Effectiveness |
| 9.1 | Equipment |
| 9.2 | Bonus System |
| 9.3 | Personnel |
| 9.4 | Planning |
| 9.5 | Standardization |
| 9.6 | Design and Construction Specification |
| 9.7 | "Critical Mass" |
| 9.8 | Drilling Operation |
| 9.9 | Household VIP Latrine |
| 9.10 | School VIP Latrine |
| 10.0 | Conclusions and Recommendations |
| 10.1 | Conclusions |
| 10.1.1 | Water Supply |
| 10.1.2 | Sanitation and Health Education |
| 10.1.3 | Linkages and environmental Impact |
| 10.2 | Recommendations |
| 10.3 | Timetable |
| | Appendixes |
| 1 | List of Resource Persons |
| 2 | List of background documents |
| 3 | Transport and Equipment |
| 4 | Water Quality Standardization |
| 5 | List of Figures |
| 6 | List of Abbreviations |

PREFACE

This Report consolidates and presents the findings and recommendations of the evaluation assessment of the UNICEF assisted Water Supply, Sanitation and Health Education Project. The mission was carried out in the Sudan from November 15 - December 5, 1989 by the following members:

- Dr. Mohammed El Hadi Abu Sin
University of Khartoum
Team Leader
- Mr. M. (Mike) A. Murtada
Canadian UNICEF Committee
- Dr. Ulrich Oltersdorf
University of Glessen (FRG)
German UNICEF Committee
- Mr. Hans Spruijt
UNICEF Head Office Representative
- Dr. Omer Abdel Salam
Ministry of Finance and Economic Planning
Sudan

The mission's terms of reference are given in the Introduction. In the Sudan, the mission was guided in its official contacts by:

Mr. Thomas Ekvall,
Chief WES Section
UNICEF Sudan

During the fieldwork, and also during the briefing/debriefing, with the Government Authorities and UNICEF in Khartoum, El Obeid, and Kadugli. The mission received the much appreciated support and cooperation while in Kordofan by:

Mr. Hamid Hassan,
Director NRWC
El Obeid

Mr. Willem Heijstek
WES Coordinator
El Obeid

Mr. Youssif Adam
Executive Manager, NRWC
El Obeid

Mr. Mansour Nassir
Executive Manager, NRWC S.K.
Kadugli

Mr. Mohammed El Fatih Youssif
WES Coordinator
Kadugli

The mission made a 10-day field trip to Kordofan, and conducted field survey, supplemented by discussions with the local authorities, and with the various staff members of National Rural Water Corporation (NRWC), and UNICEF Project Coordinators and staff members, Ministry of Planning, Ministry of Health and several villages and rural councils in North and South Kordofan. The mission itinerary is given in the Introduction, and the name of the organizations and officials contacted are listed in an appendix (1).

The mission's draft Report was presented to Ministry of Finance and Economic Planning (MFEP) and UNICEF Khartoum on December 03, 1989. The mission's final Report was presented, after incorporating the recommendations and directions of the MFEP, NRWC and UNICEF, on December 4, 1989.

The secretarial and typing work of the report was carried out by Ms. Shadia Kamil Rezeig and Mrs. Florence Olebe. Without their extensive effort and patience in the drafting and completion of the report would not have been possible.

INTRODUCTION

Purpose and scope

1.1 Scope and Nature of task

Within the broad frame of UNICEF Master Plan of Operation and Plan of Action 1987-1991 and Plan of Action, 1988, 1989 for N.a.s. Kordofan (see literature cited) the purpose and scope of this document could need to be visualized. The scope of this document should also be viewed in the time frame (3 weeks) made available to complete the task of the mission in assessing the performance of the WES.

Accordingly the purpose of the document and its objective, is to give a comprehensive and to date evaluation of WES interlinked activities of:

- Borehole drilling, hand pump installation and maintenance
- Latrine construction
- Health education

Fig (1) shows the location of WES in Sudan - (Kordofan Region, North and South Kordofan with provincial headquarters of El Obeid and Kadugli.

Although the effort in this task is extended whenever possible into the start of the project to get the necessary depth of experience, yet emphasis will be made on the last three years spelled out in the term of reference of the mission.

The scope of the task is to provide a comprehensive assessment of the WES performance along the themes and chapters of this document. In spite of the satisfactory organization & logistic provided by UNICEF-Khartoum, the time frame was the main limitations to attain the full aspiration of the team.

Bearing in mind the time frame the team addressed itself to the set objectives in the term of reference to the best of its ability. This was made possible by the programme of meetings in Khartoum and project area supplemented by a carefully planned field survey.

1.2 Objectives of Evaluation

The set objectives around which this document is revolving are:

- a) Assess the progress and performance of the project which has concentrated exclusively on handpump installation, village-level handpump maintenance, latrine construction health

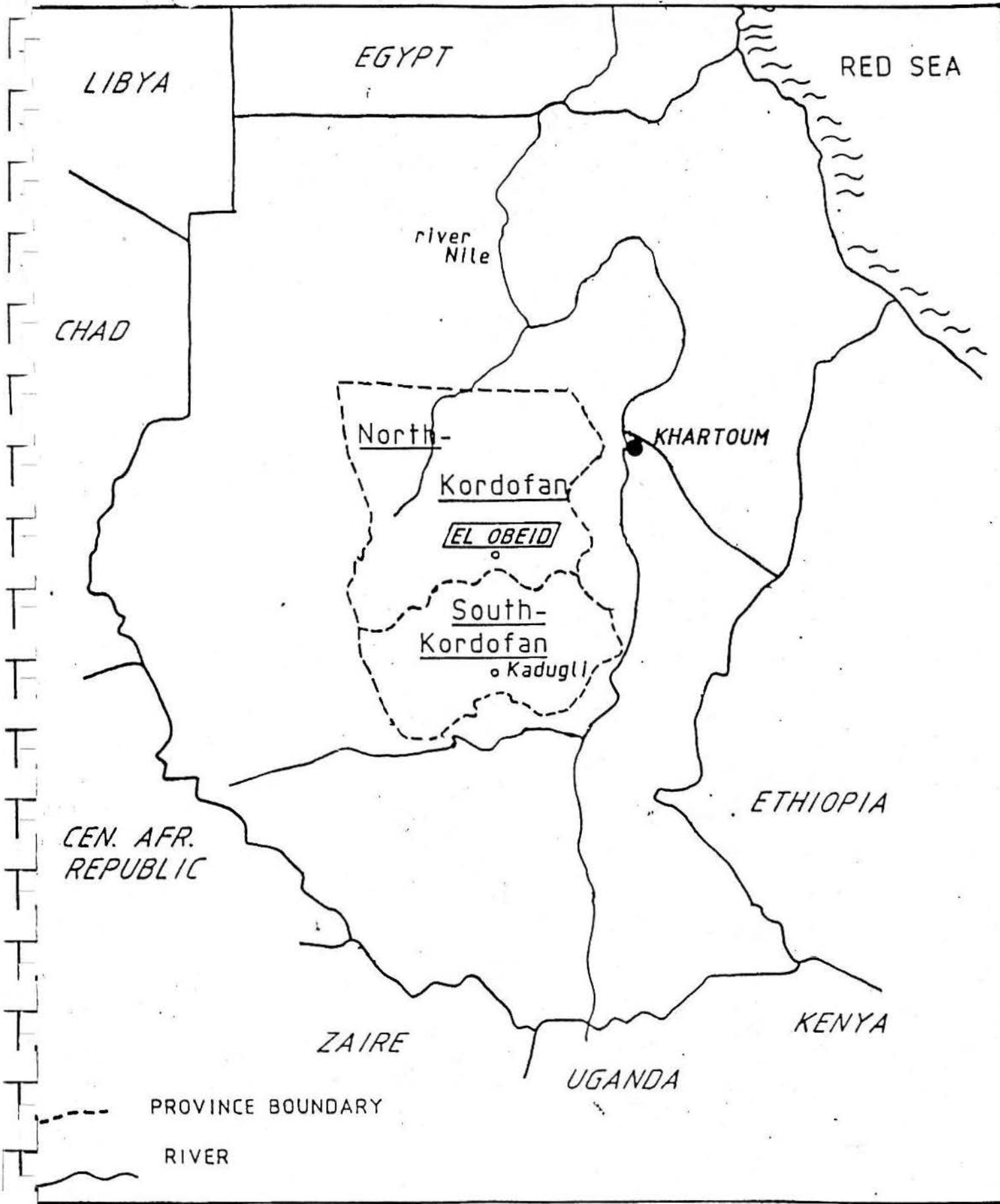


Figure 1 : Location of the UNICEF project area in Sudan

education and the linkage of these activities to the control of diarrhoeal diseases since 1988 in order to establish the suitability and relevance of this strategy for expansion in other areas which are hydrogeologically similar.

- b) Evaluate project achievements vis-a-vis the programme's general and specific objectives as spelt out in the Plan of Operations.
- c) Document the performance of the project to-date to serve as a resource document for future programme development and implementation.
- d) Identify specific project features (equipment, maintenance, personnel, monitoring system, etc.) which have advanced or hindered the realization of project objectives.
- e) Evaluate the environmental impact of the project based on the study report prepared by the University of Khartoum.
- f) Recommend improvements in the project mix to maximize achievements, with specific emphasis on developing institutional capacity building and sustainable support networks for community mobilization and water system maintenance.
- g) Review the cost effectiveness of the programme.

1.3 Plan of work and field visit programmes

To meet these objectives the following plan of work and procedure is formulated:

Field visits were arranged for 9 of 21 days of the evaluation. Field programme of visits in the field was arranged by both El Obeid and Kadugli. The programme was examined, revised and amended by the team to suit the purpose. The programmes, presented below have given the team a satisfactory opportunity to cover all activities of the project in the two areas of operation.

Logistics and organization provided by UNICEF-Khartoum have enabled the team to perform the study programme set below and field survey to the best of the team satisfaction in the process of data collection, observation and inspection of activities in all stages.

1.3.1 Programme for WES evaluation team in North Kordofan

18 November 1989

Upon the arrival of the four evaluators, a courtesy call was made to the Governor, accompanied by the Commissioner of North Kordofan, round 11.00 a.m. The rest of the day the team will have discussions with the following departments/organisations:

- NRWG-one big meeting, followed by individual meetings with NRWG staff;
- First Executive Officer El Obeid district
- Ministry of Health - Meeting with the Regional Public Health Officer and his staff;
- Regional MFEP and EEC (financing of latrine construction)
- Youth training Center;
- Kordofan Radio;

19 November

06:30 visit to Temed, Kalda and the tree nursery;
09:00 breakfast;
10:30 departure for Abu Haraz;
12:00 meeting with Rural Council Administration Officer and visit Abu Haraz town to;
14:00 departure for Abu Zabad;
17:30 arrival Abu Zabad;

20 November

07:30 meeting with Rural Council Administrative Officer of Abu Zabad;
09:00 breakfast;
10:00 field visits to Abu Galeb, Bakhit Gembu, Abu Ngeza, El Bakri, El Bentu;
14:30 return to El Obeid;
18:30 arrival El Obeid

21 November

06:30 visit to the drilling team operating in Sheikan;
08:30 breakfast;
10:00 departure to Rahad district, with a stop on the way in Aradeba and passing through Nauwa Tabaldia and Assobri;
12:30 arrival in Rahad district and meeting with Rural Council Administrative Officer;
14:30 return to El Obeid with stops on the way in El Hegeina and Wad El Bakri and passing through Rigela, Buruki and Tendelti;
18:30 arrival El Obeid;

22 November

This last day in North Kordofan had been used for further contacts and meetings that could not be completed on the first day, visits to the workshop and the warehouse and a wrap-up meeting;

23 November

8:00 departure for Kadugli;

1.3.2 KADUGLI WATER AND ENVIRONMENTAL SANITATION PROJECT
PROGRAMME FOR EVALUATION TEAM

(23RD-27TH NOVEMBER 1989)

Thursday 23rd November 1989
1st Day

8:00 Departure from El Obeid

(i) Hamadi Town

- a) VIP latrine construction (Awlad Musa)
- b) Handpump performance

(ii) Dubeibat Town

- a) Meeting with the officer of the rural council at the council building
- b) Tour around the handpumps in the town and the stores of the spare parts and tools. Discussions with the pump technicians.
- c) Visit to the base camp in Dubeibat.

(iii) Farshaya village

- a- Training of handpumps mechanics.
- b- Tour around the town for Sanitation and VIP latrine constructions.
- c- Discussion of Sanitation, Health Education + latrine constructions.

(iv) Dakber Village

- a- Drilling of boreholes
- b- Installation of handpumps
- c- Evening social gatherings.
- d- Discussion with the field teams.
- e- Wrap up session for day 1 (at the end of day 1 and early morning of day 2).

1st Night in Debker

Friday 24th November 1989

2nd Day

(v) Sunjukaya village

- a) Integration with other organizations (NMRDP).
- b) Nurseries.

(vi) Dilling Town

- a) Meeting with the rural council area Executive Officer
- b) Visit to slab manufacturing site and stores of spare and tools-handpump technicians.
- c) Visit to one of Dilling area with good coverage of latrine-visit to some houses.
- d) Discussions on Health Educ. and Sanitation components and all softwares of the programme.
- e) Meeting with southern Kordofan Commissioner.

2nd Night in Dilling

Saturday 25th November 1989

3rd Day

Kadugli Town

- a) Drive from Dilling to Kadugli (Dara village).
- b) Checking into the guest house
- c) Visit to the project premises - main offices- Laboratory W/shop and stores (discussion with section chiefs project management
- d) Meeting with Ministry of Education (M.O.E) and Ministry of Health (M.O.H) and Nutritionrtment (integration with other government departments). (Social gathering).

Sunday 26th November 1989

4th Day

Kadugli Town

- a) School latrine programme
- b) Health Education at schools
- c) Training of women as pump mechanics
- d) Maintenance set up in town (visit to one Administration committee).
- e) Visit to Murta/Kulba sanitation and construction of VIP latrines
- f) Wrap-up session.

Monday 27th November 1989

5th Day

Return to Khartoum

1.4 Data Collection Procedure

Within the programme outlined above the, the team devised on procedure of the evaluation which include briefly these steps:

- Consultation of literature provided by UNICEF-Khartoum related to the mission job. (see reference list). This was followed by exchange of ideas and discussions to deepen understanding of objectives and widen teams knowledge of the project components, system of work and the environmental setting of the project area. The meetings made in Khartoum with UNICEF-Khartoum, Min. of Planning, National Rural Water Corporation (NWRC) was an integral part of this process.
- After that and before leaving to the field the team set a tentative plan of the expected report and each member was assigned to a special topic of focus within the integrated report accepted by the team to reflect the nature of the project objectives and activities.
- The team has the advantage of being together for quite a long time and this had been advantageous in exchange of ideas, evaluation, past experience etc. This was observed also in the field visit.
- Field visit into specially selected villages to provide a spectrum of ones with complete programme facilities, partial facilities and no facilities at all. At each village, group interviews, individual household interview resource persons interview plus personal observations and recording of data etc was carried out.
- The team was able to study all on-going operations of the project of drilling, installation and maintenance of handpumps, VIPs etc. visits and interviews were also made to institutions affiliated or cooperating with the project i.e. Nuba Mountains Rural Development project, Nutrition Dept. of Ministry of Health etc.
- A large number of resource persons were interviewed at the village level including health committee members, village health workers, sheikhs of villages, Omdas etc. plus government officials i.e. rural council executive officers, district officers, assistant regional governor, south Kordofan province commissioner as well as some officials of relevant department in the region. A list of some of these persons is shown in Appendix (1).
- A wealth of data was collected in raw form from the area particularly from the two offices of UNICEF in El Obeid and Kadugli. Such data and that provided in Khartoum was sorted out, checked and rechecked against the set objectives of the mission. Then the tentative plan of the report was reconsidered by the team and approved in its final form and

each member is requested to focus on a specific aspect while certain chapters were left to be treated jointly to ensure consistency and integration necessary for a report of this nature. UNICEF-Khartoum kindly provided chance of all members of the team to be in one place to ensure convenient exchange ideas and information. Supporting services of typing, computer, photocopying etc. was also provided in quite acceptable level.

This procedure has enabled the team to evaluate the following with a reasonable level of confidence:

- Hydrological, technical performance in water supply, sanitation/health education
- Project management and institutions cooperation and effectiveness
- Linkage with other child survival and development activities
- Environmental impact
- Sustainability
- Cost effectiveness
- Socio-economic impact

Based on such task recommendations are made in the direction of improving the project performance and ensure sustainability local institutions and community participation as a safety valve for the project in the future.

Inspite of the appreciated effort made by all institutions and individuals there are some limitations and constraints that have faced the team in the course of study. The main ones are:

- The duration of time allotted for the team to complete all stages of the evaluation report.
- The wealth of literature to be consulted and made use of in the short time available
- Lack of properly compiled base line data for the whole project. Good record of data is available, but fragmented and scattered in the different involved departments, and persons.

It is worth mentioning that the organizing efficiency, UNICEF-Khartoum and branches in El Obeid and Kadugli had substantially reduced the effect of such constraints. Accordingly the team feels that the findings arrived at are quite good, original, objective, valuable and provided the necessary documentation and substance to the report.

2. Background of the UNICEF-assisted Water Supply, Sanitation and Health Education Project (WES) in Kordofan/Sudan

2.1. Pertinent facts about Sudan

2.1.1. Population of Sudan

SUDAN'S 2.5 million square kilometers makes it Africa's largest country. Except for highlands along the Red Sea, in western Darfur and eastern Equatoria, the country is a gently sloping plain stretching more than 2,000 kms from south to north and a little less from its western border to the Red Sea (Fig. 1).

Sudan's peoples are very diverse. At independence in 1956, the only census to consider ethnic factors was carried out, which identified 597 "tribes" in 19 ethnic groupings. These can be considered as four main categories. Arabs represented 39% of Sudan's population in 1956 of 10,263,000. Census figures of 1973 and 1983 and a growth rate today of around 2.8% a year suggest a mid-1985 population figure of 21.55 million, if the impact of famine is ignored. Nilotic and Bantu Negroid southerners make up approximately 20%, while 18% come from African Sudanic tribes and about 10% are Nubians. Sudan also has large numbers of refugees from neighboring nations.

Sudan has a low average density of population, at 21.3/sq mile, and half of its people live on the best 15% of the land. The movement to the towns and cities is accelerating, from 8.3% living in urban areas in 1956 to probably 25% to 30% today, with up to two million living in the "three towns" of Khartoum, Khartoum North and Omdurman. Both drought and war have brought a sharp increase in urban numbers within the last years. The population is young: 9.75 million or 45.2% are aged 0-14 years. While there is a slight excess of men to women in the total population, the ratio of male to female varies widely in different areas because of the migration of men for work in urban areas and on agricultural schemes. About 70% of Sudanese live in rural areas, adopting a variety of strategies, from transhumans using camels in the dry north to cattle herding in the wet savannah and sedentary farming in the far south, to cope with the country's natural diversity.

2.1.2. Population of Kordofan

The Kordofan region is in central Sudan (Fig. 2). The region is generally flat, except some locally hilly sand dunes especially in the northern parts. It slopes gently from east to west from about 400-600m above sea level. The Nuba mountains in the southern part of the region acquire the highest altitude in the region reaching about 1500m above sea level.

Kordofan shows mixture of tribes with Kabbabish Arab camel nomads in North Kordofan province and Baggara cattle nomads in South Kordofan where rainfall levels are higher, while settled Negroid

Nuba people living in and around the Nuba mountains. The main religion is Islam, though the Nuba and other tribes hold differing faiths. The largest South Kordofan town is Kadugli, from where a partially paved road runs 300kms north to El Obeid, the region's largest town, El Obeid had been undergoing a rapid increase in population even before the effects of the drought brought a sudden influx. The region's population is 3,093,294 density is 21.0/sq mile, infant mortality medium to high, literacy was 34.3% male, 10.8% female, and school enrollment was set at 55.9% male and 32.1% female.

The population of North-Kordofan is according the latest census in 1983 1.8 millions living within 36 rural councils (being about 3000 villages?), those of South-Kordofan is 1.4 millions living within 29 rural councils (being about 2000 villages?)

2.1.3. Climate in Sudan and Kordofan

From north to south of Sudan, climate varies from desert with almost no rain to semi-desert, dry and wet savannah, and equatorial with high rainfall. The rainfall is concentrated in a wet season, which occurs between May and October in the far south and for a shorter period in the north, as dry air blowing across the north meets a very humid front from the south. Total precipitation varies across the country from more than 1,200mm to almost zero, with 400mm-800mm falling in the central plain. The rainfall is extremely erratic over both time and distance, so even within a village two fields can receive very different amounts. Peak daytime temperatures in the north can reach 48C in June and 40C in December but stay a little lower in the south, where the humidity is much higher. Sand or dust storms - "haboubs" - are a hazard during the summer in the north. The climate in Kordofan is generally hot all the year around. Rainfalls varies from 200mm/year in the north gradually to about 800mm/year in the south of Kordofan. June-August are the wettest months of the year and the temperature drops to about 30 C, but from December-February is the most dry period and the temperature sometimes drops to even less than 20 C.

2.1.4. Family Life in Rural Kordofan

Farming families usually have more than one plot of land, partly because inheritance breaks up ownership into smaller plots but also as a defense against the variability of the climate and to widen crop options. Their life is dependent - especially in the northern part of Sudan - on the availability of water and good soil. The soils of Sudan vary from sand and sandy loam in the north and west to heavy alluvial clay in the center, east and mid-south to literate tropical material in the far south.

A wide range of grain varieties for use as seed is usually available in local markets, and farmers will carefully select one or two whose characteristics are expected to suit the soil of each plot and the expected rainfall. The small vegetable garden close to the house or hut is usually known as the "Jubraka" or

near farm and is cultivated and controlled solely by the woman. The family will also have a small plot close to the bed of the wadi on which will be planted higher yielding varieties of grain that need better soil or a cash crop such as groundnuts. Since farmers cannot afford chemical herbicides, pesticides or fertilizers, they rely on arduous hand weeding and the use of plant pest and manure. Their own herds or those of nomads are allowed to graze on the stubble of fields after the harvest, and the soil's fertility is maintained by rotating crops and allowing long periods of fallow.

The end of the dry season is often a time of hunger, with little money to spare, even for the seeds and tools to plant when the wet season begins.

Within village life, there is usually a careful separation of male and female roles, with women doing a majority of the work, particularly the heavier or more repetitive tasks, such as grinding grain or weeding fields. Children are also expected to help, which may mean they never go to school or soon drop out.

Traditional agriculture is the main occupation for about 85% of the families living in Kordofan. Main products are livestock, millet, sorghum, groundnut, gum arabic, cotton, karkadeh and sesame. 0.8 millions (24%) of the population are nomads, having herds of about 3 million cattle, sheep, goats and camels.

2.2 Health and Nutritional Status

2.2.1 The Health System in Sudan

The backbone of the primary health care system in Sudan is the cadre of community health workers, and by 1985, 5,000 community health workers had been trained, an impressive result, though still short of the target. Would-be community health workers are selected by their own community and sent to attend training schools for one year before returning to their home areas to start work. Thirty four government health training schools have an overall output of around 600 graduates per year. In what is a fundamental flaw in the entire primary health care system, by 1985 only seven women had been trained as community health workers.

While community health workers were a new concept in Sudan, the government had been training village midwives since the pioneering work of two British sisters in 1920. They introduced the concept of giving illiterate women training which was not intended to grant them entry into the medical elite but to involve them in the service of their own community, something clearly appropriate for primary health care.

When the community health worker returns after training, the village that chose him is expected to build a primary health care unit, which may vary from a small hut with little furniture to a clean, breezy two room building. The adequacy of the primary health care unit depends mainly on the commitment of the local

people. Nomadic primary health care workers are provided by their communities with an animal -- camel, horse or donkey -- so they can travel with people. Supposed to be supported and supervised by the medical assistant and assistant health visitor who should be stationed in the nearest dispensary. The dispensary personnel are to be supervised and supported by the public health officer and the health visitor located in the nearest health center but in reality health personnel are concentrated in larger villages and towns leaving the rural health units unsupervised.

The Ministry of Health estimates that one quarter of the rural population have access to a primary health worker. Even this low access rate may be an optimistic view of reality. A large proportion of the 25% will have to walk 10 kilometers or more to the primary health care unit, many more would be likely to find that the unit had no drugs and some would be absent collecting drugs or salary. The lack of communications, poor roads, fuel shortages, inadequate training and low budgets make management and supervision of the community health workers very weak. Unequal distribution of health facilities mean rural people are less well served than those from urban areas and southern remain more neglected than their northern compatriots.

Despite the adoption of the concept of primary health care, an unequal distribution of trained staff is repeated at every level of the health service. Highly qualified personnel are concentrated in Khartoum, or have left the country for better pay overseas. According to the Ministry of Health, there were 2,330 doctors in the country in 1984, of whom 57% were in Khartoum and another 18% were practicing in Central region. The ratio of doctors to population ranges from 1:350 in Khartoum to 1:80,000 in the south.

In the following the structure of the health service in Sudan within regions is summarized:

| Level | Staff | Facility |
|----------|---------------------------------------|--------------------------|
| Region | Director general for health services | Regional hospital |
| District | Assistant director general for health | District hospital |
| Area | Medical inspector | Rural hospital |
| | District medical assistant | |
| | Health visitor | |
| Village | Nurse | Dispensary |
| | Village midwife | Dressing station |
| | Community health worker | Primary health care unit |
| | Village midwife | |

The situation in the Kordofan region regarding the health services and the health situation of the population is obviously very close to those described for the Sudan. In South Kordofan are according the information of the Medical Officer for South

Kordofan 7 working hospitals (and two more are planned), one of those is a provincial hospital (250 beds), 2 are district hospitals and 4 of them are rural hospitals (each 120 beds). In South-Kordofan are 14 health centers (two more are constructed but not yet in function). There are about 100 dispensaries and about 200 primary health units, but approximately 20% of them are closed, due to different circumstances (lack of personal, civil war, etc.).

2.2.2 Patterns of Diseases in Sudan

SUDAN's general pattern of disease and the high incidence rates are similar to those in other poor African countries. The basic cause is poverty, with its associated inadequate food intake, low educational levels, lack of safe drinking water, poor environmental conditions and inadequate housing. Sudan has high rates of birth, disease and death, and the most dangerous time is the first year of life, followed by childhood and women's childbearing years. Between 1973 and 1983, the life expectancy at birth of the average Sudanese was estimated to have risen from 43 years to 48 and is expected to have reach 49 years in 1985, which is poor.

The infant mortality rate for the whole of Sudan -- the average number of deaths of children under one year old out of every 1,000 live births -- fell from 140 to 120 between the censuses of 1973 and 1983 is classified as very high. But the rate is believed to vary considerably across the country, with worst figures being found in poor rural areas and the lowest death rates in the wealthier places like Khartoum and Central region. While comprehensive data are lacking, some surveys suggest a range of rates from 150/1,000 to 190/1,000. Sudan's child death rate -- the average annual number of deaths out of every 1,000 children aged one to four -- is put at 21, almost half the 1963 level of 40/1,000 but all of these rates are estimates based on inadequate vital statistics. Information on maternal mortality is totally inadequate. Formal registration of birth and death varies a great deal, from one region to another and even where registers are maintained, collection and analysis of the information is sporadic.

Easily prevented diseases are the major killers of children in Sudan, as across all of Africa, and death rates for all disease are highest for children under two. Ministry of Health child death figures show 31.8/1,000 for 1/12 months, 35/1,000 for 13-24 months and 5.4/1,000 for 25-48 months, which probably highlight the impact of weaning and malnutrition levels in combination with common infectious diseases. Although not well documented, patterns of disease show seasonal variations: in summer, the chances of infection and the effects of any disease are likely to be exacerbated by malnutrition, which lowers natural resistance. The hungriest time of the year in the subsistence farming calendar is during late summer, when last year's food stocks are depleted and the new crop is still growing. Malaria carrying

mosquitoes are far more common during and after the wet season. Diarrhea is more prevalent and more dangerous in the summer, when surface water has been depleted and is generally highly polluted, and heat -- temperatures na reach 48C -- accelerates dehydration. Diarrhea, measles, pneumonia, malaria or unspecified "fever" cause 82% of the deaths among children under five years old. Others believe 40% of all deaths of children under five are associated with diarrhea, while the Control of Diarrhoeal Disease Department puts the figure for child deaths due to diarrhea at 82,000 a year. The attacks of diarrhea per child and year vary between 3 to 9.

Underdevelopment in Sudan clearly has a negative impact, worsening or delaying improvements in infant mortality rates, nutrition levels, disease incidence, average life spans, basic education and people's abilities to survive unaided. As elsewhere, "development" or "modernization" in Sudan can be a double-edged sword. While education, for example, has generally been a positive factor for women, increasing their understanding of health and nutritional issues and thus improving their children's chances of a healthy life, the growth of wage labor and urbanization has often meant rural women being left with the family while men spend months or years away working.

2.2.3 Remarks on Nutritional Status of the Population of Sudan

An indication of declining nutrition standards in Sudan are the estimates for average daily per capita calorie intake. As a percentage of requirements, these show a fall from 10% in 1980 to 90% in 1983. Diet varies across the country, with sedentary farmers in the north having a high carbohydrate, low protein diet of millet or sorghum eaten as a porridge with some vegetables but more limited meat supplies. The nomads of northern and western Sudan have a diet higher in fats and proteins from milking their animals, while southern pastoralists, who is slaughter few animals for meat, have far more fish. Settled southern farmers may grow maize or root crops, such as yams or cassava, and produce a wider range of vegetables. While Moslems will not eat pork or meat that has not been ritually killed, other food taboos vary from group to group, though they more often affect women and children.

The nutritional situation and the economy of Sudan relies almost entirely on agriculture, which produces up to 40% of gross national product, 90% of export earnings and the majority of government revenues, making all planning dependent on an erratic climate and fluctuating world commodity prices. Almost all rural people depend directly on agriculture, as subsistence farmers, migrant workers or traders, and almost all industry is based on agricultural products.

Arable land covers around 160 million acres or 27% of Sudan's total area of 600 million acres, but only about 15% of arable land is farmed, while another 160 million acres is natural pasture, which supported up to 55 million head of livestock in

the final years before the losses of the recent drought. Dams on both the Blue and White Niles have been used to increase the amount of river water utilized for irrigated agriculture. The major agricultural products produced in Sudan are cotton, sorghum, groundnuts, sesame, gum arabic, wheat, millet and sugar cane, of which the first five are main exports, while a wide range of vegetables and fruits are grown. The main livestock reared and exported are cattle, sheep, goats and camels. Poor land preparation can affect yields, but more important is Sudan's extremely erratic rainfall, which varies enormously over time and distance. Agricultural production per person and per acre in the traditional rainfed sector are low, which is a result of the subsistence strategy of minimizing risks rather than maximizing returns. Cereals are the main subsistence crops: millet in drier areas of light soil, with groundnuts and gum arabic as cash crops; sorghum in heavier soils with better rainfall, adding sesame for cash income.

Though surveys of reliable precision and methodology to assess the nutritional status of the population in representative parts of the Sudan were not conducted until early 1986, there has been sufficient evidence from various localized studies that malnutrition in many forms is widespread and severe. The Ministry of Health, with USAID, has initiated a Nutrition Surveillance Project, in which a nationwide nutrition survey will be undertaken quarterly. Results of the first survey carried out in the six Northern regions during May-June 1986 showed that 12% of children under five years old had values below 80 percent weight/height.

The National Health Programme (1977/78 - 1983/84) estimated that 2.3 million, i.e. approximately 50 percent of children under five years old, were suffering from some degree of malnutrition. Although protein-energy malnutrition is the most prevalent form, other forms of malnutrition caused by micro-nutrient deficiencies are also reported, including Vitamin A, iron, and iodine deficiencies. Maternal depletion and poor nutrition during pregnancy is also a priority nutrition problem.

The last several years have constituted particularly perilous time for children, since the cycle of drought, famine and the civil war in the South has had a major impact on the well-being of the child population. Many nutrition surveys were conducted by NGOs during the period of emergency relief in connection with food distribution. The baseline survey for the Joint Nutrition Support programme in the Red Sea Hills in Feb/March 1983 revealed that more than 80% of the children surveyed were malnourished. The UNICEF/OXFAM joint nutrition survey in Kordofan showed that the percentage of children who were moderately or severely malnourished rose from 10.9% in February 1985 to 18.5% in May/June 1985.

2.3 Availability of Water in Sudan and Kordofan

Water sources in Sudan include rivers - seasonal and perennial - and their dams, surface ponds, small reservoirs called "haffirs", hand and diesel powered boreholes and wells. In southern Sudan groundwater supplies are generally good, with low use and good recharging. Because of the higher rainfall in the south, surface water and rivers are the main sources for people and animals, which can often mean poor quality, leading to disease. Urban water systems in the south are limited to main towns, such as Juba, Wau and Malakal, and neither boreholes nor wells are common. In northern Sudan the lower rainfall and higher population mean ground water supplies are usually poorer, with high use and low recharge. Particularly during the recent drought, the water table in many areas has been falling, forcing many people to walk further, dig deeper and spend longer drawing water. Northern Sudan makes great use of diesel-driven boreholes, the haffirs which collect seasonal run off, and deep well handpumps for both humans and animals. Conservation is generally poor and the higher temperatures means that much potentially useful water is soon lost in evaporation. There are 3,000 deep well handpumps installed in Sudan, about 800 haffirs and at least 5,000 diesel driven boreholes, though another 1,000 boreholes are believed to have been drilled and left capped because of dislocations between budget plans for drilling and the provision of pumps and tanks. The boreholes supply water yards where animals may be watered. Dug wells are usually found near seasonal water courses, and some have been carefully lined with bricks, stones or bones. The majority of haffirs were dug in the eastern and central clay plains to allow human settlements and given extra grazing for livestock, but lack of attention and maintenance has allowed many to silt up, which lowers their capacity. Provision of any extra water in an area obviously shifts the balance between provision and use, allowing more people and animals to live near the supply. Unless careful measures are taken to conserve grazing, for example, or trees, extra water will always increase the risk of damaging the environment, which has happened in northern Sudan with spreading desertification around water points due to the extra pressure on the land from expanding settlements and livestock herds. In areas where the access to water is difficult, the water is often supplied by businesses which employ men to deliver it using donkey-drawn carts fitted with two 200 litre barrels.

For the National Conference on Rural Drinking Water (Khartoum, 10-13.Oct.1987) the availability for rural water was estimated as following:

total 197 Mcm, which come from the following sources

| | | |
|--------------|---------|------------------------------|
| wateryards | 138 Mcm | |
| hafirs | 27 Mcm | |
| open wells | 17 Mcm | |
| handpumps | 6 Mcm | |
| sand filters | 9 Mcm | (Mcm = Million Cubic Meters) |

The per capita consumption in different regions of Sudan varies between 0.8 liters/day in Southern Sudan and 4.4 liters/day in central region; Kordofan region figures to 2.7 liters/day. There is a huge demand for more water. A minimum calculation comes to a figure of 600 mill qm per year in Sudan. The international recommendations of 18-20 liters p.c. daily indicate a need which is 6times higher then the current supply. The demand is further increased by the fact that water is needed as well for animals and for other purposes (e.g. mud brick production). It is estimated that only about a third of the population of Sudan has access to safe water.

The water resources of Kordofan were also presented in the above mentioned National Conference on Rural Drinking Water.

There are superficial deposits at places of good annual precipitation especially around the slopes of Jebels, Khors and Wadis. Their water lasts until shortly after the rainy season. Ground-water is extracted from boreholes provided with mechanical units including diesel pumps, storage tanks and pipe delivery systems. The whole system is called "Wateryard".

There are about 720 boreholes scattered all over the region in about 523 wateryards distributed as shown further below.

The capacity of these wateryards if they would be run with 75% efficiency was found to be about 16 Mcm/year, but due to lack of funds, spare parts, poor periodic maintenance, inadequate means of communication to report breakdowns, shortages of fuel and lubricants, failure of self-help programmes due to effects of drought and desertification and bad organization all these combined to result in complete deterioration of the existing wateryards and now about 35% of these wateryards need complete rehabilitation.

The second important water source in the region is surface water. Due to higher precipitation surface water acquires greater importance in Southern Kordofan than in Northern Kordofan. In Northern Kordofan there are about 72 Hafirs with a total capacity of about 4 Mm³ while in Southern Kordofan there exist about 250 Hafirs with a total capacity of about 14 Mcm.

Water Sources in Kordofan Region:

| COUNCIL | BOREHOLE | WATERYARDS | HAFIRS & DAMS |
|--------------|----------|------------|---------------|
| 1 El Obeid | 88 | 55 | 29 |
| 2 En Nahud | 193 | 131 | 7 |
| 3 Umm Ruwaba | 177 | 130 | 19 |
| 4 Sodari | 38 | 21 | 3 |
| 5 Bara | 78 | 63 | 15 |
| 6 Kadugli | 18 | 16 | 41 |
| 7 Rashad | 23 | 18 | 102 |
| 8 Dilling | 15 | 11 | 52 |
| TOTAL | 720 | 523 | 324 |

This water is used for the human population and their animals, who are listed below.

Human Population of the region (85)

| COUNCIL | TOTAL POP | URBAN | RURAL | NOMADS | TOTAL |
|------------|-----------|--------|--------|--------|---------|
| El Obeid | 316005 | 140522 | 101122 | 66361 | |
| En Nahud | 486438 | 43779 | 403744 | 38915 | |
| Um Ruwaba | 374475 | 44935 | 329538 | - | |
| Sodari | 405874 | 4059 | 109585 | 292228 | |
| Bara | 245744 | 12287 | 223627 | 9830 | |
| Kadugli | 352040 | 45765 | 285152 | 21122 | |
| Rashad | 352064 | 42357 | 234889 | 107818 | |
| Dilling | 291008 | 26191 | 200796 | 64022 | |
| Fula Abyei | 393144 | 47177 | 161189 | 184778 | 3216790 |

Animal population of the region (87)

N. Kordofan

| | | | |
|--------|--------|--------|--------|
| Cattle | Sheep | Goat | Camel |
| 107649 | 293572 | 386833 | 187051 |

S. Kordofan

| | | | |
|--------|--------|--------|-------|
| Cattle | Sheep | Goat | Camel |
| 444912 | 624565 | 471531 | 26955 |

According to an estimations available water sources capacities if they were run with 65% efficiency are as follows:

| | | |
|------------------------------|------|-----|
| 1. W. yards | 14 | Mcm |
| 2. Hafirs | 10 | Mcm |
| 3. UNICEF Handpump wells | 3.5 | Mcm |
| Total | 27.5 | Mcm |
| Human pop. consumption/year | 13 | Mcm |
| Animal pop. consumption/year | 22 | Mcm |
| Total | 35 | Mcm |

Deficit 27.5 - 35 = -7.5 Mcm/year

2.4. The history of the UNICEF-assisted Water Supply, Sanitation and Health Education Projects (WES) in Sudan

UNICEF's involvement in water and sanitation in the Sudan began in 1975 when a hand pump programme was planned for southern Sudan. Implementation began in 1976 with drilling in Equatoria Region. However, in mid 1977 the programme area was moved to Bahr El Ghazal Region with Wau town, the capital of the Region, as it's base.

A second programme was started in South Kordofan province in late 1978. Programme activities included: the exploitation of ground water by borehole drilling and handpump installations; the improvement of surface water sources, including rectification of 'hafirs' (man made reservoirs) of 5,000 to 50,000 cubic meter capacity; and construction of treatment plants adjacent to those 'hafirs' serving significant populations.

A three-pronged approach consisting of the provision of potable water, sanitation and health education so as to maximize the health impact was introduced in 1979. They did not attain sufficient integration with the programme to have the desired effect in reducing water borne diseases.

'Hafirs' power pumps, dug-wells, water treatment plants and small earth dams were added to the programme in the early 1980's. This was undertaken in response to the government's preference for these technologies compared to the uncertainty with the newly introduced hand pump technology. At the same time these activities were geographically dispersed in response to political pressure to spread development assistance over a wider constituency. UNICEF's limited resources were therefore spread over large geographical areas of this vast country which consequently diluted the assistance.

Community participation in, and responsibility for, hand pump maintenance was included in 1983 in the programme. By 1983, there were sufficient pumps installed for the NRWC to see clearly that breakdowns were a major problem. This has been increasingly stressed ever since. Despite this community emphasis, many pumps were still maintained by the NRWC.

In response to the worst drought and famine in a century that hit Sudan in early 1984, UNICEF extended its hand pump programme to the Red Sea Province. This programme included construction of a dam for "water harvesting". However, in 1987, the hand pump programme was closed down due to high ground water salinity. The programme is presently rehabilitating dug-wells, a more appropriate solution for the supply of water for the population of Red Sea Province.

Late in 1984, UNICEF diverted drilling rigs to El Obeid, North Kordofan Province, to alleviate the severe water shortage resulting from the influx of people fleeing the drought. These displaced people put strain on the water supply of El Obeid town. An emergency programme was integrated into the regular NRWC programme for North Kordofan Province.

By the mid-1980's the programme was technically diversified and geographically dispersed. Logistic delay problems with technical specifications for equipment, procurement of materials, and technical supervision emerged. Programme management difficulties also came to the fore. During this period a wide variety of makes and models of vehicles and other equipment were procured by, or donated to the programme which resulted in maintenance and repair bottlenecks. As the vehicles aged the programme had to purchase spares for all the different vehicles resulting in over stocking of spare parts. This tied up a considerable amount of capital leaving the overall programme with insufficient liquidity. Even different types of handpumps were installed.

The full impact of working in too large a geographical area, employing too many different technologies and having a variety of equipment was finally realized in 1987. The programme was redesigned that year to reduce geographic dispersal and to concentrate on bore holes with hand pumps, latrines and health education. 'Hafir' construction, power pumps, embankments and treatment plants were found to be expensive and impractical to maintain. Transport and equipment were standardized in the 1987-91 programme with the full support of NRWC.

However, the major enduring problem in these early years was inadequate government commitment to hand pump technology. While there are a number of crucial factors influencing the success of the low cost approach to water and sanitation, the first and possibly most important is government commitment. While donors have supported water programmes that have resulted in an estimated 5000 hand pump installations throughout the country the government has only recently expressed serious interest in hand pumps.

Over the past decade the NRWC has had to devote most of their limited resources to an endless rehabilitation programme of comparatively high technology rural water supplies. As early as 1930, but accelerating in the 1950s and 1960s, over 3,500 water yards were constructed consisting of deep bore-holes fitted with power pumps, elevated tanks and reticulation.

Up to 1986, UNICEF concentrated its WES (water and environmental sanitation) support to NRWC activities in Kordofan, Red Sea Hills, Bahr El Ghazal and Western Equatoria. It reflected a strong commitment to drilling in as many communities as possible and frequently in remote rural areas. Concentration in form of standardization of the equipment (drill rigs, trucks and handpump) was also achieved. In mid-1987, when rural El Obeid district again faced a serious water shortage caused by a localized drought, UNICEF emergency hand pump programme. Between September and December 1987, 286 hand pumps were installed within easy reach of the Kordofan Regional capital, El Obeid. For the first time handpump technology achieved a highly visible profile. In the space of just 3 months over 50,000 villagers were provided with clean water. The speed with which the programme was implemented and the "saturation" effect resulted in a dramatic increase in the popularity of hand pumps. All the neighbors in adjacent areas began clamoring for hand pumps. This sudden rise in hand pump popularity helped to convince senior government officials and politicians alike that handpumps were indeed a good form of water supply. It was also possible to show these same senior officials, politicians and donors the viability of hand pumps because of easy "show and tell" advocacy. This advocacy has been made easier since both BBC and Sudan T.V. made documentaries of villages which have the proper concentration of hand pumps, household latrines, active health committees and trained local villagers for maintenance and repairs.

2.5 Description of the current UNICEF-assisted Water Supply, Sanitation and Health Education Projects (WES) in Kordofan/Sudan

The UNICEF office in Khartoum in collaboration with the government of the Sudan plans their different projects. The projects, which are carried out by appropriate governmental institutions and assisted by UNICEF, are outlined in the Master Plan of Operation. The current one is the "Child Survival Programme in the Sudan 1987-1991"

The WES is one part of it and it is carried out in collaboration with the National Water Corporation and the Directorate of Rural Water Development (NRWC). There are 4 major projects, beside those two described here in South and North Kordofan, those in Bahr el Ghazal/Western Equatoria and in the Red Sea Region.

The South Kordofan WES-project gains from the long lasting experiences since similar project activities are going on since 1977. The Head Office of the project is in Kadugli, all facilities (office, workshop, store, laboratory) are within the NRWC. All the WES-staff are Sudanese citizen, except one Kenyan. The organization of the staff is shown in an organogram (ref. Fig. 3).

The estimated costs for the 5-year period of the project are US\$ 8.094.400, which will be financed by UNICEF (US\$ 7.176.400) and Sudan Government (US\$ 918.000). The UNICEF funds for the years 1987-1989 coming from the following resources:

| | | |
|----------------------------------|-----------|------|
| General Resources | 1.781.192 | US\$ |
| CUC/CIDA (Canada) | 1.269.128 | US\$ |
| German Committee for UNICEF | 355.201 | US\$ |
| Saudi Arabia | 155.531 | US\$ |
| UK UNICEF Committee + Government | 576.428 | US\$ |
| Swiss UNICEF Committee | 283.531 | US\$ |
| Swedish Government | 282.120 | US\$ |
| Bank of Sudan | 145.360 | US\$ |

The annual working plan is discussed with NRWC, the Ministry of Finance and Economic Planning and UNICEF and a yearly agreement is signed by these institutions as the "Plan of Action".

In the following a crude description of the flow of activities in the WES-project is presented. The further details are given in the later chapters of this evaluation report.

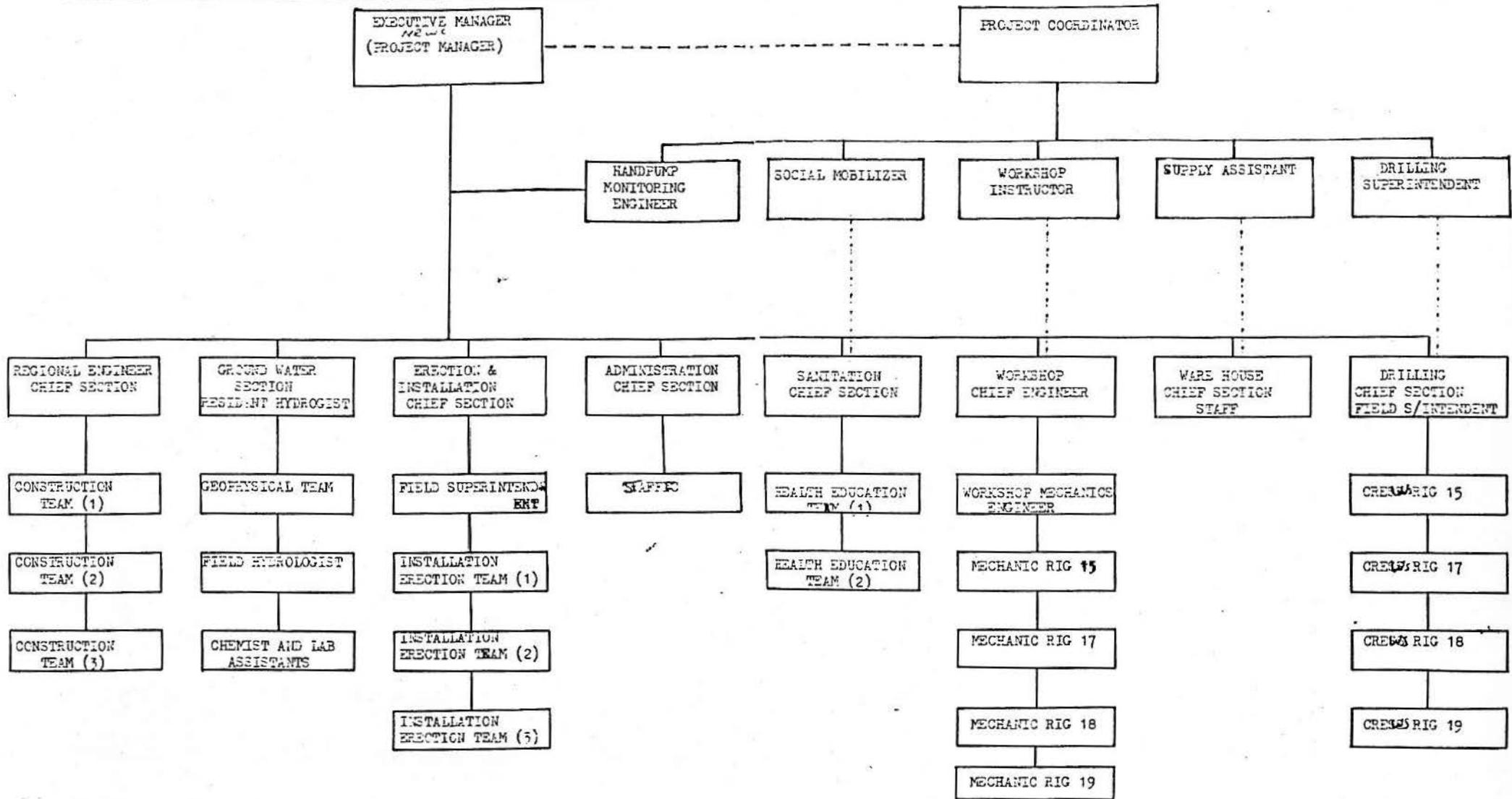
The applications for water handpumps were made by the elected village committees to the Rural Councils and hence to the District Executive Office. The application is then forwarded to the Provincial Water Board. This board draws its members from the various local government departments - NRWC, health, agriculture, education, forestry and soil conservation etc. - and is usually chaired by the Provincial Commissioner. The WES project coordinator, the hydro-geologist and a social mobilizer are also present. The Board processes all applications and review areas for new drilling operations. Recommendations for drilling are made to the NRWC. A survey of the proposed area is then conducted. Present policy is to try and cover one geographical area at a time with the drilling rigs so as to avoid unnecessary movement of equipment and support vehicles, and also to facilitate the administrative and technical supervision.

The following informations are used in the selection process:

- location and population of villages (district map)
- estimations of number of wells to be drilled in each village
- expected depths of boreholes, depending on the local hydrogeological conditions, which are surveyed by the geophysical teams
- sketch mapping of the tentative borehole locations.

Fig. (3)

ORGANIZATIONAL CHART NRWC, UNICEF, WES, SOUTH KORDOFAN



The selection criteria for the boreholes are:

- in each village at least 2 ("insurance aspect")
- one borehole for 200 people
- the borehole should be located as to be easily accessible to all people of the village, the borehole should not be located within the inner compound of any family
- priority is given to schools, hospitals and to other government institutions
- the borehole should be located at least 25 to 30 meters from any likely source of pollution.

Since the active participation and full motivation of the benefiting population is considered as the key indicator of a successful sustainable water and sanitation programme prior to the drilling of the borehole community mobilization is sought. In cooperation with the Ministry of Health, health education teams visit the selected villages.

The villagers are requested to build a village health committee, which should be composed out of 5 women and 5 men, who later on are trained and are responsible for different task:

- handpump maintenance
- health education
- sanitation programme (handpump fencing, VIP-latrine)

After the establishment of the village health committee the drilling crews can do their work. The work plan is adjusted in such a way, that geographical regions are covered completely in order to avoid unnecessary and costly transportation of the drilling equipment.

On the successful boreholes:

- deeper than 90 feet, but not exceeding 250 feet
 - yielding more than 200 gallons/h of safe water
 - completely cased and screened
 - dynamic water level pumping must not exceed a 150 feet
- by the installation teams India Mark II handpumps are installed according to the specification given per the India Mark II installation manual. The work is finished by building a proper cement platform and drainage. The installations are completed on less than one month time after the successful well is drilled.

The care-taking of the handpumps and their maintenance is in principle the task of the villagers. For this the village health committee (VHC) is provided by an informative and illustrated manual, which includes also sanitation and health education topics. Two members of the VHC's - one female, one male - are appointed to become village handpump mechanics. These people are trained in two weeks courses (at Kadugli Youth Center) in groups of 20-25 persons. The village handpump mechanics, who are capable of repairing all aspects of the pump receiving a certificate.

The villagers have to buy a standard set of tools and certain spare parts for a subsidized price of 500.00 LS. (about 30% of actual cost). The installation of the handpump itself is free for the villagers. The spare parts need to be bought for the actual prices. Records on all repairs have to be kept with the VHC.

For repairs, which cannot be done by the village handpump mechanics, rural council handpump technicians are trained and employed by the rural council. The whole handpumps maintenance is controlled by a monitoring engineer of NRWC, who prepares yearly monitoring reports on the functioning of the handpumps in the South Kordofan province. For difficult repairs there is a provincial mobile maintenance team.

Stores for spare parts are at the sites of the rural council handpump technicians. They keep records on the sale of spare parts. There are refresher courses in handpump maintenance, because there is also a fluctuation in the village handpump mechanics.

The way as the villagers are collecting the money needed for the maintenance the handpumps is given free to them, e.g. a certain amount per family and month or taxation on certain items, like sugar or fuel.

The health education and sanitation sector of the WES project is concentrating on the construction of ventilated improved pit (VIP) - latrine. The final aim is the complete coverage of a village with one VIP for each family. For this purpose the members of the VHC are trained in building a VIP and they have to inform their villagers.

The families have to dig the pit (at least 4 m deep, diameter 3-3 1/2 feet) after the siting of the VIP is done together with the VHC and the health team of the WES-project (at least 30 m away from the next handpump or any other water source, and at least 6 meters from the kitchen and sleeping quarters.)

The pit should be lined to the stable stratum with bricks. This work has also be done by the family. The slabs are made of reinforced concrete by the WES construction teams at district level. The slab consists out of two unequal pieces, one with the drophole and foot rests and one for fitting the PVC pipe. The 2 pieces joined together form a 1,50 m X 1,00m unit. The slabs are installed on the prepared pit by the WES construction team. The family receives this to a subsidized price of LS 50.-

The design of the superstructure and their construction is again in the hand of the family. It can be a simple native hut (e.g. wooden materials or mud bricks) of spiral or rectangular shape. The roofs can be made out of grass covers, but also zinc sheets, it should be dark inside the VIP latrine. The VHC will be held responsible for advocating for use of VIP.

Further activities in health education should be organized via the VHC. The members of the VHC are trained by the WES-Ministry of Health-Health Education Teams.

There are courses (of 6-day duration) on the usage of the project manual. The topics are dealing with:

- domestic and personnel hygiene
- control of water-borne diseases, like diarrhea (usage of ORS)
- immunization (EPI)
- water case, storage and protection
- nutrition education (local produce, weaning foods).

At the end of the courses the trainees are awarded certificates. The VHC will be held responsible for advocating for use of VIP, and it is expected that they start to implement the following:

- fencing and maintenance of handpumps
- campaign for a clean village
- teaching mothers on immunization (EPI) and ORS
- reporting of activities.

The VHC is in addition stimulated to start further activities, e.g. usage of water for free nurseries on vegetable gardens (ref. Chapter 6, linkages).

All the described WES-project activities are monitored by usage of a set of appropriate monitoring forms, and there are set criteria for successful boreholes, handpump installation, VIP-latrines, VHC and village handpump mechanics.

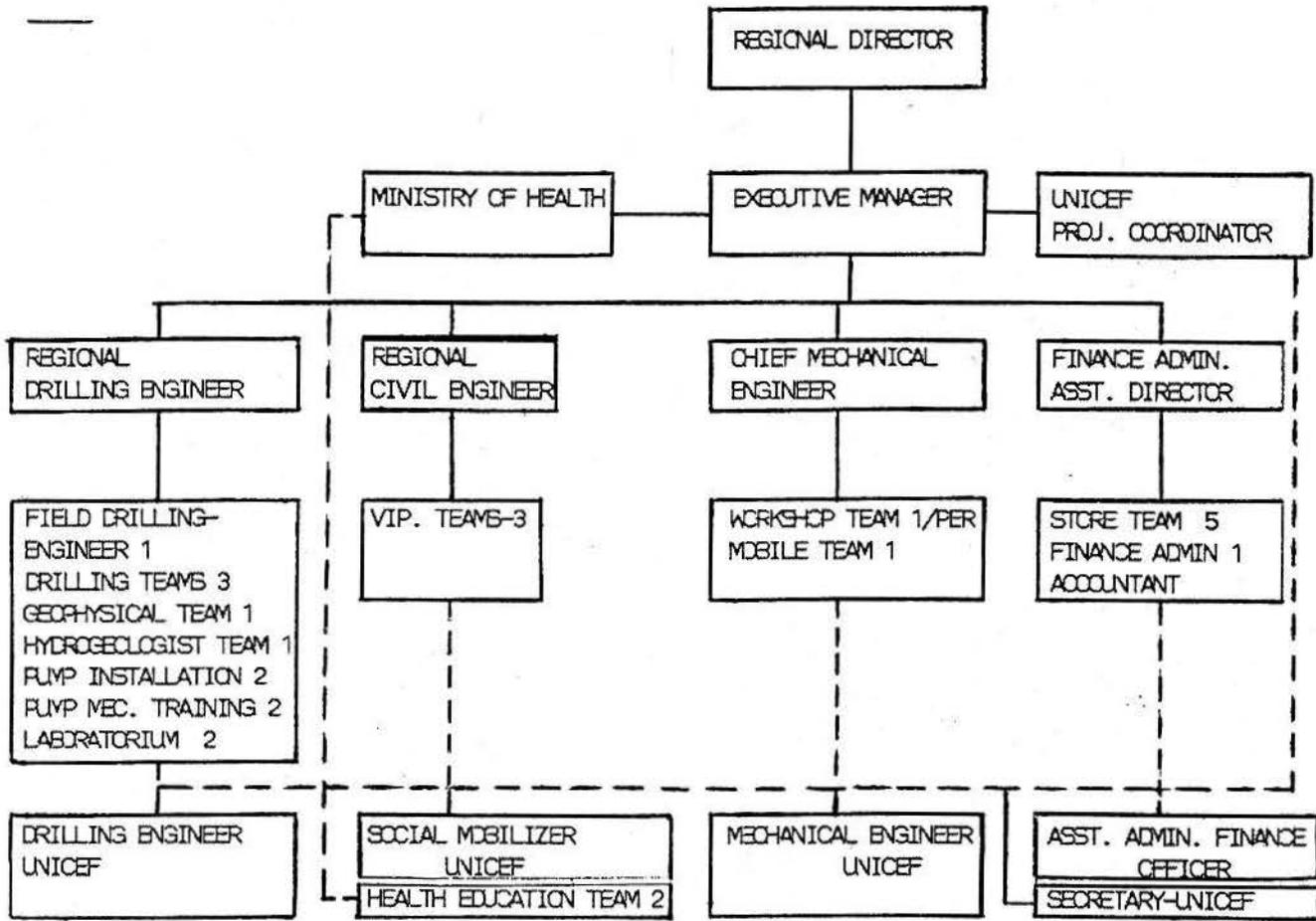
The North Kordofan WES-Project is new compared with those in South Kordofan, which was just described. It is based on the experiences of the last mentioned one.

The project offices are in El Obeid. The UNICEF staff has offices in an UNICEF-building which harbors as well other UNICEF projects. Further offices, the store and the workshop are on the grounds of the NRWC. There is a small laboratory and a new one will be build soon. The WES project coordinator is a foreign UNICEF staff member, the other staff is mainly Sudanese. The organization of the staff is almost identical to those of the South Kordofan (see Fig.3,4) organogram. There are:

- 3 drilling crews
- 1 hydrology/geophysics crew
- 2 handpump installation crews
- 2 handpump mechanics training teams
- 2 health education teams
- 2 VIP installation teams.

ORGANIZATIONAL CHART NRAC, UNICEF, WES, -NORTH KIROCFAN

FIG.4



KEY

- DIRECT RELATION
- INDIRECT RELATION

The estimated costs for the 5 year period of the project are US\$ 5.197.700, which will be financed by UNICEF (US\$ 4.707.700) and the Sudan Government (US\$ 490.000). The UNICEF funds for the years 1987-1989 coming from the following resources:

| | | |
|-------------------|-----------|------|
| General resources | 1.942.044 | US\$ |
| CUC/CIDA (Canada) | 1.389.472 | US\$ |
| USAID | 103.020 | US\$ |
| Sport Aid | 206.374 | US\$ |
| Sweden | 220.587 | US\$ |

The annual working plan is discussed between NRWC and UNICEF and a yearly agreement is signed by these institutions as the "Plan of Action".

Since the activities and their organization is principally identical to those described for the South Kordofan-WES-Project, it is here simple referred to it.

3.0 Government Water Supply, and Sanitation Sector Strategy and Policy Guidelines

3.1 A Review of Past Strategies and Policies

The, then, concept of socio-economic modernization based upon sectorial export-oriented growth poles, with anticipated substantial foreign financial flows; designed to impart major restructuring of the Sudan economy hassled to fundamental structural imbalances were further perpetuated by the occurrence of cyclical periods of droughts with a devastating degradation ecosystems and an impending food shortages in retrospect 1984/85.

The attempts made by the various types of organizations failed to curb environmental and natural resources deterioration, which became so perplexed in rural areas to the extent that it was difficult to reconcile with the problems of environment and, water and other natural resources. Current problems were thus solved at the expense of long-term perspective measures, in the absence of integrated planning and of policy measures aimed at rational development and use of water resources. Therefore, the whole issue of water supply was dealt with in a professional/departmental fashion. Such tendency among other factors has led to the dispersal of agencies concerned with water supply and environmental quality interaction. The sector had been subjected to frequent administrative changes with regard to ministries, decentralization cam centralization of authorities, confusion over responsibilities and rival attitude shared between the various agencies managing the water sector. The consequence of was inability to keep pace with the various problems in the field of water supply with a decline inservice coverage. ea. 32% of total demand or about 200m³ p.a. No consideration has been given to water resource operation and maintenance nor to the link with other natural resources, such as variations in the type of land, climate, vegetation cover and the distribution of human and animal population. Also, environmental health deterioration caused by conditions poverty, poor health education, and water-borne and water related diseases have not been given due consideration. It was reported that water-borne and water related diseases contribute about more than 30% of the total mortality level i.e. of those registered in health centers, and that about 90% of the efforts made by the health authorities is within this field.

3.2 Water Supply and Sanitation coverage and Investments:

Estimates of the 4-Year Salvation, Recovery and Development Programme (4-Yrs. S.R.D.P) 1988/89-1991/92) and World Bank (WB) report of 1988 on water supply and sanitation coverage are as follows:

| | |
|----------------------|--------|
| - Rural water supply | 30% |
| - Urban water supply | 47% |
| - Rural sanitation | 10-20% |
| - Urban Sanitation | N.A. |

The number of water points runs into thousands and categorized as follows:

- 3600 water yards
- 1100 hafirs and small dams
- 170 slow-sand filters
- over 4000 hand-pump wells
- 62 urban water facilities

Almost 3000 water yards, all hafirs and dams, and urban water facilities need major rehabilitation.

Investments

During the period 1981/82-1985/86 water supply received not more than annual average investment of 4% of total public development expenditure; where as in retrospect 1987/88 investment capital amounted to about 12% of total public development budget. The 4-yr. Programme assigned and increasing trend of investment which culminates to an amount of 20% of total budgetary appropriations. An annual investment of about \$30 m. is envisaged during the 4-yr. Programme period for rural water and about \$13-15 m. for urban water supply.

Sector Organization and Management

As mentioned before administrative instability of institutions has adversely affected water supply coverage and its quality, and paved the way for developing the sector away from sustainability.

Water Corporations Mandates

The National Corporation for the Development of Rural Water Resources (NCDRWR) Act covers all aspects of linkages i.e. between water, environment, renewable resources and other ecosystem components. It also sets up a technical advisory committee with three professional experts in environmental issues as well as representatives from the drought affected regions, to be appointed by the minister. However, the Corporation Act has granted a wide range of powers to its executive organ leaving the task of coordination with other relevant organizations to the board of directors. This would naturally lead to water related problems of land use and environment being treated in isolation from water supply. The danger in this trend lies in the high cost of reminding the degradation in environment and ecosystem. This in fact depicted in the Corporation's staff number (over 15000) and unskilled personnel (about 60% of total staff number). Also, other features are the complete negligence of operation and maintenance of water points and a bias towards new and high capital investment. The same is true for Soil Conservation, land use and water Programming Department (SCLUWP) of the Ministry of Agriculture which has gradually moved away from its functions of

planning to expand its activities in the execution of water projects. The consequence of this move is competition over financial resources and a worsening of ecosystem problems as well as increase in the cost of providing water. All water acts and regulations excluded monitoring and evaluation with the exception of SCLWP department. Within the field of water research there has been overlapping between agencies. After the transfer most hydrologists to the NCDRWR, the Geological Research Corporation (GRAS) has become incapable of playing its role in the water field inspite of its long history and experience in ground water research. Although there is no specific reference in the water Corporation's Acts to the relationship with the Ministry of Health (MOH) there does in fact, exist considerable cooperation between them in practice. Moreover, there exist no overlapping or conflict between the functions of the Ministry of Irrigation (MOI) and other water authorities.

3.3 Objectives, Strategies and Policies

The 4-Year Programme has set some general and specific objectives within a strategy framework. These could be summarized as follows:

General Objectives and Strategies

- 1.1 Assessment of water resources with a view to develop and conserve them within a framework of a long-term perspective of integrated and sustainable rural development. In the short and medium-terms measures for provision of water to the most needy areas/groups constitute high priority. Low-cost solutions with micro-agricultural activities using excess water or water run-offs, and rural sanitation and health education should be the pillars upon which projects are designed.
- 1.2 Reconciliation of provision of adequate and safe water supply with ecological balance and ecosystem protection and development. Also water supply should be linked with unenvironmental quality improvement. Furthermore, water-borne and water related diseases which constitute more than 90% epidemics should as well receive utmost attention i.e. through environmental health services. Such measures would reduce both mortality and morbidity levels and improve the nutritional status of the community members.

Specific Objectives

- 2.1 Attain some fare degree of the water decade targets in the water supply and environmental health services by the end of the 4-Year Programme. About 50% of these targets in the field of water supply could be achieved

through rehabilitation of existing productive capacities and the remainder through development of new water sources.

- 2.2 Assign special priority in the water and sanitation programmes to the most needy areas and vulnerable groups particularly mother and child who were affected by water scarcity.
- 2.3 Attain sustainable water supply systems with adequate revenue to cover the cost of operation and maintenance of water facilities.
- 2.4 Assess water resources in a way to secure conjunctive development, use and protection of both ground and surface water resources whenever technically and economically feasible.

Some Important Policy Issues

National policies and instruments contained in the 4-Year Programme have addressed primarily areas in respect of management and organization of water resources, operation and maintenance of water facilities, and financial and manpower resource mobilization vide the following:

- The disposal of water agencies caused by some professional practices, political instability and limited financial resources had led to weaknesses of administration and management, a lack of cohesiveness, scattering of necessary information required for planning, competition of over resources and overlapping and conflict of responsibilities. To revert this trend an interagency coordinating body has been proposed and considered by the Government for further detailed review and consideration. Regional government and local authorities are expected to resume responsibilities in planning, execution and monitoring of water programmes through their representatives in the regional organization structure of the NCDRWR and urban water corporation.
- To broaden the national/local economic base and to increase water demand coverage a cost-recovery system has been introduced for assessment and adoption by the Government.
- Ensure community participation in operation and maintenance as a short-term policy measure, and stimulate their physical and financial capabilities to initiate their own needs in the long-term perspective measures. Community involvement is justified in many respects viz:

- to ensure adequate and continued water supply and preventive health measures;
- to reduce the cost of operation of water service born by the Government- the cost of labor in the Northern Region has been estimated at only 50% of the cost born in other regions because of self-reliance.
- Low-cost technology is the most desirable option for investment in the water sector. A technology that can be easily absorbed by the economy and the local communities when-ever the resource of water may permit.
- This is also important for partially or wholly manufacturing of water inputs. The impact of this policy will be substantial in terms of lessening the heavy dependence on foreign aid and in broadening the national economic base through sectorial linkages.
- Adaptation of renewable energy technology particularly in remote areas where supplies of fuel, spare parts and transport are difficult to provide.
- Secure an appropriate amount of foreign exchange with technical assistance to rehabilitate and operate the aging water facilities and limit the wide variations in types f water pumps, engines etc.
- Review water rates and improve revenue collection.
- Issue water laws and regulations to protect and regulate water resource utilization from malpractices and pollution.
- Use should be made of indigenous local expertise and provide training opportunities for local staff. In this respect local training institutions such as Wad-El Magboul of the NCDRWR should be upgraded to provide training for at least the redundant staff of the water corporations.
- Support water research to identify and count for water resources and to provide least-cost and efficient solutions to water management.
- Line water supply with environmental health service to reduce water-borne diseases which in turn would increase human and animal productivity.

3.4 Conclusion

In conclusion there is a need to develop a set of policy mix and instruments required to achieve the sectorial objectives using appropriate strategies to impart sustainable water supply and sanitation management and use. UNICEF-sponsored programme in Kordofan Region has adopted the same approach in the development of ground water using simple technological packages based upon water hand-pump introduction, health education and sanitation coverage. The programme emphasized the role of water and of women as elements of change i.e. women as productive labor using excess water and water-run-off in micro-agricultural activities thus improving the nutritional standard of families and reducing the cost of providing water. The experience gained due to the programme has a valuable contribution in terms of simple technological packages designed to develop on a sustainable basis a hydrological difficult zone prone with drought and desertification. To ensure sustainable development and use of ground water resources and health preventive measures i.e. sanitation and health education, the Programme adopted the concept of people's participation and cost recovery system. Such programmes would encourage the country to develop hydrological similar areas using the same set of technologies and approaches. This would tend to increase water supply and sanitation coverage, and, provide least cost and efficient solutions that can be absorbed by the economy and the beneficiaries.

4.0 TECHNICAL ASPECTS

4.1 Overview of Water Supply in Sudan

While water-borne and water-related diseases are major contributing factors to the high rate of infant and child mortality and morbidity in Sudan, the scarcity of water supplies, unhygiene personal practices and a polluted environment are also constraints to socio-economic development.

Less than a quarter of Sudan's rural population has access to potable water. During the rainy season villagers in most areas collect water from highly polluted sources e.g. natural depression or shallow dug wells. In the dry season, people are forced to walk long distances fetching for new supplies. This is often the role of the woman.

4.1.1 Kordofan Background

Kordofan occupies the central of Sudan. The project area is shown in figure (5). Central Kordofan has a varied ecology ranging from low rainfall, thorn-scrub savannah on sandy soils to riverain and mountainous areas, surrounded by clay plains and sandy-clay pediplains. Annual rainfall averages between 350 mm to 550 mm, but with considerable seasonal variation and uneven distribution.

The economy is nomadic and low level agriculture with livestock together with food and cash crops. Spurred by poverty, most families have some members who have migrated out of the area in search of permanent or seasonal labour. As a result, the urban areas in Kordofan are expanding rapidly. Due to continuous drought, compounded by the flood of 1988 and the continuing of civil war, life has become a matter of survival.

4.1.2 UNICEF Water, Sanitation and Health Education Project

4.1.2.1 UNICEF Programme Reorientation:

Up to 1986, UNICEF concentrated its WES (water and environmental sanitation) support to NRWC activities in Kordofan, and other regions. It reflected a strong commitment to drilling in as many communities as possible and frequently in remote rural areas. In mid-1987, when rural El Obeid district again faced a serious water shortage caused by a localized drought, UNICEF mounted an emergency hand pump programme. Between September and December 1987, 286 handpumps were installed within easy reach of the Kordofan Regional capital, El Obeid. For the first time handpump technology achieved a highly visible profile. In the space of just 3 months over 50,000 villagers were provided with clean water. The speed with which the programme was implemented and the "saturation" effect resulted in a dramatic increase in the popularity of handpumps.

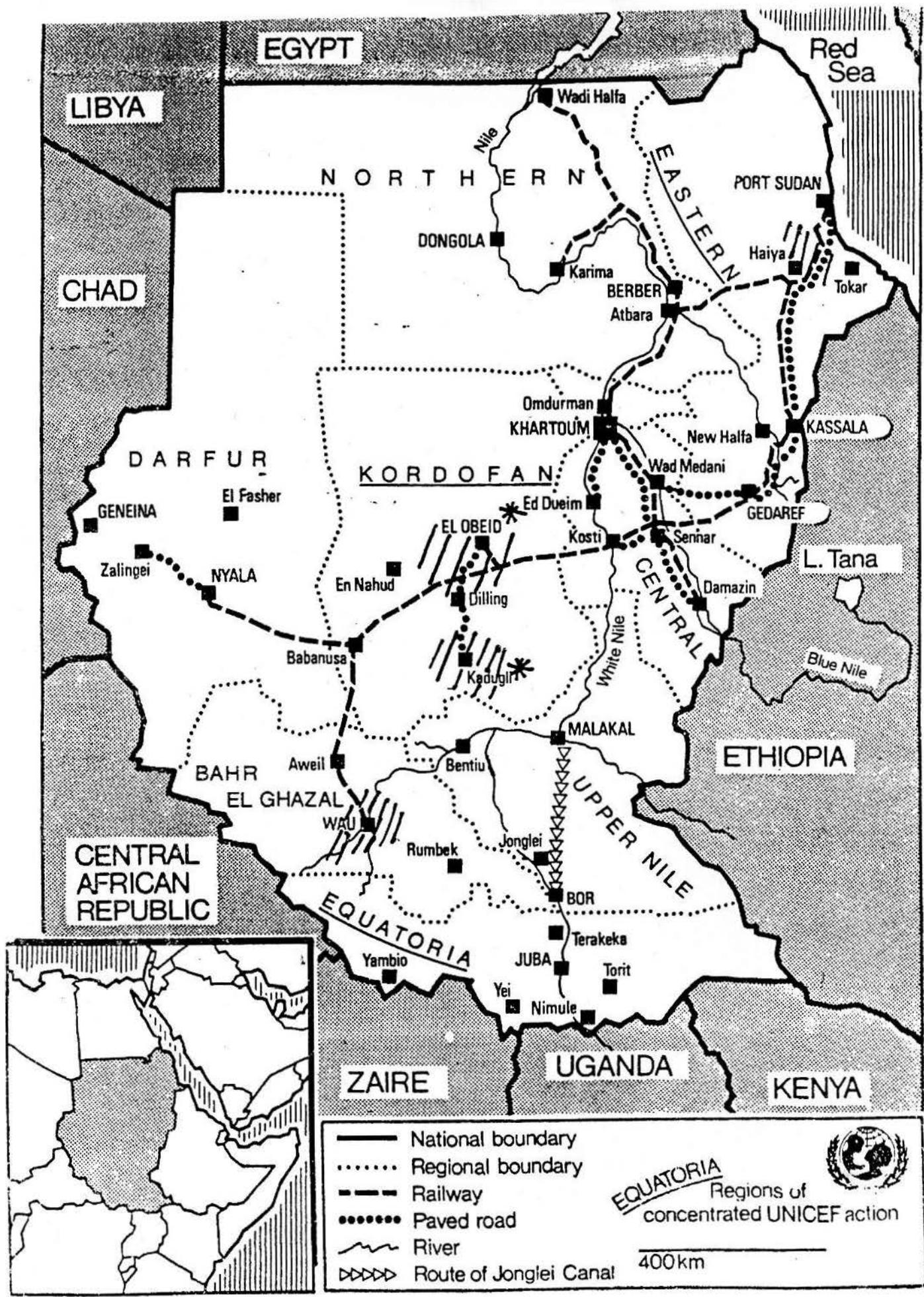


Fig. (5)

At the village level, there has been no need for any persuasion. The low cost approach has been already preferred over more complicated and unreliable systems, although, in villages where there are too few handpumps and where breakdowns force people to draw water from unprotected sources, the handpump can be mistrusted. In turn, this can prompt the community into petitioning for a motor-driven water yard. Since handpumps are now owned by the community, maintained by local residents and installed with back up capacity they are increasingly preferred over water yards; the latter are frequently broken, or lack fuel, leaving the community without continuous potable water. However, this is not to suggest that water yards are less important than handpumps but rather to assert that handpumps are readily accepted for domestic household water supply. Water yards are indispensable in some locations with a very deep water table for domestic use and for watering livestock herds in the dry season.

A Health Education and Environmental Sanitation component was later added as an integral part of the project in 1984 and addressed the problems related to poor personal and health hygiene, water handling, and excreta disposal practices. A unique programme emerged and included:

- Establish trained village health committee, i.e. participation of village personnel and residents
- Construction of ventilated improved latrine

4.1.2.2 Borehole Drilling and Site Selection

A borehole site selection criteria was established by NRWC and UNICEF to concentrate the drilling in rural council by rural council and supply all villages in each rural council with boreholes and handpumps where technically possible.

The summary of the project achievement are shown in the following bar chart titled Evaluation of Boreholes in Kordofan.

The chart showing the number of successful and unsuccessful borehole and the percentage.

The pump installation work is lagging behind the drilling due to logistic problems, however, with the recent arrival of pumps, the gap will be tremendously reduced before the end of the year.

Since the arrival of the geophysical equipment in November 88, the successful rate of the drilled boreholes has risen from 65% to 69% (total project analysis) and to 77% in 1989.

4.1.2.2 Site Selection

Until 1986 applications for boreholes were made to the District Executive Officer who would forward them to UNICEF in Kadugli for sorting according to district. Siting was considered by the

Hydro-geological Section upon consideration of the application date and the size of the village. Priority was given to schools, health centres and police stations. This system was seen to discriminate against villages where there was no spokesperson to articulate the needs of the village and make an application.

In 1987 the applications were made by the elected village committees to the Rural Councils and hence to the District Executive Office. The application is then forwarded to the Provincial Water Board. This board draws its members from the various local government departments - NRWC, health, agriculture, education, forestry and soil conservation etc.. - and is usually chaired by the Provincial Commissioner. The WES project coordinator, the hydro-geologist and a social mobilizer are also present. The board processes all applications and reviews areas for new drilling operations. Recommendations for drilling are conducted. Present policy is to try and cover one geographical area at a time with the drilling rigs so as to avoid unnecessary movement of equipment and support vehicles, and also to facilitate the administrative and technical supervision.

4.1.2.2 Siting of Boreholes

Initially detailed hydro-geological surveys were not conducted and the failure rate for boreholes was very high (50%). To improve the success rate UNICEF and FINNIDA financed a study on the use of Refraction Seismic Measurements for siting borehole wells in the project area of El Efain, Habiela, Lugorr and Masakeen. Test drilling was carried out in 6 locations in each of the areas. The hydro-geological and geophysical equipment has also been updated and an EM system electronic system has been added. A training course was held in El Obeid in October 1988 to introduce the new methods. As a result of these measures the success rate of boreholes has improved dramatically, now in the region of 75%.

4.2 Water Availability and Quality

4.2.1 Water Resources

Kordofan Region is a semi-arid region with average annual rainfall ranging from 500 mm to 800 mm. The intensity and distribution and occurrence varies considerably and some areas may not receive the annual average.

Evapotranspiration is expected to be rather high as evident from the short availability of surface water resources. Most surface water, in hafirs and depression, disappears within a short-period of time i.e. two months after heavy rainfall.

Groundwater recharge takes place from direct precipitation and percolates/infiltrate through the soil into the surficial deposits and the bedrock basement complex. Additional recharge

may be also received along Wadi Channel, under favorable conditions.

4.2.2 Geological Setting

The geological environment of Kordofan is complex and variable. A number of surficial and deep seated tectonic features are evident, where mountain forming uplifting/upthrust appears responsible for the emergence of the circular Nuba mountain. Another important features the cross faulting; an indication of tectonic activities during the pleistocene period.

The Basement Complex

The basement complex occupies the central parts of the Kordofan District, except for the encircled Nubian sandstone outcrop North of Abu Zabad at Saataa, Khuwei. The Nuba mountains serve as recharge area for the groundwater resources.

The basement complex, can if weathered and fractured, contain good aquifers. The groundwater in these formations appear in fractures, joints and fissures associated with faults. The project drilling programme has been concentrated on the basement complex area.

NAWA Series

The Nawa Series is composed of unmetamorphosed? beds of Orks grits and mudstone. The Lateral extent of Nawa formation is limited and subsequently does not constitute a potential regional aquifer in Kordofan.

Nubian Series

Nubian sandstone formations form a favorable aquifer when attains a thickness of not less than 60 meters. The Nawa drilling programmes have concentrated on these formations, and a large number of successful boreholes have been completed in these rock formation. The formations, are liable to caving and collapsing and mud/foams rotary drilling techniques may be more suited.

Umm Ruwaba Series

Umm Ruwaba formation is comprised of a thick accumulation of unconsolidated sands, gravel and clays. It is considered to be the second most important aquifer in Kordofan. The depth of the aquifer and the static water level requires different drilling and well completion techniques as developed for drilling the basement aquifer.

Alluvial Deposits

The alluvial, surficial deposits are good aquifer found only in isolated valleys in form of unconsolidated silt, clay, sand and gravel that would easily collapse during drilling.

The drilling techniques applicable to this formation are required to overcome the collapsible nature of such formation i.e. using cable tool drilling machine and protective casing, screen and gravel-pack installation.

4.2.3 Water Basins

Tectonics and geology plays an important role in the occurrence and distribution of ground water basins and sub-basins. These water basins/sub-basins are either in a simple form i.e. comprised of one geological unit such as En Nahud Basin, or complex Basin composed of two or more geological units such as Baggara Basin.

Seven ground water basins are recognized in Kordofan Region. These basins are tabulated according to their hydrogeological importance as follows:

- 1 Sahara Nile Basin
- 2 Sahara Nubian Basin
- 3 Nahud Basin
- 4 Sudd Basin
- 5 Baggara Basin
- 6 Eastern Kordofan Basin
- 7 The Alluvial Basins

4.2.4 Water Quality

Due to the increase in number of boreholes drilled, representative samples are collected from each village for chemical analysis.

The project Laboratory in Kadugli has been equipped to carry out basic chemical analysis for the physical testing and major Anion and Cation as summarized in the following table.

UNICEF WATER SUPPLY AND SANITATION
PROJECT - KADUGLI
ANALYSIS DATA OF WATER

BOREHOLE No..... Lab ref. No.

LOCALITY:..... Date of sampling

PHYSICAL AND CHEMICAL TEST

| | |
|---------------------------------------|-------|
| Colour: | UNIT |
| Turbidity at 25 c: | FTU |
| Conductivity: | us/cm |
| Total dissolved Solid at 180 c: | MG/L |
| PH: | MG/L |
| Carbon dioxide: | MG/L |
| Total hardness: | MG/L |
| Total Alkalinity as CaCO3: | MG/L |
| Total Chlorine as CL:8 | MG/L |

ANION

| | |
|-----------------------|------|
| Choloride: | MG/L |
| Nitrite: | MG/L |
| Nitrate: | MG/L |
| Sulphate: | MG/L |
| Hydrocarbonate: | MG/L |
| Phosphate: | MG/L |
| Fluorine: | MG/L |
| Cyanide: | MG/L |

CATION:

| | |
|-------------------------|------|
| Ammonia: | MG/L |
| Iron Total: | MG/L |
| Manganese: | MG/L |
| Copper: | MG/L |
| Calcium: | MG/L |
| Chromium: | MG/L |
| Silica: | MG/L |
| Analysis done by: | |
| Chemist: | |
| Observations: | |

Date of report:

The project laboratory in Kadugli is also equipped to perform a small number of bacteriological test for coliform counts.

The project Laboratory in El Obeid has a Hach Kit Unit and is not equipped for Bacteriological test.

Both Laboratories depend on the main Laboratory in Khartoum for their detailed and increasing number of water samples required.

The water quality collected from the handpump well and analyzed Annex II falls within the permissible level, and indicates that the water is fresh and new. It has been reported that one or two areas displayed saline water, and isolated cases of bacteriological coliform count of +10. These boreholes were disinfected and chlorinated and tested.

Plans are underway to expand the Laboratory facilities and increase the number of trained Laboratory assistants and technicians.

At present the Lab has Hach Kits (DR/EC-1) for physical chemical tests, a mini-conductivity meter and 2 incubators for bacteriological testing.

At El Obeid, one Hach Kit (DR/EL-1) is available. No bacteriological testing equipment are available and samples are sent to Kadugli and Khartoum for further analysis. More instruments have to be purchased to enable full physical-chemical analysis and a larger number of samples analysis.

4.3 Drilling Operation and Well Construction

4.3.1 Borehole Drilling

Drilling operations are carried out utilizing three airdrilling machines in the province of North Kordofan province and four air drill machines in South Kordofan Province.

The drilling starts¹ with 200 mm (7 7/8") diameter drag bit, through the overburden into the weather section of the basement complex. Drilling continues some 2-3 feet into the solid sound rock, with 6 1/2" hammer rock bit.

The overburden and the weathered sections are cased with 140 mm (1/2") Plain mild steel tubes into the solid sound rock. Drilling is then continued in the hard rock as an open hole 115 mm (4 1/2") in diameter.

4.3.2 Well Construction

The cost of boreholes with handpumps depends mainly on appropriateness of the borehole design, construction methods and the efficiency of the drilling operations.

The borehole design(s) need to be sufficiently simple for rapid

construction and for decisions on construction aspects to be taken in the field by drilling crew(s). The simplicity of the design must not jeopardize the quality of the end product i.e. a borehole with acceptable life span that produce sand and silt-free water of good bacteriological quality.

4.3.3 Low Cost borehole Design

A common low cost design for wells constructed in hard rock areas is to case off overburden and unstable rock formations with small diameter cemented steel or increasingly more common plastic casings (PVC) of 120-125 mm I.D. and continued to drill a small diameter hole 110-115 mm into the rock with pneumatic hammer, and tungsten carbide bits. The main advantage with this method are:

- simplicity,
- rapid construction,
- minimum supervision requirement,
- and low cost.

Disadvantages may include:

- problem with siltation and build up of sand in the borehole;
- difficulties in determining to which depth casing is to be installed; and
- difficulties of rehabilitation if required.

This design is also used with larger diameters at a higher cost but with the definite advantage of allowing eventual reconstruction and rehabilitation i.e. installation of screen(s) or gravel-pack(s), since most hand pump(s) cannot be installed in bores smaller than say 100 mm.

Borehole design requiring mud rotary drilling techniques are substantially expensive and this less appropriate for the low cost handpump approach.

4.3.4 Well Development

The well development adopted by the project is through air-jetting using the drill pipes. The well development continues until a silt sand free water is achieved, or until the borehole is condemned as a non-producer. A water sample will then be collected for physical and chemical analysis. The dry well(s) i.e. (non-producers) are then stripped off its surface steel casing and abandoned.

Hydrofracturing unit is presently stored in El Obaid, awaiting the remaining parts to arrive from another province and spare parts from overseas.

4.3.5 Platform Construction and Handpump Installation

The recommendations of the manufacturer of the selected handpump, the India MKII (Hayati) are essentially being followed as regards the design and the specification of the platforms. In addition, a live or dry bush fence is also constructed at a reasonable distance surrounding the platform.

The platform construction team comprises of a foreman, 4-5 crew members and one driver and an assistant driver.

The handpump installation is carried out by an installation team, directly or within few days after completion of the drilling operation.

4.4 Handpumps

4.4.1 Handpump Selection

The following criteria were considered when the Mark II (Hayati) was chosen.

- Type and numbers of pumps that exist/brought into Sudan;
- Local acquired experience or performance of existing pumps;
- Simplicity of installations;
- Maintenance aspects at the village level and village level operation and management (VLOM);
- Pumps does not have easy access for the withdrawal of the rising main without the use of heavy lifting tackles or others as a safe guard;
- corrosive resistance which is important under aggressive water conditions;
- the low cost of investment which varies between US\$ 300 to US\$ 3,000;
- commercial availability
- local manufacturing aspects and potentiality.

The India Mark II can be maintained on village level. The rising main can be lifted out from setting down to 50 m by hand without the use of tripod and heavy lifting tackles. Village mechanic can maintain all aspects of the pump from threading of pipes and rods to replacing all parts of the pump.

There are no patent rights or royalties associated with the manufacturing of the Hayati.

4.4.2 Local Manufacturing of handpumps

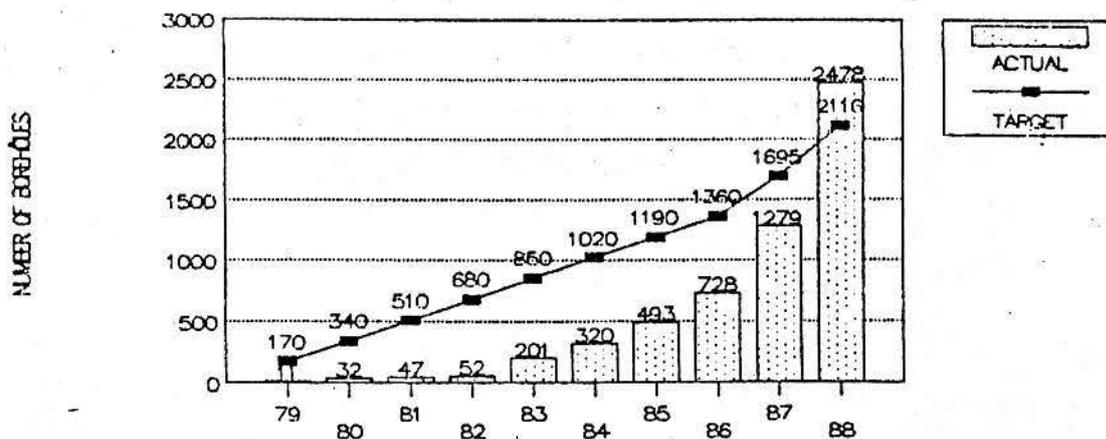
With Sudan's need for tens of thousands of handpumps and the availability of production facilities, local manufacturing should be priority and started as early as possible. The advantage with local production are numerous:

- reduced dependency on foreign suppliers;
- reduced foreign exchange out flow;
- creation of job opportunities;
- possibility of reducing overall cost;
- improved supply of spare parts;
- simplifying future design improvements to suite local conditions
- improved possibilities of maintaining standardization

The cost per successful borehole in US\$ for the period 1976-1988 are given in the follow figure.

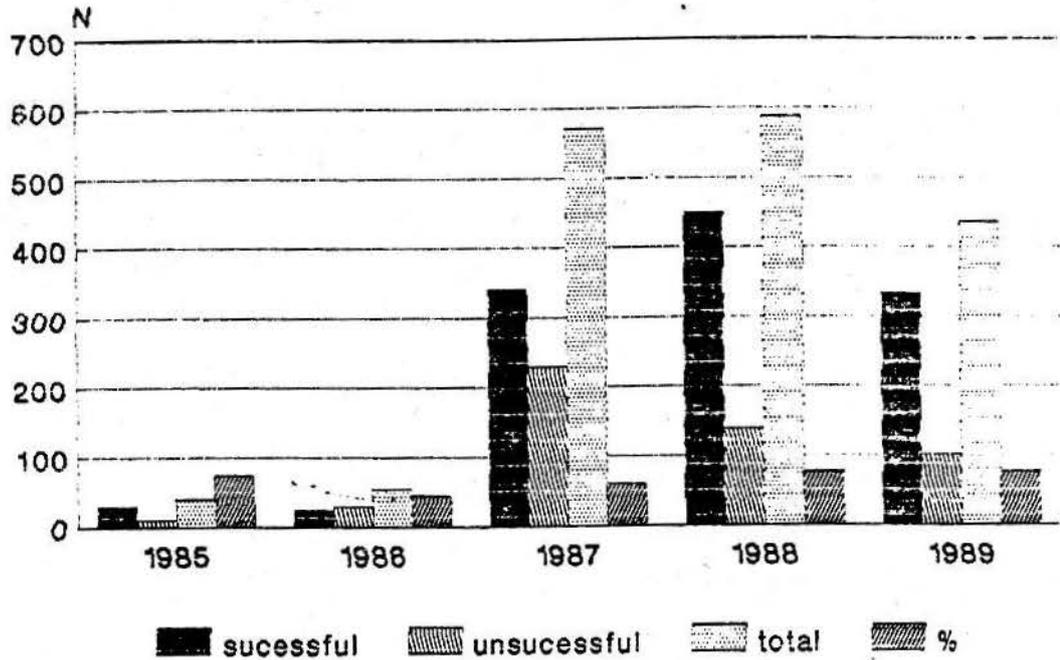
Fig. (6)

ACCUMULATED SUCCESSFUL BOREHOLES KORDOFAN REGION, SUDAN

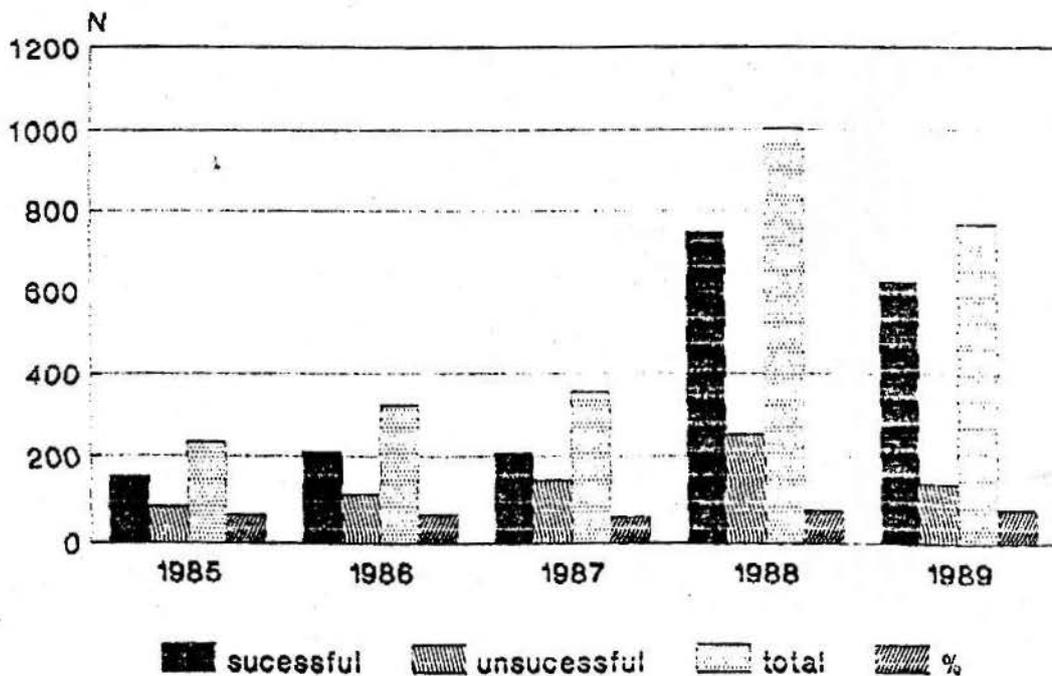


A detailed breakdown of the cost and cost effectiveness is given in Chapter 8.

Evaluation of Boreholes in North-Kordofan



Evaluation of Boreholes in South-Kordofan



1989 includes till Oct. 89.

4.5 Maintenance of Handpumps - North Kordofan

4.5.1 North Kordofan

Pump Maintenance

The pump maintenance is the combined work of the village, NRWC and the Rural Council. NRWC and the Rural Councils are responsible for the technical supervision, drilling and the sale of spare parts and tools.

The maintenance activity of the WES project started in 1987 with the training of two mechanics for each of the twenty handpumps.

The training team comprised 2 maintenance engineers and 4 women mechanics in 2 teams.

The village pump maintenance system is set up as follows:

- 1 two volunteer village mechanics
- 2 Rural Council technician
- 3 NRWC Mobile Team

The village pump mechanic is supervised and supported by the village council. His/her duties are outlined as follows:

- Repair all parts of the pump;
- Replace the pump spare parts as necessary;
- Ensure that spare parts and tools are available in the village;
- Convince the people to collect money for spare parts and tools;
- Inform the Rural Council pump mechanic when there is a more complicated breakdown;
- Make sure that the pump is fenced off that the platform is well maintained and the area around the pump is clean.

Pump mechanics are trained by the NRWC and supervised by the executive officer of the rural council.

The duties of the rural council mechanic are,

- to supervise the volunteers village mechanic
- to follow up the maintenance of all handpumps and service complicated breakdowns
- distribute spare parts to all villages
- to supervise the spare parts store and fill in the spare parts price form
- to prepare monthly maintenance reports to the NRWC and the rural council officer.

The NRWC mobile team is supervised by the erection engineer and is responsible for:

- repair breakdown which are beyond the scope of the rural council mechanic;

- control the maintenance activities of the rural council mechanic and plan the maintenance system;
- order and control the spare parts for the rural councils, keeping inventories and costing;
- arrange for monthly trips for monitoring and evaluation of the systems in the area;
- write quarterly and yearly reports to the project manager and UNICEF co-ordinator.

Constraints

- lack of spare parts;
- high cost of spare parts;
- lack of transportation for moving between villages;
- no proper payments for the Rural Council Mechanic;
- no incentive for the village mechanic who may be forced to migrate in search of work;
- spare parts occasionally disappeared when handled by the volunteer village mechanics.

The following table summaries the number of mechanics trained, their locations in North Kordofan

| District | Rural Council | Mechanics trained | | No.Village |
|------------|---------------|-------------------|--------|------------|
| | | Male | Female | |
| El Obeid | El Obeid | 38 | 24 | Sababs |
| Bara | Sodari | 10 | 20 | 9 |
| El Obeid | Abu Haraz | 19 | - | 10 |
| El Obeid | Sheikan | 31 | - | 30 |
| Umm Ruwaba | El Rahad | 40 | 40 | 40 |
| El Obeid | K. Tagat | 30 | - | 20 |
| En Nahud | Abu Zabad | 46 | 34 | 40 |

4.5.2 Maintenance of Handpumps - South Kordofan

In 1979 the first boreholes were drilled by the UNICEF assisted water project (WES) in Kadugli town. The first handpumps were installed.

During the first months different handpumps were tried out such as the Duba pump, Zimbabwe pump, Nira pump and the Vergent, as well as the India Mark II. The supply of spare parts for the upkeep of the pumps was a problem. Finally the India Mark II was chosen as the most appropriate pump for the South Kordofan area.

The maintenance system for handpumps has been through different stages. In the beginning maintenance was carried out by mobile teams using mobile tripods for pulling out the pipes and pump cylinders for repair. Various other techniques and approaches were tried out in order to create an efficient system.

In 1985/86 the tools were standardized for installation and maintenance of handpumps.

4.5.3 Constraints and Maintenance Problems

Problems which have occurred over the years are the following:

1. The silting up of boreholes as a result of sandy water results in:
 - the fast wearing of the leather cups of the pump cylinder;
 - occasional reduction of the borehole depth;
 - sticking of the pump cylinder and pipes;
2. Pump parts falling into the borehole
3. Wearing out of parts e.g. leather cups, and the pump cylinder and the pump rods getting broken.
4. Inappropriate initial installation e.g. loose installation.
5. Loss of nuts and bolts.
6. Wear on the bearing.

Handpump maintenance was improved by involving the community and creating a system with the following categories of people:

1. Mechanic Caretakers (since 1988 no caretaker trained)

Two volunteers are selected from each village with handpumps for a 2 days on-the-job training course for maintaining the parts of the pump which are above the ground.

Caretakers can be men or women and the main tasks are:

- tightening the nuts and bolts;
- greasing the chain and the bearing;
- keeping the area around the handpump clean;

Problems with caretaker are:

- men leave the village in search of job opportunities
- caretakers are not trained to repair the pump below ground where most of the problems occur.
- the people are not prepared for the concept of voluntary work at village level hence there is dissatisfaction as to the working conditions.

2. Village Pump Mechanics

Village pump mechanics may also be men or women and they are selected for a 2 week on-the-job training course which includes maintenance of the pump both above and below the ground.

Problems with mechanics are:

- they also migrate in search of work as they are unpaid workers

Given this experience with the village maintenance system it was decided to advocate for community ownership of the handpump.

A 2-day workshop was held in Kadugli on the 25-26 May 1989 for officers of the Rural Council on the issue of community based maintenance. A new system was agreed whereby - 2 pump mechanics, either men or women are selected from each village and equipped with special and standard tools. They receive a 12 day on-the-job training course and are expected to deal with most aspects of handpump maintenance except with regard to:

- a) pipes and cylinders dropped in the well,
- b) occasional cleaning of the bore hole.

The community benefiting from this service pays the pump mechanic for the work on a case by case basis.

3. Pump Technicians

Two pump technicians are appointed from within each rural council to undertake a 2 month on-the-job training course on handpump maintenance. Technicians are trained to carry out repairs and to fill in monitoring forms. They are provided with tools and handpump spares for sale to the village committee.

Pump technicians are paid by the Rural Council Authorities. They are charged with reporting on the working condition of each handpump to the Rural Council.

NRWC Mobile Team

The function of this team is to visit the rural council offices in the areas where the project is operating replenishing the stocks of spare parts and tools used by the pump technicians. They also collect the monitoring forms. The function of this team is also to service the handpump in the following cases which are beyond the capacity of the village pump mechanic and technicians:

- reinstallation of the handpump (replacing concrete foundation);
- cleaning of the borehole;
- retrieval of fallen pump parts from the borehole.

The whole system for the installation of handpumps has developed since the early days of the project. There is now a better initial installation.

The final model of borehole is a much improved version including:

- improvement of the borehole design using screens where necessary;
- reinforcement of the pump platform with iron bars between apron and drain.

There is now a wide distribution of subsidized tools and spare parts are made available at cost price.

4.6 Performance

In 1988 drilling targets were surpassed for the first time in the 12 years that UNICEF water programme has been operational in Sudan. The installation of handpumps on boreholes has improved considerably, and in the Kordofan Region, of the 2,606 successful boreholes drilled, 85% have pump installed on them (Fig. 6-7).

Several factors have contributed to the unprecedented increase and high performance:

1. The concentration of drilling operation in one area. Upon completion, the entire activity is mobilized to the next area i.e. the sweep approach.
2. The introduction of production bonus payments, instead of fixed incentives, has stimulated both the increased productivity and cost effectiveness of both drilling and handpump installation operation.
3. The increased rate of successful number of boreholes, and the upgrading of skill and training of the drilling and the geophysical crews.
4. In addition, UNICEF and NRWC improved the service levels to communities by increasing the number of handpumps per person of population, i.e. 1:200. In practice, a minimum of two boreholes in any community, even when it is smaller than 200. This assured a continuous supply of borehole water.
5. Utilization of applicable technology and better suited drilling machine. It is worth noting that these achievement have been made utilizing only the airdrill "down the hole hammer" fitted with pneumatic tungsten carbide rock bit.

4.7 Transport and Equipment

The project operates a number of rigs, transport and passenger fleet, and auxilliary compressors and equipment.

The present policy of standarization of transport and equipment has not be fully implemented. The detail of the

available equipment and transport vehicles etc., and an estimated cost for implementation of the standardization approach are given in Appendix (3).

4.8 Project Management

4.8.1 Human Resources and Manpower

During the early stages of the water and sanitation programme, UNICEF, in cooperation with NRWC developed the nucleus of an infrastructure capable of expanding to meet the demand of the project.

The overall management of the project was transferred to the NRWC in 1985. The quality control of the project is presently shared between UNICEF and NRWC as depicted in the following table. Close participation and coordination is maintained, that enhances the quality control and efficiency of the operation.

The Plan of Action for 1988 tabulated the staff requirement for North Kordofan as follows:

(Table No.8 Plan of Action 1988)

| | |
|---------------------------------|-------------------|
| 1- Drilling operation | 47 persons |
| 2- Installation and maintenance | 27 persons |
| 3- Workshop store Admin. | 24 persons |
| 4- VIP latrine | 13 persons |
| Total | <hr/> 111 persons |

Similarly, the plan of action for 1989 tabulated the staff requirement for North Kordofan as follows:

(See Page 4: item 2.2 and item 2.3.)

-Staff to be provided by UNICEF

| <u>Title</u> | <u>Number</u> |
|----------------------------|---------------|
| Project coordinator | 1 |
| Mobilizer | 1 |
| Mechanical Instructor | 1 |
| Drill Instructor | 1 |
| Admin and Supply Assistant | 1 |
| Total | <hr/> 5 |

-Staff to be provided by NRWC for North Kordofan.

| <u>Title</u> | <u>Number</u> |
|----------------------------------|---------------|
| Executive Manager | 1 |
| Drillers & rig crews | 36 |
| Hydrogeologist/geophysics teams | 11 |
| Pump installation teams | 21 |
| Handpump training teams | 6 |
| Health Education team | 6 |
| VIP latrine teams | 24 |
| Workshop/store staff and drivers | 10 |
| | 94 |

The actual number, however, will be determined during the execution of the plan. A difference in the number and job description of personnel working on the North Kordofan project and South Kordofan project may be incurred resulting from execution other activities on the project(s).

4.8.2 Logistic

The following logistical supports have been operational as follows:

- 1 - Project offices in both El Obeid and Kadugli, manned by a number of qualified staff and either separated from NRWC as in El Obeid, or annexed to NRWC as in Kadugli
- 2 - Water quality Laboratories at El Obeid - Hatch Kit, and Kadugli - two Hatch Kit and two incubators for bacteriological testing are in working conditions.
- 3 - Mobile camp offices, e.g. Dabker, Dubeibat,
- 4 - Workshops at both El Obeid and Kadugli for maintenance work and vehicle repair.
- 5 - Main stores for spare parts, casing, screens, handpumps components, at El Obeid and Kadugli
- 6 - A fleet of vehicles and trucks for project personnel, equipment and material transport
- 7 - Computer facilities are established at the project offices in El Obeid and Kadugli.

Monitoring / Follow-up

A comprehensive definitions for the various constructions have been prepared for case reference as follows:

I. A Successful Borehole for Handpump

The definition of a successful borehole is:

- Deeper than 90 feet
- Final inner diameter not less than 4 inches
- Yielding more than 200 gallons per hour of sand free water at all times
- Water quality to conform to national standards
- Completely cased and screened in loose formation or casing cemented into stable formation for hard rock with open hole in stable rock. In both cases the casing is to be sealed for sanitary purpose with cement or bentonite.
- Dynamic water level pumping with 200 gallons per hour must not exceed 150 feet
- Borehole depth should not exceed 250 feet if not otherwise instructed by supervising hydrogeologist

II. A Correctly Installed Handpump

The definition of a correctly installed handpump is:

- Cylinder installed to between 75 and 155 feet
- Pedestal installed plumb, with top of legs embedded half an inch into the partially reinforced, 1x2x4 mix concrete with maximum gravel size of half an inch, cured for 7 days under one foot of soaked sand. All specification and concrete details to be as per India Mark II installation manual with the addition of reinforcement between the drain and the apron as per issued specifications.

III. A Successfully constructed Latrine

The definition of a successfully constructed latrine is:

- Circular pit with a minimum depth of 12 feet
- Maximum depth must be at least 3 feet above ground water level
- Diameter must not exceed 3 1/2 feet and should not be less than 3 feet.
- Pit should be lined with brick masonry when walls of the excavated out is unstable. This may only be necessary for the first two or three feet.
- Slab installed as per manual
- Superstructure completed with the inside being dark
- Screened vent pipe extended above the roof
- Is used by everyone in the family
- Minimum distance between latrine and handpump or other water source must be at least 150 feet

IV. A Functioning Health Committee

- Consists of 10 people, five male and five female including: traditional leaders, School teachers, health worker and pump mechanics
- Is registered with the Executive Officer
- Is trained in the use of the programme manual
- All pumps under the committee's responsibility are fenced, clean and working
- Latrines are being used and new ones are being constructed
- Waste water from the pumps is being utilized
- Has an up-to-date list of children under 1 year of age

V. A Trained Pump Mechanic

- Is certified by the project
- Is capable of repairing all aspects of the pump
- Has access to all required spare parts, special and standard tools,
- Is a member of a Health Committee

It is evident that the progress of the programme is monitored. The following monitoring survey reports for Dubeibat Town and Dilling covering the period 8-13 Nov, 89 detail the format of reporting. The frequency of the coverage and number of villagers and sites are hindered by the availability of transport. It is evident that when the drilling base camp and the crew(s) are available in one area the installations in the area are more frequently inspected and reported.

SAMPLE REPORT

Monitoring Survey Report - Dilling Town

(8-12 November, 1989)

On 8th of November, 1989 a monitoring survey programme started for the handpumps within Dilling town and continued for four days. A total of handpumps surveyed is 165.

Here below is a brief summary of the findings:-

| | | |
|-------------------------------------|---|--------------------------------|
| Number of handpumps functioning | = | 148 |
| Number of handpumps not functioning | = | 17 |
| | | ----- |
| | | 165 |
| | | |
| The percentage of that functioning | = | $\frac{148}{165} \times 100\%$ |
| | = | 89.2 % |

For more details see the table attached.

Findings

The hygienic condition of most handpumps (platform) needs improvement regarding the high ratio of platform with cracks.

The majority of these handpumps has been unfenced.

Some of the trained handpump mechanics in Dilling quarters still need to get tools and spares.

Most of quarters have tools and spares.

SAMPLE REPORT

Monitoring Survey Report - Dubeibat Town (12-13 November, 1989)

Herebelow is a result of handpumps monitoring process within Dubeibat town.

| Total of hand-pumps | Broken | Low Yield | Needs Development | Remarks |
|---------------------|--------|-----------|-------------------|---|
| 24 | 2 | 1 | - | The broken hand-pumps are one in Hubob and the other in Munara (quarters) |

| | | |
|---------------------------|---|----|
| Handpumps functioning | = | 22 |
| Handpumps not functioning | = | 04 |
| Total | = | 24 |

The percentage of that functioning = 91.7 %

It is expected that these two handpumps will be repaired within this week.

Also the hygienic condition around the handpumps is satisfactory although the pumps are not fenced.

Some of the village mechanics have no tools to work with in villages near Dubeibat, this was clear from the visit paid to some of them. Villages that need spares and tools are:

- Eradiba
- Munago Ismael
- El Shafea
- Issa

Table:

| Location | Total No. of Handpumps | Needs Development | Low yield | Broken (not functioned) |
|---------------------|------------------------|-------------------|-----------|-------------------------|
| Mattar | 13 | 2 | 2 | 1 (new) |
| Hagar El Mak | 08 | - | - | 1 |
| Gaar Hagar | 07 | - | - | 1 |
| Torag | 12 | - | - | 1 |
| Hilla Gadida | 15 | - | - | 2 |
| Teacher's Institute | 07 | - | - | 1 |
| The Market | 10 | - | - | - |
| Tomat | 10 | - | - | 1 |
| Barracks | 11 | - | - | 2 |
| Departments | 11 | - | - | 1 (hospital) |
| Agoz | 20 | - | - | 1 |
| Suffa | 04 | - | - | 1 |
| Muasin | 09 | - | - | 1 |
| Malakia | 06 | - | - | - |
| Radeef | 03 | - | - | - |
| Sangaat | 03 | - | - | 1 |
| Schools | 16 | - | - | - |
| Total | 165 | 2 | 2 | 15 |

$$2 + 2 + 15 = 19$$

The progress of the entire project is also monitored and auditing of planned viz achieved is carried out. An example of the exercise is given as follows:

Project Target Viz Achievement

| | Planned | Achievement | %Age | Remarks |
|--|---------|-------------|-------|---|
| 1. Drilling of Boreholes | 500 | 624 | 124.8 | |
| 2. Geophysical investigation | 100 | 169 | 169.0 | |
| 3. Borehole rehabilitation | 50 | 4 | 28.0 | will be met |
| 4. Handpump installation | 600 | 335 | 55.8 | |
| 5. Handpump rehabilitation & platform rehabilitation | 200 | 101 | 50.5 | |
| 6. Handpump mechanics | 260 | 178 | 68.5 | will be met |
| 7. District technicians | 5 | 5 | 100.0 | |
| 8. Boy scout training | 20 | 30 | 150.0 | |
| 9. Monitoring and survey | 5 | 3 | 60.0 | will be met |
| 10. Village Health Committee | 100 | 90 | 90.0 | will be met |
| 11. Kadugli latrines | 800 | 554 | 71.3 | |
| Dilling latrines | 500 | 569 | 110.8 | |
| Hamadi Council | 200 | 63 | 31.5 | |
| Eastern District | 1,200 | 34 | 2.8 | |
| 12. School latrines | 25 | 5 | 20.0 | |
| 13. Micro Nurseries | 10 | - | - | left for other organizations |
| 14. Staff training | 55 | 58 | 105.5 | (28 formal training 30 on the training) |
| 15. Sanitation campaign | 3 | 5 | 166.7 | |
| 16. Computer generator room and Coordinator office | 2 | 3 | 150.0 | |

Naturally, the qualifications and number of people are based on the level of expertise attained and the work load.

In a concerted effort to recognize the effect of provision - clean safe handpump water, a market improvement in the standard of living and production at the village well noticed as detailed in Chapter (7), Environmental and Social Impact.

To further the knowledge and the impact of WES on the productivity, a monitoring programme is recommended, as shown Chapter 6.5.

5.0 Sanitation and Health Education

5.1 History of the Programme

Environmental Sanitation

- The sanitation component of the project was added as an integral part of the project in 1982. During the first years promotion of sanitation and hygiene was taken up, first through village health workers and since 1985 through establishing and training of village health committees, drawing from a broader base of people to include youth leaders, teachers and village leaders.

- Latrine coverage in 1983 was reportedly only 8%. The project adopted in 1985 the Ventilated Improved Pit (VIP) latrine. To promote this type of latrine, using a reinforced concrete squatting slab and a vent pipe of P.V.C, demonstration latrines were built, first in South Kordofan in 1985 by the engineering department of the National Rural Water Corporation.

- According to the WATSAN Plan of Operations 1987-91, the GOS and UNICEF embarked upon a 3-pronged approach, in which sanitation promotion and health education activities are strongly tied to water supply activities. The objectives for the period for both health education and sanitation were stated as follows:

- (1) establishment and subsequent training of 1,120 village health committees (of which some 470 in Kordofan), each consisting of 3 men and 3 women.
- (2) production of training reference manuals.
- (3) health education in schools, teacher to school children, further to parents
- (4) construction of 1,040 demonstration latrines of VIP type, 470 of which in Kordofan.
- (5) establishment of sanitation teams, composed of engineers, technicians and village workers.
- (6) expansion of sanitation activities throughout the project area, together with governmental agencies and NGO's. From the budget sections of the Plan of Operations follows, that a composite coverage of 12,200 latrines was foreseen as target for the planning period, of which some 6,500 in the Kordofan Region.
- (7) training of local artisans in VIP construction methods
- (8) share construction tasks with the village and find joint financing arrangements with them for further VIP latrine

construction

- (9) achieve improved sanitation around handpumps: fencing and effective disposal of waste water and animal faeces
- (10) efforts towards eradication of guinea worm infestations
- (11) recording of observations and using questionnaires to analyze socio-cultural data during following exercises
- (12) evaluation of the project in Kordofan in 1987 (south) and 1988 (North)

The Plan of Operations mentions that production-bonuses will be available to increase the efficiency of all project comments.

- Sanitation promotion started in North Kordofan in 1987. Staff of the National Rural water Corporation (NRWC) were trained and 59 demonstration VIP latrines were constructed. Four (4) different squatting slabs were tested and one slab was retained, to be used in the construction of demonstration latrines in all North Kordofan

As per October 31, 1989, a total of some 4,380 VIP latrines were constructed and some 550 health committees were established and trained by the project (since 1985), spread over all 7 districts of the WATSAN-Kordofan project area.

Technical Aspects

5.2 Methodologies used and Appropriateness

Environmental Sanitation

5.2.1 Latrine design

a) Household VIP latrines

The design of the VIP latrine used in the project is as follows:

Superstructure:

Walls rectangular or circular made of sundried mud blocks with mud mortar, fired bricks with cement mortar or sticks plastered with mud and/or cowdung, similar to the local houses, depending on the choice of the owner. The design includes a 'privacy wall' inside the VIP. A door is no longer needed with this solution.

Roofing, rectangular or circular, thatched, sticks plastered with mud and/or cowdung similar to the local houses. In urban areas also zinc roof are sheet. The

inside of the superstructure should be dark. All materials are supplied by the owner.

Squatting Slab:

Two (2) unequal slabs of concrete, reinforced with 6 mm re-bar and wire mesh:

- 1.00 m x 1.00 m with drophole and foot rests
- 1.00 m x 0.50 m with ventpice hole dia 5" or 6"

These slabs are supplied by the project and are prefabricated in district level pre-fab centers.

Vent pipe

P.V.C. pipe of 3 m length dia 5" or 6", supplied by the project. Thus for the PVC pipe is imported from Europe.

Pit:

Circular, with minimum depth of 4 meters and maximum depth is 7 meters, but at least 3 feet above the highest water level. Diameter not less than 3 feet and not larger than 3 1/2 feet

First 2 of 3 feet lined with brick masonry, or to the stable stratum to prevent collapse of the pit, as the upper part of the soil is usually unstable.

The pit is dug by the owner. The mortar for the brick lining and the shedled labor for the lining is supplied by the project.

The design of the VIP latrine opted for in the project corresponds with the Plan of Operations and it has been well received by the beneficiary population. Some constraints were met in South Kordofan, for the purchase of red bricks, recommended by the project.

The construction of the slabs of double reinforced concrete (re-bar and wire mesh) and the provision of PVC pipes for the vent pipes on its own represents a major operation, but goes along relatively easily with the cost-intensive drilling programme. It is therefore likely, that the operation from the project side will continue smoothly.

From economical point of view and for sustainability of latrine construction, it is, however desirable to continue considering alternative designs, as also is indicated as an objective in the Plan of Operations.

In this context it is interesting to note that during a briefing at the MOH in El Obeid, the regional public health inspector indicated that the ministry organized in 1985 a workshop for 16 health workers in the Rahad Rural Council in the context of the Rural Health support Project, funded by USAID. The participants at this workshop were reportedly trained in the construction of VIP latrines, with the use of only local materials. For the squatting slab wood was used, brought in from other areas and sticks, plastered with mud were used for vent pipe construction. The total cost was calculated in 1987 at Sudanese LS. 500. Few latrines of this type were built, but the initiative aimed at the promotion of latrine construction. Ten similar workshops were planned to train health workers in other areas, who in turn would train village health workers. The project was, however, discontinued.

More efforts should be done in experimenting with different designs. The following experiments are suggested:

1 - Brick lining of the upper part of the pit:

The fired, red bricks could probably, without any difficulty, be replaced by sun dried mud bricks, while the mortar could be of mud.

2 - Vent pipe of ceramic pipe

Local artisans make ceramic pots of good quality. Clay is available and kilns are already used for fire bricks. Certainly appropriate forms for pipe requests of one to several feet are required, and techniques have to be acquired.

3 - Vents pipes of locally manufactured PVC pipes (Khartoum or later El Obeid)

The project already made investigations towards the possibility of local ordering of PVC pipes for both borehole drilling and latrines construction. So far this did not materialize, because the manufacturers consider the amount of pipe needed too small to start production. However, it is important to follow the developments in this sector, so that, on the long term, the sustainability of the project will be served.

Also the possibility of a government joint-venture with the private sector for the production of PVC pipes in El Obeid could be explored. Raw materials could be supplied by UNICEF, as is done already in several countries.

For vent pipes also 4" pipe can be used, instead of 5" pipe used so far. The project management already decided on making

meters. The compartments can be emptied. The contents can be used as compost, but the important factor is that the superstructure remains and the economic lifetime of the latrines is on the order of 30 years.

Other cost savings can be made by applying ferrocement. The amount of cement needed will be reduced considerably, probably on the order of 30-40%. Both the lining of the pit and the brick walls of the superstructure can be built of ferrocement.

Ferrocement VIP school latrine blocks have been successfully built in Nepal, Burundi and Rwanda. More information can be obtained from the UNICEF offices in these countries.

5.2.2 Procedure for household latrine construction

The approach used by the project is to:

1) link the construction of VIP latrines to the water supply component. This linkage has taken different forms. In villages where handpumps are already installed health committees are established and the latrine construction component is added. In villages where the drilling still has to start up, the village health committees are established some time in advance and villagers are told that the drilling will start when the latrines are all completed, and to

2) complete one village with latrines before works in the next village are started up. The approach follows the approach adopted for drilling and it is applied for entire rural councils and districts as well.

The project has instituted a step-wise implementation for village-wide household latrine construction. The following steps were identified:

Step 1. Village health committee establishment and training by project health education/social mobilization team. Following the selection of the village in the borehole programme

Step 2. Siting of the latrines by the NRWC project engineer and the provincial or local health inspector.

Step 3. Digging of the first 2 or 3 foot of the latrine pit by the home owner

Step 4. Lining of the top section of the pit by the NRWC sanitation team. Bricks are supplied by the house owner, cement mortar is supplied by the project

Step 5. Digging of the latrine pit by the home owner to required depth (4-7) meters, but 1 m above highest ground the water table)

Step 6. Installation of concrete slabs, cementing 2 slabs together and cementing of vert pipe in slab by the project (sanitation team)

Step 7. Construction of the superstructure by the home owner

Step 8. Inspection by the project (In North Kordofan: payment of Sud. LS.250 subsidy to home owner, provided by the EEC).

5.2.3 Household latrine promotion

The project concept used is to make use of as many ways of promotion of health messages as possible. The project has been very successful in this, as health messages, including sanitation promotion, are disseminated through:

- a comprehensive, simple, manual complete with images depicting, among others, sanitation messages covering all relevant phases of V.I.P. latrine pit construction, installation of the squatting slab and ventpipe, construction of the superstructure and the use and maintenance of the latrine.
- the establishment of village health committees, to be composed of 5 men and 5 women, taken from a broad base of people in the village and training of these health committees, among others, in all sanitation messages.
- dissemination of health messages through the Kordofan regional radio, 15 minutes, twice a week.
- including health messages, and sanitation promotion in curricula of youth groups, boy scout training camps, nutrition courses for women and some schools
- Construction of demonstration VIP latrines.

It is evident that the promotion of VIP latrines has been very successful. The establishment of village health committees and the preparation of the reference training manual ensure the continuation of the process.

The claims by villages, for VIP latrines, not even served by the water component of the project, show that the radio broadcasting and the mouth - to - mouth passing on of the health education messages are effective.

The good impact of the VIP promotion must be attributed to the good management of the programme, the receptiveness of the authorities and the population to follow-up on the messages, the fact that the demonstration latrines conform to the pretenses that they virtually do not smell and are fly-free.

One effect of the successful marketing for VIP latrines is that a demand is created, that cannot immediately be satisfied. The construction programme is slower than the promotion. In this phase the project should seek to promote a greater degree of self-help. Local production of squatting covers, vent pipes and lining of the pit with exclusively local materials should, where possible, be encouraged. Experimentation should therefore be stated up with speed.

5.2.4 Guinea Worm Disease

Guinea worm disease prevalent in South eastern Kordofan. Handpumps have already been installed in certain villages, and tapping of drinking water from handpumps has been promoted in favor of water from surface water (hafirss) and dug pits in the river beds, which are infected by Guinea worm.

Due to the insecurity situation, caused by the civil war, these areas can no longer be reached, other than by Kordofan radio. Many people are leaving the area and move towards the North.

In the new edition of the training manual, messages towards the reduction of drinking with Guinea Worm polluted water are incorporated. These actions are all what can be done under the present circumstances and they are considered adequate.

5.1.5 Fencing of handpumps and disposal of waste water and animal faeces

The concept of the project is that the village should assure cleanliness around the handpump.

Through the training of 10 volunteers, appointed by the village council in the village health committee during a 10-day intensive course and the distribution of the reference training manual to the village leaders and the VHC members, the motion of hygiene and sanitation are passed on the villages. Furthermore health messages are disseminated by the project through the Kordofan radio.

- Fencing of the handpump area

No data are kept by the project on the effective fencing of the handpump area.

During the evaluation mission field visits, the team observed that in the rural areas about 80% of the handpumps seen were fenced, by branches of thorn trees. The project promotes the planing of life hedges. Effort to this send were observed, and about 20-30% of the hedges had small life fences, planted to ultimately replace the branches of thorn trees. The fenced handpumps effectively kept livestock away from the

pumps platform area.

In the urban centres (Dilling, Kadugli, Hamadi), only about 50% of the handpumps were fenced.

-Disposal of waste water and animal faeces

All handpumps create excess water and waste water is drained away from the pump by a concrete drain of 2-3 water length.

The project promotes the reuse of the waste water from the handpumps to supply water to a vegetable garden and mini-tree nurseries directly adjacent to the handpump drain. In the Plan of Action 1988 for South Kordofan the objective was set for the creation of 50 of such tree nurseries and for 1989 a total of 10 was set. A few of such tree nurseries were inspected. The number of tree nurseries built is not known to the evaluators. The Nuba Mountain Rural Development Project followed up in some cases. In a few cases it was observed that the project provided a brick-lined pit to collect the excess water to facilitate watering the plants.

Few handpumps, (less than 10%) however, were observed to have adjacent gardens or tree nurseries, and waste water was creating pools of standing water in places where the water would not drain.

As most households keep and heads of livestock, the pools are considered useful to water these animals. In a few cases especially in the urban areas it was observed, that special pits were dug to serve as watering holes for goats, sheep, donkeys, and camels. The accumulation of animal faeces is then unavoidable around these handpumps.

Promotion is, however, done to water the animals some distance away from the handpump, but this seems to be too cumbersome for the people.

The observation that some 80% of the handpumps in the rural areas are fenced, is an indication that the health education messages are successfully passed on to the villagers, who are the owners of the handpumps. More gardens could be created, and this should still be further promoted.

The low percentage of fences in urban centers is attributed to the presence of the administration in the town. The explanation given was that there is a stronger feeling in the towns, that the government should take care of the streets. Further promotion to health committees in the urban centres is desirable on this issue.

HEALTH EDUCATION

5.2.5 Contents and Procedure

The health education teams (2 in each province composed of 1 man and 2 women each) are basically responsible for organizing the community to participate in the new WATSAN activities.

The most important tool used is to establish village health committees (VHC). These are established and subsequently trained according to the following 3 step procedure:

- 1- Health education team contacts the village leadership and invites the community through their leaders, to elect from amongst themselves 10 persons, 5 men and 5 women who are influential in the village.
- 2- Village elects the health committee members among which the 2 village pump mechanics.
- 3- Health education team shows during the course video films on hygiene, sanitation, diarrheal diseases and control, vaccination and oral rehydration therapy. For this purpose a video and t.v. and a generator set is available. All villagers are invited and can see the films. Text so far is only in English, but translation is given.

The health education team includes health education in the training of handpump mechanics.

As long as the borehole drilling, pump installation and VIP latrine construction goes on, the VHC's are active. Refresher courses after one year or maximum two would reactivate the committees again.

5. 2.6 Institutional set-up

The project is functioning as a combined NRWC/Ministry of Health/UNICEF operation. The main management is ensured by the NRWC executive manager in each of the Provinces, seconded by the UNICEF Project Coordinator.

For the health education and sanitation components the Ministry of Health has assigned social mobilizers to ensure the coordination of the health educations teaching. The teams therefore, 2 in each of the 2 provinces, (4 in total) are also staffed by MOH health educators (1 man, 2 women) (in each team)

In total 12 health educator are at the moment ensuring the health education activities in the field.

UNICEF has appointed the health, education/sanitation activities one national social mobilization officer (in each province) to assist the Ministry of Health and the NRWC sanitation section.

Transportation is assured by one vehicle (Landrover 110) for each health education/social mobilization team, in South-Kordofan. In North Kordofan the two teams share one vehicle. (Toyota LC)

The sanitation activities, notably the VIP installation activities, are coordinated by the NWRC engineering departments in the two provinces. Two (2) teams work in each of the two (2) provinces. They are staffed by the NWRC. The composition of the teams is as follows:

Composition of VIP Installation teams

| | | |
|-----------------------|------|-----------------------|
| Engineer (Supervisor) | 1 | |
| Team leader | 1 | |
| Skilled labourers | 2 |) Total 11-13 members |
| Casual (labourers | 5-7) | per team |
| Drivers | 2 | |

In total 46 NWRC staff in 4 teams ensure the V.I.P installation activities in the field in the whole Kordofan.

The coordination between the ministries involved in the water supply and construction, (for VIP construction) and health (for sanitation and hygiene promotion) is most successfully achieved in the Kordofan WATSAN project. This is most clearly seen on the provincial level where professional staff of both ministries occupy the same office space and join in the team outreach to the population.

As a result of the successful promotion drives spreading health education messages, training of handpump mechanics and villagers in health education alongside the construction of VIP latrines and other sanitation promoting activities, such as fencing the hand pumps has brought the so important of water and sanitation to the district, rural council village and household level.

As the project continues, efforts could be made to strengthen the WATSAN coordination on all administrative levels to include the ministry of education, as the ministry and its network has an important role in constructing school latrines and teaching health education.

It is clear that the availability of Government Staff notably NRWC personnel to the project, has allowed the project to expand rapidly. The priority the NRWC and the MOH has given to the project is evident and this fact has greatly contributed to the success of the project.

5.1.7 Performance

Much has been achieved since the sanitation activities were started up both in terms of establishment of health committees, and the subsequent training of the members in terms of promotion and construction of VIP latrines and in the preparation and distribution of reference training manuals.

The numerical achievements to date against targets have been summarized in Tables 2 and 3:

Number of Health Committees:

| | PLANNED | | | ACTUAL | | |
|-----------|----------------------------|-------|-------|----------------------------|-------|-------|
| | North (K-O-R-D-O-F-A-N) | South | Total | North (K-O-R-D-O-F-A-N) | South | Total |
| 1987 | - | - | - | 67 | 84 | 151 |
| 1988 | 200 | 100 | 300 | 121 | 88 | 209 |
| 1989 | 300 | 100 | 400 | 101 | 90 | 191 |
| SUB TOTAL | 500 | 200 | 700 | 289 | 262 | 551 |

TOTAL PLANNED END 1987-1991 470

*No Plans of Action were made for 1987

TOTAL including provision
for Southern Sudan: 770**

In addition 5 school latrines have been built in S. Kordofan, and 6 other are being built in North Kordofan.

Table 3: Summary of targets and actual establishment and training of village health committees in North and South Kordofan

Note: As civil war in Southern Sudan limits substantially the provision of assistance, planned for this region, allocations for Southern Sudan could possibly be applied for Kordofan.

The implementation rate compared to the target for the period 1987-1989 is: 78%.

Number of VIP Latrines:

| | PLANNED | | | ACTUAL | | |
|----------------------|-------------------|-------------------|-------|-------------------|-------------------|-------|
| | North Kordofan | South Kordofan | Total | North Kordofan | South Kordofan | Total |
| 1985 | | (900) | 900 | - | 12 | 12 |
| 1986 | | (900) | 900 | - | 616 | 616 |
| SUB-TOTAL | | 1,800 | 1,800 | | 628 | 628 |
| 1987 | | 900 | 900 | 59 | 464 | 523 |
| 1988 | 1,200 | 1,800 | 3,000 | 481 | 791 | 1,272 |
| 1989 | 1,200 | 2,700 | 3,900 | 1,049 | 909 | 1,958 |
| SUB-TOTAL 1989-1991: | | | 7,800 | 1,589 | 2,164 | 3,753 |
| TOTAL since 1985 | | | 9,600 | 1,589 | 2,792 | 4,381 |
| TOTAL 1987-1991: | | | 6,470 | | | |
| TOTAL 1987-1991 | | | | | | |

(TOTAL including provision for Southern Sudan: 11,720)

The implementation rate, compared to the target for the period 1987-1989 is: 48%.

Table 3. Summary of targets and actual construction of VIP latrines in North and South Kordofan

The results of inspection of VIP latrines during the evaluation is given in Table (4).

5.2.8 Cost and cost-sharing

The model of VIP latrine, that the project is using requires contributions from the house-owner, the Sudanese government (water corporation and ministry of Health) and UNICEF.

The cost to the house owner varies, at the moment, from Sudanese Ls.320 (lowest cost of pit digging, and superstructure was calculated at LS. 570, whereas in North Kordofan the EEC pays a subsidy of LS. 250 for each completed VIP latrine) to Ls.3200 (pit digging and superstructure of brick wall with zinc roofing and (ref. field report from Kordofan staff July '87), calculated without EEC subsidy. (Situation to date in South Kordofan).

Table (4)

OVERVIEW OF INSPECTION OF VIP LATRINES IN KORDOFAN
19-26 NOVEMBER 1989

| District | Rural Council | Village | Completed | VIP Latrines Inspected | | Used by Population | Clean | Under Construction | Remarks |
|----------------|---------------|------------------|-----------|-------------------------------------|-------------|--------------------|-------|--------------------|------------------------------|
| | | | | Faulty Super structure of vent-pipe | Collapse | | | | |
| North Kordofan | | | | | | | | | |
| El Obeid | :Sheiken | :Tineid/Kazgeit | 5 | - | | 5 | 5 | | - |
| | | :Ka'ida | 8 | 1 | :4 (school) | 4 | 8 | | :Roof blown off by wind |
| En Nuhud | :Abu Zabad | :Far Tan Gouf | 3 | - | - | 3 | 3 | | - |
| | | :Jantou El Bahri | 6 | - | - | 6 | 6 | 3 | :No super structure |
| | | | 3 | - | 1 | 2 | | 2 | :built in storm water course |
| Um Kusba | :El Rahad | :Nuwa Anadsaba | 2 (USAID) | - | - | 2 | 2 | | |
| | | | 4 | - | - | 4 | 4 | | |

Table (4) (cont'd)

| District | Rural Council | Village | Completed | VIP Latrines Inspected Faulty Super structure of vent-pipe | Collapse | Used by Population | Clean | Under Con- struction | Remarks |
|----------------|---------------|--------------------|--------------|---|----------|-----------------------|-------|-------------------------|---|
| South Kordofan | | | | | | | | | |
| Dilling | :Hamachi | :Awlad Musa | : - | : - | : - | : - | : - | : - | :4 pits being dug |
| Dilling | :Dubeibat | :Dubeibat | : 1 | : - | : - | : - | : - | : - | : - |
| Dilling | | :Dilling | : 1 | : - | : - | : 1 | : 0 | : - | :Pit filled to :capacity, many :files |
| Kadugli | | :Dana | : 2 | : - | : - | : 2 | : 2 | : - | : - |
| Kadugli | | :Kadugli | | | | | | | |
| | | :-- Al Koz | : 8 | : 4 | : - | : 8 | : 8 | : 2 | :No roofs |
| | | :-- Radeef quarter | : 4 (school | : - | : - | : 4 | : 2 | : - | :Screen Tom :--faeces around : one school |
| | | | : latrines): | | | | | | :--Ashes for cleaning |
| Kadugli | | :Murta | : 2 | : - | : - | : 2 | : 2 | : 3 | : - |
| Kadugli | | :Kulba | : - | : - | : - | : - | : - | : 4 | :Pits lined and being :deepened rectangular :form |
| | | | | | | | | | |
| | | | : 49 | : 5 | : 5 | : 47 | : 44 | : 14 | |

The cost to the project participants, water corporation, ministry of health and UNICEF was calculated at US\$116 for 1988 activities in South Kordofan (output some 800 latrines in that year) and at US\$ 152 per latrine (in North Kordofan output 500 latrines that year.)

Assuming as coverage contribution of US\$ 134 to the homeowner portion to US dollars: Sud Pounds 600 = US\$ 133, the total cost of the latrine comes to US\$ 267.

A further splitting up of the contribution of UNICEF and the Government of Sudan gives the following percentual contributions:

| Contributing Party | Cost of simple VIP Latrine | Percentual Contribution |
|---------------------------------------|-------------------------------|----------------------------|
| Government of Sudan (NRWC and MOH) | US\$ 62 | 23% |
| UNICEF | US\$ 72 | 27% |
| Homeowner | US\$ 133 | 50% |
| | US\$ 267 | |

The cost breakdown exercise shows that the homeowner portion equals at least 50% of the total cost.

6.0 Linkages of the UNICEF-assisted Water Supply, Sanitation and Health Education Projects (WES) with other child survival and development activities

6.1 Introduction

In 1982 a UNICEF-supported workshop was held in Kadugli entitled Environment, Sanitation and Water related diseases. The outcome of the workshop lead to the addition of environmental sanitation and health education components to all UNICEF-assisted water project, now known as WES. Environmental sanitation and health education has implications to the health and the development of the population (especially of children). There are further activities from different sites - from government institutions in Sudan, but also from organizations from abroad - which directly and indirectly support the WES-project related activities. It is a positive sign of WES that there are several further activities which try to link those together.

6.2 Activities in the South-Kordofan-Project

The WES-Project work is directly linked with the Ministry of Health regarding the project programmes in the sanitation and the health education sessions, which were described elsewhere in this report. The further cooperation with other institutions will be described in the following.

6.2.1 Health Activities

The Ministry of Health is linked to the WES-project in further different ways. The public health sector has to look to waste disposal, control of market, house visits, etc., but due to lack of funds and equipment the functions are fulfilled only at a low level. The bad control of waste disposal in Kadugli Town was obviously. There is lack of transport, only one tractor and one car is available, which has also to carry the water for slaughter house. It is proposed to introduce donkey carts as a cheap alternative for these purposes. One cart cost about 7000 LS and a donkey 1000 LS.

The Ministry of Health is also responsible for collecting health data, which would be valuable for monitoring the progress of the WES-project. In their objectives, stated in the "Plan of Operations", a reduction of communicable and especially water-borne diseases (e.g. diarrhoe) should be achieved. In reality there is a lack of data. The collected data on several levels, even at village levels public health posts are supposed to give monthly reports, are not properly processed to be useful for monitoring aspects. According the given statements in most cases that after water introduction a reduction in some disease are observed, e.g. often reductions in diarrhoe incidence were

mentioned, but no "hard" data are available which would prove this progress. Examples for the collected data on morbidity data at village levels and their trends are shown in Fig. 8-10. Some of them seem to indicate impressive improvements, but this data are not controlled and the results have to be taken very carefully. They cannot prove the positive influence of the program, but they give positive indication.

6.2.2 Educational Activities

There are linkages to activities of the Ministry of Education. Some brief training sessions on health education were done in several primary schools, main emphasis is put on topics regarding VIP-latrines functioning and using, and fencing the handpump area. Similar training in health education is done with boy scouts group in the towns (Dilling and Kadugli).

The main cooperation with the Ministry of Education is done together with the School Garden and Nutrition Education Department, which is involved in another UNICEF-assisted project not being part of the WES-project. There are 3 months courses for women on nutrition education. In 4 years 1300 women were trained in Kadugli (by 5 staff members) and 3000 in the province (by 11 staff members).

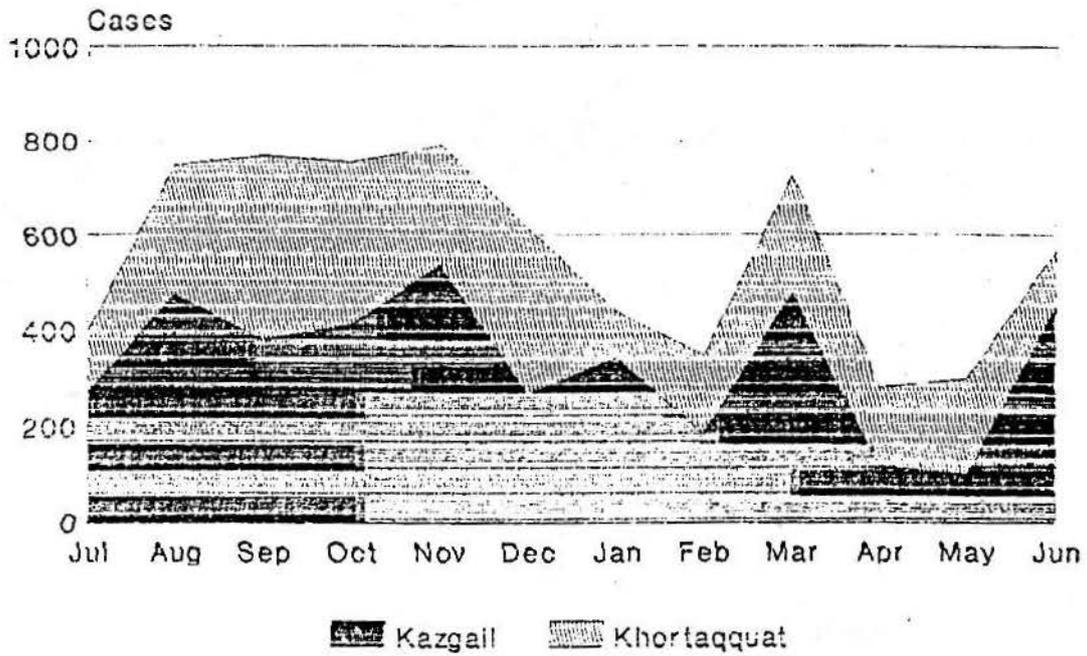
The courses are run in groups of 25 women, who living for that time a center. Due to the civil war situation in the moment there are only course in Kadugli. For married women obviously there are difficulties for them to participate, the time constraint is especially important. Nevertheless their seems to be a high motivation since many can manage to overcome the problems.

The content of the education and training courses include the following topics: infant feeding, nutrition of pregnant and lactating women, use of fuel for cooking, reforestation, gardening, use of sheep milk, egg from chicken, food storage, hygiene, clean water usage, growth monitoring of children, immunization, diarrhoe (ORS), handicraft and cloth making (sewing). As teaching aids there is a wide variety used, e.g. flannel graph, video and playing drama (theater, e.g. the use of ORS was presented us in this form during our visit).

6.2.3 Agricultural Activities

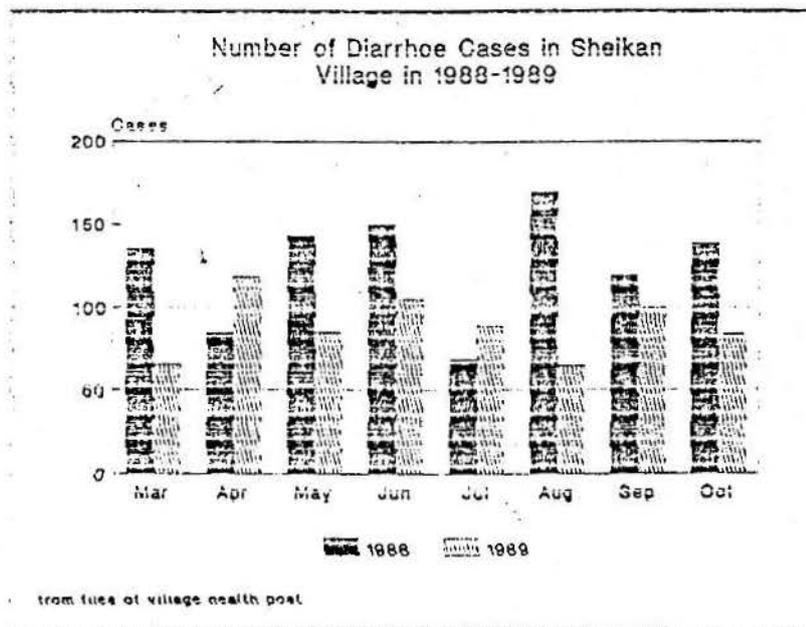
A special links to the Ministry of Agriculture is given by the Nuba Mountain Rural Development Project) (NMRDP). The NMRDP was established in 1980, it is a EEC-supported project. The basic aims of NMRDP are to increase the food security and the standard of living of rural households in South Kordofan. The project has the head quarter in Kadugli and 4 subcenters in Kadugli, Umm Serdibba, Sunjukai and Dabkar. In the Extension and Training section of the NMRDP there is a community development section, which is further subdivided in micro-projects and women programs. Emphasis is on active participation and on the self-help approach.

Number of Cases of Diarrhoe in
Kazgail and Khortaqqat (Sheikan)
between July 1988 and June 1989



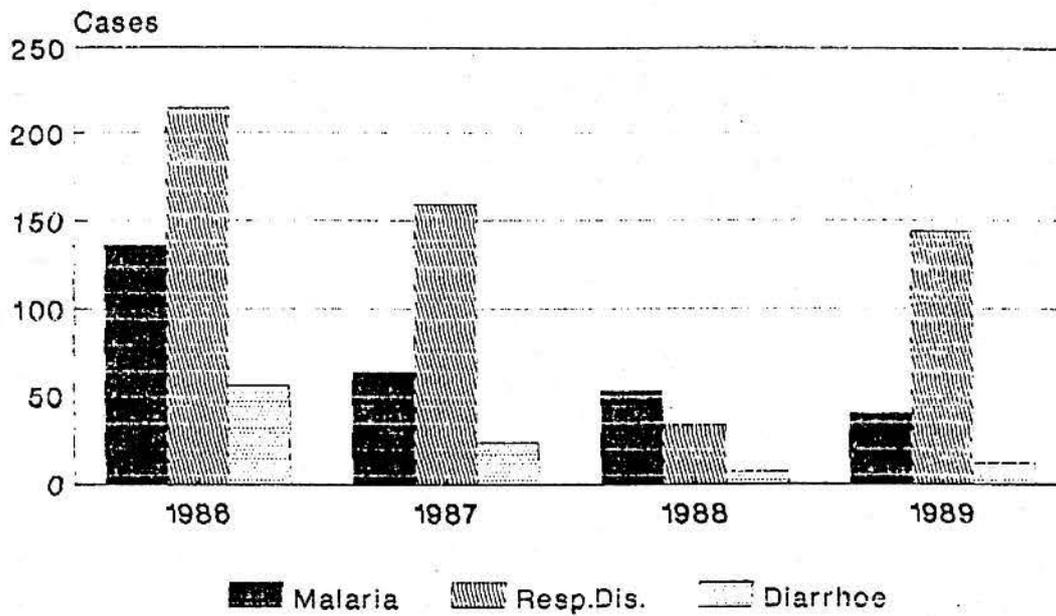
from file of village health post

Fig. (9)



from files of village health post

Incidence of selected environmental diseases in Tumaid Village/N.Kordofan in one month, selected March, dry season



Files of the Health Aselstant Worker

The women programs started with a Kordofan Rural Women's Conference in Dilling, over 200 women attended this meeting in April 1989. The activities of different government departments and of the different Non Government Organizations (NGOs) in community development, women activities and health should be coordinated. Therefore programs in preventive health care for women and children were planned together with WES-UNICEF in Kadugli and the EPI (immunization) in Dilling. (in connection with the immunization team, organizing travel together with team, health education of mothers, who are waiting with their children)

There were two women courses (3 months duration) on topics of horticulture, gardening, health education, etc.

10 micro nursery projects (tree nursery, fruit trees <e.g. mango>, live fencing) were completed in 1989.

Beside this more formal links there are in the WES-projects some more informal horticultural "micro projects", like vegetable gardens and school gardens in some cases next to handpump.

6.3 Activities in the North-Kordofan-Project

Since 1987 the WES-North Kordofan-Project has combined with their other activities a health education component. The aim was to raise the awareness of villagers on health matters and spread simple health messages. The program was implemented by Ministry of Health staff. The main task was to train the village health committee members (ref. other chapter). UNICEF assisted in providing audio visual aids and transport, and pays a bonus to the staff.

Further social mobilization activities supplemented the WES-project.

6.3.1 Health Activities

On different further sites there are more links to the Ministry of Health.

The nutritionist within the Ministry of Health runs in coordination with WES-project courses on nutrition education for women. The project is preparing nutrition education materials, like flip charts, pictures, video and slides. The project is at an initial stage and receives assistance from USAID (diet survey) and UNICEF (health section). There are given nutritional guidelines within health education, including growth (monitoring) of children, but main priority of mothers - is water. Water is the main nutrient.

In addition there is cooperation with health posts and village health workers in different ways, as membership in village health committee, immunization program, distribution of ORS-solution (in the moment there is no supply and there are at village level almost no drugs <e.g. against malaria, often mentioned as the most important disease>). The EPI (extended program on immunization) is a further site for cooperation. There are some

health statistics collected, e.g. monthly reports, but they are of limited value (ref. the same section for the WES-Project in South Kordofan).

The cooperation with public health officers in North Kordofan is similar to those described for South Kordofan, being siting and inspection of VIP-latrines. There are obviously problems in supervision, the main reason given lack of transport, there are no cars. The control of leakage water at the handpumps was in several cases not properly. There is almost no proper waste disposal, especially in towns.

The UNICEF-programme of Zonal Development, which is in close cooperation with the Ministry of Finance & Economy, Department of Planning & Economics with its objectives:

- development of the social sector,
- improve the delivery of the social services,
- increase the awareness by regional and local officials of the special needs of children and women,
- strengthen coordination between different departments,
- promote monitoring and evaluation shows links to the WES-project.

There are women's development programmes in three districts of South Kordofan (Dilling, Bara, Obeid). Their targets are increase of households' food security and income generation among rural women. The range of activities covered include:

- Jubraka (home gardening)
- rain-fed agriculture
- small scale irrigation agriculture
- cheese-making
- grain stores
- women's woodlots (tree nursery)
- bee-keeping

The cooperation between UNICEF and the Ministry of Finance & Economy resulted in provision of finance for the VIP-latrines from the EEC. The EEC micro-project program is run through the department and part of the funds was allocated to VIP-latrines in three rural councils (Sheikan, Abu Zabad, Elrahad). Up to now 1405 VIP-latrines were installed within this program. The EEC fund up to now disbursed amounts to LS 635.000.

Further coordinations with the Ministry of Finance & Economy, especially regarding the water program, should be encouraged.

6.3.2 Educational Activities

The youth training center within the Ministry of Youth and Sports started in 1973 a program of training courses in boys scout camps (12 days duration), which is a kind of literacy program, but also contains component of health education. There are further adult education programs, including 6 months courses for women in handicrafts and health and nutrition education, which include topics like sanitation, hygiene and diarrhoea treatment (ORS), and

uses different teaching aids, like playing small drama. The target groups are the poor, the illiterate, school droppers and displaced adolescence. The team has 39 trainers. Some activities are jointly done with WES-program. For handicrafts there was some support given by UNICEF, like sewing machines and equipment for leather work. Till now there are 200 participants.

Twice a week there is a health education program broadcasted at Radio Kordofan (Tuesday, Saturday, 4,30 p.m., for 15 minutes). The series of radio programs were planned by the Regional Ministry of Health, the Department of Culture and Information and UNICEF. It was started in 1988 and up to now 88 different programs were produced, there are several times repeated. About 35 of them are WES-UNICEF-related (e.g. parts of waterpump manual, function of village health committee, water storage, water related diseases, control of diarrhoe, VIP-latrine, garbage disposal).

The program shows good acceptance, an indication for this that it was never changed, despite the fact, that Radio Kordofan changes the program schedules every three months. Radio Kordofan receives letters from villages asking for receiving UNICEF-support (handpump). The coverage is difficult to assess. Every time we asked in villages during the field visit for this program, the people in whole Kordofan were aware of the program, were listening to it. There are obviously enough transistor receiver in the villages, but in the moment there are problems with the supply of batteries in Sudan.

The cost for the program is rather cheap. Two people produce the entire health program; they face problems with their simple equipment. They are in need of more batteries, cassettes and better recorder equipment. The total cost of the radio program to UNICEF in 1988 was \$ 5.500.

In addition Radio Kordofan has in normal program reports on UNICEF activities in general.

6.3.3 Agricultural Activities

In linkage to the WES-Project one can find in the vicinity of handpumps some vegetable gardens and some school gardens, as well some tree nurseries and some trials for making live fence and shadow trees in schools could be observed.

6.4 Conclusions

In conclusion the WES-Project is concentrating on its main aim, providing the people of Kordofan with water. Giving people water is not only a social service, good and safe "water is life" (the arabic name given to the Indian Mark II handpump is "Hayati", which means "my life"). Water is an important prerequisite to achieve good health conditions and its effects are increased if aspects of hygiene and sanitation are considered, the WES-Project

recognizes them. But water can be used in many different ways and for several purposes. Providing people with water has influence on the development of the community, giving water has economic implications.

Providing water and sanitation facilities mean for a successful project to acknowledge the technical expertise, e.g. to site properly the drilling for water, to use the appropriate equipment, to select a durable, easy to maintain handpump or to construct sustainable slabs for the VIP-latrines. In managing the technical site of such projects, it is not unlikely to neglect the human site. The final aim of all development project to give the population and the community a chance for a better development, can be achieved only by a proper use of the offered goods - water and sanitation (VIP-latrines). Education and training of people is necessary. The people themselves have to use their chances, have to use the water and the latrines. The WES-project is recognizing that in having emphasis on introducing village health committees, as cores for different selfhelp activities, like handpump maintenance and public health control. Since there are so many possibilities to use water (as food, personal hygiene, washing clothes, feeding animals, brick making, irrigation of vegetable, trees, etc.), many further project parts could be included. There is the danger to "concentrate" at one place - at few villages - to show all possibilities of water usages and forget to expand the program for the advantage of more people. As more complex a project is, as more difficult it is to manage, the slower is the extension process.

The WES-project has found a good compromise. It is concentrating on a package of water, VIP-latrines and health education, but indicating by using occasional linkages as described in this chapter the further possibilities of the given implements. The additional "micro-projects" should be regarded as kinds of pilot projects. The villagers themselves in cooperation with other institutions and organizations should make better use of the given water.

The idea to introduce package programs in the villages (water + sanitation <VIP-latrines, village health committee, health education> + even community development activities <horticulture, handicrafts, etc.> is appreciated. The aim to organize water supply and sanitation (or even further activities) in a similar time frame seems to be unrealistic. The supply of water as such is a technical matter and can be managed in that way. The proper usage of water and sanitation facilities, health education and community development are to handle in a quite different way. The progress in drilling successful boreholes and installation handpumps can be organized rather efficient as the WES-Project evidently managed to do. This "speed" can not be maintained regarding the installation of VIP-latrines. They should be installed by selfhelp. This cannot be managed and executed technically. The VIP will be constructed on a individually basis. That means their are individual readiness and time schedules for the necessary means, e.g. digging after time of harvest, saving

money for buying bricks, etc. Each village and their villagers have their own character and thus their own "speed" of approaching the different tasks. Waiting until the "whole package" is achieved would mean other villages would have to wait unnecessary long until they receive their water and their impacts for their own development. So it should be seriously considered to loosen the tights between the water and the sanitation parts of the WES-Project. Water extension can extend more rapidly, the sanitation and health education should concentrate on the establishment of the village health committee in this respect including some demonstration VIP-latrines, but not necessarily stick to the aim of a complete VIP coverage within the time frame given by handpump installation.

6.5 Monitoring

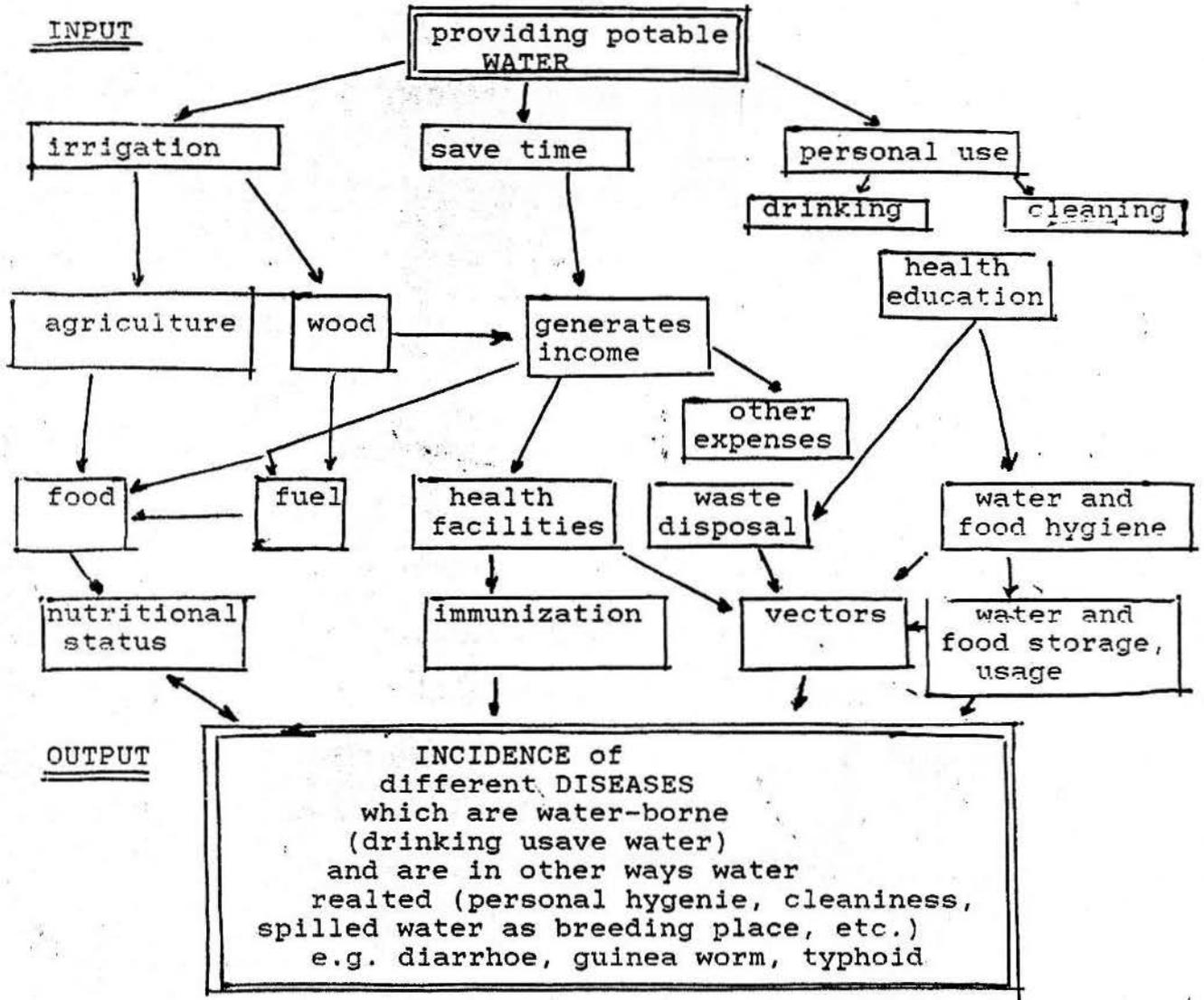
The main aim - better development of the population - can be observed in many different ways. The WES-project has a set of objectives which include monitoring and evaluation of the project beyond simple counting the constructed handpumps and latrines including the cost effectiveness of them. The health situation of the population should be improved by those measurements, the incidence of water-borne diseases (like diarrhoe) should be decreased.

In the project there are data available for the technical project progress. The progress in health is difficult to evaluate. There are no baseline data available. The effects of water on health are working within complex models (Fig. 11) and it takes time till the effects can be measured. There are many thorough scientific studies on the effects of water and sanitation projects, which quite different results (based on the complexity of the epidemiological models and methodological problems). One cannot expect from a project to implement such scientific evaluations, it would simple not be appropriate for the given situation. But neglecting any kind of monitoring and evaluation is also inappropriate.

There are on different sites of the WES-Projects and in villages several datas and information scattered. Some health posts and many dispensaries are collecting data, which are available, but not used. In some places there is growth monitoring of children. For siting the handpumps there is needed information on the village population, the immunization program need figures on the infants in a village. It would be wise to collect all this data in a village. It is recommended that the village health committee keeps a village data file on relevant aspects of community life, like:

- population - number, male, female, children, infants
- diseases
- condition of handpump and VIP-latrines
- harvest, food storage, etc.

Sketch of an epidemiological model of the complex influences of water onto the health of a population



ref: own model, OLTERS DORF Dec.1989

This has to be supplemented with teaching some simple evaluating techniques, showing them how to use such informations. It is recommended to use for that purpose techniques which are described in the book:

M.- T. Feuerstein: Partners in Evaluation - Evaluating Development and Community Programmes with Participants. Macmillan, TALC, London, St. Albans, 1986 (ISBN 0-333-42261-9)

7.0 Environmental and Socio-Economic Impact

7.1 Introduction

It is evident that the environmental issue of sustainability in a process of development in ecologically marginal and semi-marginal areas is becoming a challenging concern. WES provides a typical example of an integrated venture that has important impact at the micro-environmental level. The ecological vulnerability of Kordofan as an extension to the sahelin region, makes environmental assessment of any programme focused on the natural resource base, a vital matter. Sustainability of such project is closely interlinked with its environmental complexity in execution, monitoring, follow-up and side effects and production system.

WES is functioning in a large ecological area of variable local resource potentials, but still within a broad and ecologically delicately balanced environment (see background) section Under such conditions of the fragile environment of Kordofan subjected to successive drought years and desertification associated with both climatic conditions and human use of the resource base, environmental impact assessment is vital for any rural development ventures of WES nature.

Environment as a complex system and dynamic, needs a longer time and close look to assess and monitor resultant changes. WES spatial coverage, integrated system of standard component provides less difficulty to look into its environmental impact. The "Environmental Impact Assessment of UNICEF's Hand Pump and Sanitation Programme in Kordofan" 1989, (EAPK) will be taken as a broad base-line for this account.

Accordingly the theme of this account will consider the following main topics:

- 1- Water programme impact on:
 - the physical environment and biomass
 - water availability, use, quantity
 - health, hygiene and sanitation
 - population and economic activities and productivity
- 2- Sanitation and health education
 - health, hygiene & sanitation
 - environmental awareness, conservation and management
 - population, land use system, production and economy.

7.2 Water Programme

The complete documentation and quantification for environmental impact under the present conditions and life span of WES is rather difficult to attain in the time period of evaluation. Therefore value judgment in assessment, pointing to trends of specific indicators is the option in this context. The indicators presented in (EAPK, 1989) will be the base coupled with others the team had observed and spotted in the field visit. The treatment here of water programme and sanitation/health impact is for convenience of writing only. In reality both programmes are closely integrated system.

a- Environmental impact of water programme (HP)

The EAPK, 1989 identified no major adverse environmental consequences of physical resource base that presents a challenge to WES water programme of the hand pump (HP), drilling and installation. This fact is confirmed by the team field investigation in the project area. Still the team observations related to the main indicators and parameters of physical environment changes presented in EAPK, 1989, P.42 are summarized in the following:-

- The hand pump fencing and using live fence is progressing and extended at a reasonable rate in spite of complains of animal browsing of trees and lack of seeds of suitable amounts. What was more observed is the increase in "Hand Pump Surplus water gardens (HPSWG) and "Gubraka" or house back yard gardens, shade and fruit trees. These are seriously considered by an increasing number of villagers. Complains about lack of seedlings of shade trees and fruit trees are reported by many villages visited. It is realized that the task of providing seeds is not WES responsibility, but it would be beneficial if the Dept. of Forestry is persuaded to join the project and make use of the services WES provides. In the project area with a high risk of environmental degradation, reforestation making use of what the water programme provides is quite possible if the Forest Dept is incorporated in the project as beneficiary of the project services only.
- House gardening associated with HP is spreading fastly and already entered in family diet and earnings. In Kadugli town it was reported to the team that two families earnings from house garden

was Ls.900 and Ls.2800 respectively 1989. In few villages it was reported that Acacia Senegal seedlings were watered by HP water surplus and distributed to the farmers to plant in their fields. Survival rate was low and the reason mentioned was lack of knowledge of villagers to handle seedlings, planting time and nursing.

It is believed that if the present trend in life fencing of the HP continued and promoted it will eventually lead to substantial process of conservation of the biomass taking into consideration number of HPs, and its spatial coverage and the need of cut wood (Mostly young trees) required almost annually to fence the pump yard plus the vegetable garden around HP which has become a common feature in the area.

- The HP water provides surplus water to be used in mud houses and VIP building instead of wood and grass materials. This is in fact an important development initiated by the HP and now spreading at an acceptable pace. This is another avenue of biomass conservation which will eventually be reflected on fuel wood and charcoal supply, reducing cost and effort to get such energy sources for domestic use.
- The spreading of HP has positively contributed to an optimum or near optimum distribution and even stabilization of population. The result is lessening of the intensity of use of the biomass and soil allowing recovery of such resources as a pre-condition for recovery in productivity and rural improvement of quality of life. Such process is very essential to the success in other components of WES and its sustainability. The use of mud in building although difficult to quantify, yet the team had observed the increase in this trend in areas where suitable clay materials are to be found. It is advisable to encourage people to use other water sources in building in order to reduce the pressure on the HP and its water budget. What is suggested here is to make use of rain water collected in ponds, Khors etc.. as a mean of optimization of water resources. What is expected and actually, recommended that clay to replace wood and grass for building as a measure of environmental conservation in the project area.
- The impact of the pump on the landscape, drainage and soil degradation is limited, yet cumulative effect may be increasing. In fact the citing of the HPs and in most cases within the village where human and animal activities is intensive, the pump

impact may be minimal in disturbing the landscape, drainage and soil. In fact the team had not observed any impact in this aspect to report, and even predicted no substantial impact is foreseen. This is due to the wide spread of the HP and its role in spreading of population in large area which is contrasting with the wateryard which initiate concentration of both population and activities.

- The impact of HP on draining water resource, and balance between recharge of the limited aquifer and consumption is difficult to assess at this stage and need more hydrological investigation. It is just believed with the spreading of the HP and at present operation of making use of all available local aquifer, promoted by geophysical investigation, dry out of HP is not possible at least in the immediate future. It was reported by both El Obeid and Kadugli offices no HP well went dry since the start of WES, drilling activities (1978).
- The HP environmental impact is evident in providing clean, healthy, cheap and adequate water for the household and community. This was evident to the team in the level of hygiene in the village, cleanness of people and their clothes etc. Time did not allow a close look into the family daily use of water, storage and role of water in this, but improvement in such matters can not be missed by visitors to the village especially if they had seen that village before.

An important impact to be noted that the HP has changed the perception of the community of safe and healthy water in an area where dependence had been on almost polluted traditional water sources and for quite a long time.

The HP had indirectly contributed to the environmental sustainability in the following:-

- Water has started to be an element of improving production instead of being only a social service as believed to be in the past. It is used in household gardens and HP garden as we stated earlier. The HP water is even promoted local handicraft and pottery making as reported in Er Rahad district (Tabaldia village). It was reported that women engaged in pottery making earnings rose from Ls.130/month prior to the HP installation compared with LS. 225 after the HP. Women start to have more time saved from water fetching which spent in caring for children, house

hygiene, production etc. Fig. (12) gives a good summary of such interrelationships within WES community served. Men have more time to work in the village or seasonally migrate outside the area. Earnings from migration not only supplement family income but more important have relieved the pressure and use of the meager village resource base. Leisure time and for the first time is optimally utilized by all members of the family.

The interrelation of WES components on economy and land use summarized graphically below is gaining more momentum in the project area, at present. Such relationship is changing in nature and magnitude depending on the village ecological, ethnic structure and its organization capabilities.

HP had provided water for ruminants in the house specially goats which are an important source of supplementary food for the child and mother.

- Within the frame of the social environment the HP has provided a focus of community integration collective work and more tendency towards self-reliance promoted by the government economic policy. This trend was quite clear in all surveyed villages.

The present pace of WES and improvement in its execution, installation and maintenance of the HP is effectively projects the positive environmental impact briefly outlined above. Still the dynamic and changing nature of the environmental system demand a regular monitoring to quantify the HP results. The objectives need to be to further promote positive aspects and see the necessary linkage within WES activities and government bodies that help in maintaining sustainable intact and productive environment.

7.3 Sanitation and Health Education

The impact of these activities on the environment could be traced at this stage in improving health awareness and practices, hygiene and preventive health care and sanitation. The evaluation in this case need close follow-ups of detailed changes at the family and community levels. During the field visit the team was able to observe some indicators of hygiene, environmental health conditions. Some of these indicators are considered in Chapter 6 of this document.

A striking feature in the health awareness and improvement is the popularity and speed of health committees formation (VHCs) VIP preparation and even in villages included in HP programme but not

received the drilling and installation teams. An increasing number of villages now having a trained assistant health worker. The role of health worker is vital and effective in improving the village environmental health and making monitoring easy by the good health statistics some of them are keeping. The role of HC and the assistant health worker is quite evident in rubbish collection and burning, cleaning of village, house hygiene, water storage etc. The team observed the keenness and diligence of women in health programme and that most of detailed work and diffusion of WES message is transmitted in the village by women. Women involvement which is quite promising is a credit and asset to the project to tap and mobilize. Most of women interviewed, mostly HC. members were proud of their activities and achievements and were very keen to elaborate and convey to the team.

The recent development in WES activities of extending VIP and health education into schools is a right move in improving environment and promotion of health education. The lack of VIP or the poor hygiene conditions of the existing ones use to cause great health hazard to the child at this age and his community. The idea on which the programme of school latrine is based is logical because the pupil's health is safe guard to future family health and community. At the same time the child is a good potential element of change in the environment in totality. If he got the message right he will be a main contributor to the programme sustainability, in providing future mechanic, health worker HC member, and promoter of modernization and change in the rural community.

The idea of school latrine is believed to be a positive step in minimizing the health hazards associated with the heavy concentration of a large number of people in a limited health facilities small place and over a long period of the day. Another target area where health hazard is more serious is the market areas, mosque, flour mills etc.. it is realized that communal latrine is difficult to maintain and keep, but the idea need to be entertained and given more concern. In places like mosques, government buildings etc.. it may be easier to control and maintain. The team sees that something to be proposed to do some effort in this area after a careful study of the idea. Government departments is another target area for health hazard specially after stop of using the bucket latrine in the towns. The idea is not WES to take responsibility of doing that; but to promote the idea and provide the necessary and possible help draining from the experience acquired in the health programme. Why these ideas and suggestions are put forward, because of the integration aspect of the health environment. What has been achieved by the family and even the village may be lost by the poor conditions in the mosque, school, place of work etc.

The health lessons promoted by WES in schools is again a credit in health education diffusion and awareness at the level of the child who is a potential parent and opinion leader and work force in the village. The environmental expected good results of the

school programme are observed in the visited schools. In these schools pupils were given health and hygiene lessons of the best way of using the latrine, keeping it clean, health and hygiene in general, planting and caring of shade trees, small gardens within school premises. The idea of some schools of assigning a number of pupils to care for a shade or fruit tree is an educational method of promoting collective and group responsibility that proved to be badly needed in the village for the success of WES, at the community level.

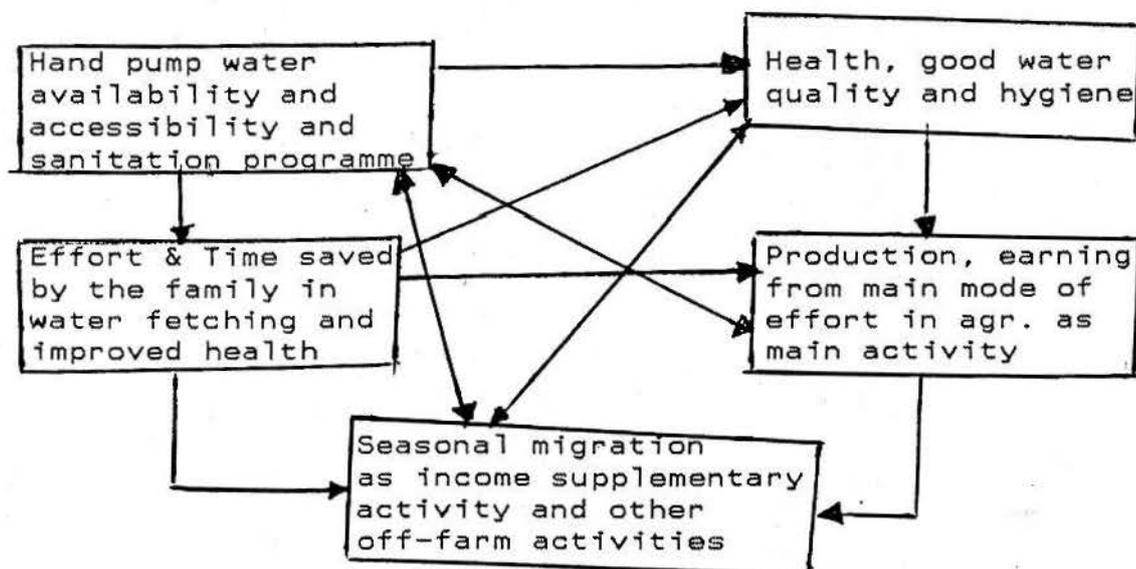
In the period prior to the VIP villages reported that human and animal waste used to be washed during the rainy season and drained to the ponds and surface water they use for drinking. They also reported that human waste causes diseases to animals, provide breeding environment for flies which causes diarrhoea and eye diseases especially for children. Such hazards are reported to disappear substantially in the post VIP period. This was supported by trends of drop in cases of diarrhoea and eye diseases, reported by assistant health workers in visited villages. To confirm this trend it is necessary to have a solid basic data based on a specially designed system to be used by assistant health workers and be manipulated to give a quantified result to enable a solidly based cost effectiveness and community benefits as the main target of WES.

The extension of VIP programme into the urban areas which are rural in function morphology and style of life is a positive step in linking the environmental hazard associated with the use of now prohibited bucket latrine in these towns is considerable and the VIP remain to be the only option to minimize the environmental risks in these towns. The team observed the keen and active role played by the town quarters or neighborhood committees in forming HC, building VIP and even providing help to families having difficulties in erecting their VIPs. El Fugara quarter in Kadugli could be cited as a good example. The installation of the HP in these quarters which suffer from severe shortage of water prior to HP installation has promoted the health conditions and contributes to the environmental conditions in such towns, which are to be considered gate ways of change in rural areas.

In the area of social environment WES in its two basic components of village based activities (HP management and sanitation health education) has increased the social binding force, group action and a mean of pulling all resources and spreading of cost operation on a wider base. This strategy is proved to be effective in such poor communities with limited resources. The team observed the trend of "Nafir" in VIP building as a measure of reducing cost for individual family and to speed up the health programme to match with the drilling programme (ie. Abu Musa, Dubeibat rural Council). "Nafir" is a day or more work to be provided by all village or part of it to an individual, free of charge in house building, farming and now in VIP.

WES environmental impact through improvement of production system is observable but premature to document and measure properly. Still its general indicators are improvement in health and reduction of time wasted due to frequent disease attack to which all family is exposed. This saved time which is added to that saved from water fetching is to be used in income-generating activities especially by women in handicraft, keeping of poultry, house garden and "Gubraka" etc. Such activities are observed to be spreading, by mostly self-ignition of the women. This in fact a high potential support with limited cost of subsidies, extension, seeds a raw materials etc. A credit system may be devised to ensure cost recovery in the future. Such area of house hold income generating activities are appealing to the utilization of women and child capabilities and will be positively reflected on the household quality of life. Men also are becoming able to practice income-generating activities within the village ie. tapping gum, casual workers, handicraft etc. or migrate into other areas in the country. The improvement in productivity, better utilization of surplus time is one of the main safety measures to ensure the WES sustainability when it becomes the responsibility of the community and local institutions to run it and to ensure also its environmental compatibility with the resource base and a rising population size and needs.

Fig (13) Hand pump, sanitation, economy & land use interaction process-KRC & SRC



7.4 Conclusion

WES is functioning in an ecologically delicate in resource base capability and subjective to excessive years of drought. Therefore its impact on the environment and resource base sustainability need to be assessed. WES is now taking a full swing of momentum in excusion, coverage and degree of utilization of its output.

Its two components of water supply sanitation and health education are interlinked, so is their environmental impact. It is a credit to WES management to insist on introducing environmental assessment in all its evaluation of the project. This in fact provides a continuous monitoring of the environmental changes to make it easier to apply the necessary corrective measures all along WES span of life.

WES at this stage of its life is having no challenging danger to the environmental at least at the micro-level. In effect it has a positive impact on the environment in conservation, management human health, socio-economic setting and future sustainability. Monitoring of environmental changes need to be an integral part of the WES evaluation activities and input whenever possible.

8.0 Sustainability

8.1. Definition:

The ability of the community to achieve and maintain self sufficient status without external assistance or minimal external assistance.

8.2. Provision of Water Supply

The project has provided a clear and safe water supply for a number of communities and villages in the North and South Kordofan project areas.

8.3. Provision of Sanitation

The project has provided facilities for excreta disposal for a number of communities and villages in the project area, coupled with the formation of health committees, health educational programmes and the proper use of water supply.

8.4. Community Mobilization

The project activities have increased awareness and community self-dependence through interaction and development of the water supply and sanitation facilities. This drive was generated from these activities and provided the inertia to reduce dependence on external assistance through sincere attempt to generate internal momentum.

UNICEF's human, material and financial assistance have motivated the communities into more self-reliance on their meager resources and their human capabilities. This assistance is manifested through the project as follows:

- Income generating activities was exercised in a small agricultural development;
- hand craft and pottery;
- the apparent settlements of Nomadic tribes;
- time saving that enhances the household's abilities for production and upgrading health standard of living,
- reduced morbidities have increased the productive time as compared to the excessive losses in unproductive time and effort to combat unhealthy conditions,
- reduced the burden on the governmental meager resource,
- increased community interaction to provide new interpreneurial ideas that may benefit the immediate community.

Based on the above and observation encountered during the field visits and review of the project document, it was evident that the project has directed the attention and created the momentum leading in the proper direction towards a self reliance, self sustained community. It is necessary to continue contributing to these efforts to ensure and achieve the final target.

A time table should be devised in cooperation with the concerned authority to reduce dependence and increase generating internal capability by the end of the twentieth century. This, is better be through a phasing out procedure to minimize set-backs and disturbance in the eco-system.

9.0 Cost Effectiveness

The cost effectiveness of the water, health and sanitation programmes are of primary concern and a pre-requisite to further programme expansion. In order to minimize costs UNICEF in cooperation with NRWC established the following programme:

9.1 Equipment

In the past, the available drilling equipment were bulky and oversized for the shallow small diameter boreholes in addition to the geological bedrock conditions in Kordofan. Mobilization, fuel consumption, and maintenance cost are more expensive when compared to smaller drilling designed for the dimensions of the project.

9.2 Bonus System

The production based bonus system - gratitude, was experimented in late 1986 and a decision was taken to switch over completely to production bonus in 1987. The payment are based on good quality and field crews alike. The production bonus has increased output to two or even three folds and has contributed drastically to the reduction in unit costs. There are a number of problems inherently associated with the production bonus system. These are:

- a) higher wear and tear on the equipment,
- b) negligence of vehicle and equipment maintenance,
- c) poor workmanship and the general lowering of quality.

It is recognized that close supervision, quality control, increasing national spirit amongst crews, combined with across the board payment cuts (reward/fine) where standards are not upheld, form a forward successful deterrent control.

The bonus scheme, though limited by design to less than approximately 10% of total programme expenditure, has proved to be an excellent incentive and management tool.

9.3 Personnel

Consistency and deep understanding of the programme and equipment employed are contributing factors to the improvement and the success of the project.

The two project coordinators, an expatriate in North Kordofan and a Sudanese in South Kordofan, have acquired technical and managerial skills on similar type of projects in Sudan and overseas. Their familiarity with the project and local conditions have extremely improved the productivity and the technical control of the operation.

The drilling operation and handpump installation are supervised also by two experience drillers, an experienced UNV (United

Nations Volunteer) who has 5 years experience on a similar UNICEF assisted project in Uganda, and an experienced Sudanese who was trained in Sudan and abroad on the project equipment and other type of equipment.

Two expatriate mechanics are responsible for the upkeep, training local staff, maintenance monitoring and trouble shooting.

9.4 Planning

In the pre-1987, drilling rigs were moved frequently and in all direction in response to political pressure.

The present approach is based on coverage of geographical areas in a progressive manner. This approach has reduced un-productive movement increased quality control and productivity. The planning cycle is based on a five year master plan, and an annual review and work plan in addition to monthly monitoring.

9.5 Standardization

Standardization has many advantages and including reduction in staff training cost and in spare parts stocks plus encouragement to local entrepreneurs to invest in local manufacturing of some spare parts items.

9.6 Design and Construction Specification

The design of latrines, boreholes and handpump installation have been standardized. This will facilitate supply planning, inventory of stock and reduce decision make process in the field.

9.7 "Critical Mass"

The Critical mass has been calculated as follows:

- one pump per 200 villagers;
- a minimum of at least 2 handpump in small communities of less than 200 people to ensure backup supply;
- pumps be installed at reasonable distance apart to provide back up capacity.

On the training level, an adequate number of village mechanics will be trained, spare parts be readily available, tool sets be supplied and with NRWC staff being fully supportive of handpump technology.

9.8 Drilling Operation

The implementation of the water, sanitation and health education programme in North and South Kordofan has achieved several significant results. The increase rate and number of successful wells is impressive and encouraging, considering the many

difficulties and bottlenecks that were overcome. These included problems of logistics, supply of personnel associated with the increase of productivity and output.

The changes in drilling techniques, design and standardization, in addition to the proper planning combined with the introduction of production bonus payments instead of fixed incentives have stimulated a dramatic increase in output and cost effectiveness of both drilling and handpump installation operations. However, implementation has to be closely monitored and payments made only for high quality workmanship.

The cost per successful borehole has apparently from a high > US\$ 9,000 to a low < US\$ 3,000 as given in the following table. Additional reduction in cost is also envisaged for boreholes constructed during the 1989 fiscal year.

9.9 Household VIP Latrine

The unit cost of the VIP latrine, so far implemented is relatively high. Many factors cause this figure (US\$ 267 or US\$ 53 per person) to be high, the most important of which are the choice of materials, the non-availability of these materials or the insufficient supply of these in Sudan at the present time (notably cement), the unfavorable hard currency exchange rate to the project and the fact that the project has just gone through the start up phase.

The investments made are fully justified, because otherwise the VIP programme would not have come off the ground.

The joint-financing arrangement with the villagers has been well implemented and as further cost savings will be made (through reduction of cost of imported materials and transportation as well as through use of more local materials), and the villagers will become more motivated as a result of the social mobilization, unit cost will come down and notably the cost to UNICEF and the Government of Sudan.

However, all cost¹ savings for UNICEF and the GOS will have to be used to keep up the momentum, the project has achieved, to start-up and support more decentralized supply centers of VIP materials (slabs, ventpipes) to double, triple etc.. the coverage and to build VIP school latrine blocks.

9.10 School VIP latrine

The unit cost of the VIP school latrine blocks, built in South Kordofan, Sud Pounds 40,000 for 350 persons (US\$ 8,900, US\$ 25 per person to Sud Pounds 70,000 for 700 persons (US\$ 15,600, \$20 per person) is also relatively high.

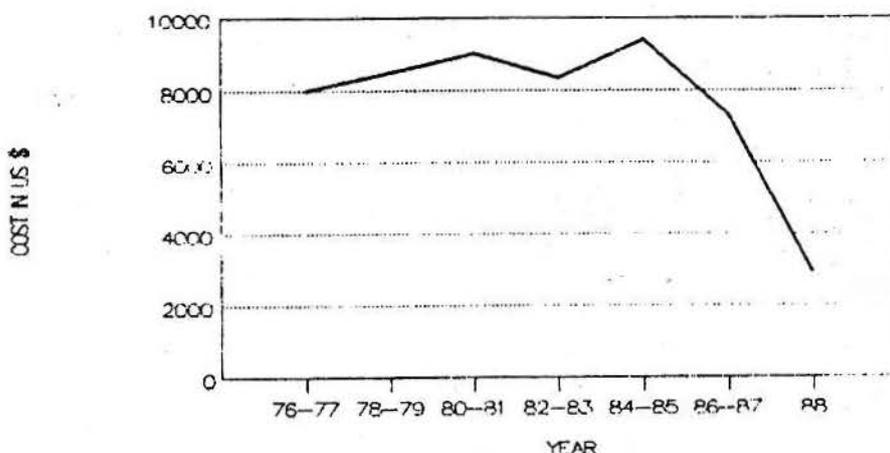
It is very important to reduce costs, and it is suggested to orient research towards the construction of double compartment latrine blocks with ferrocement superstructure and ferrocement

pit lining. The lifetime of the latrines will triple, while the simple pit latrine will require relocation every 6 or 10 years (depending on the design capacity and users). Especially in town centers this will be more and more difficult.

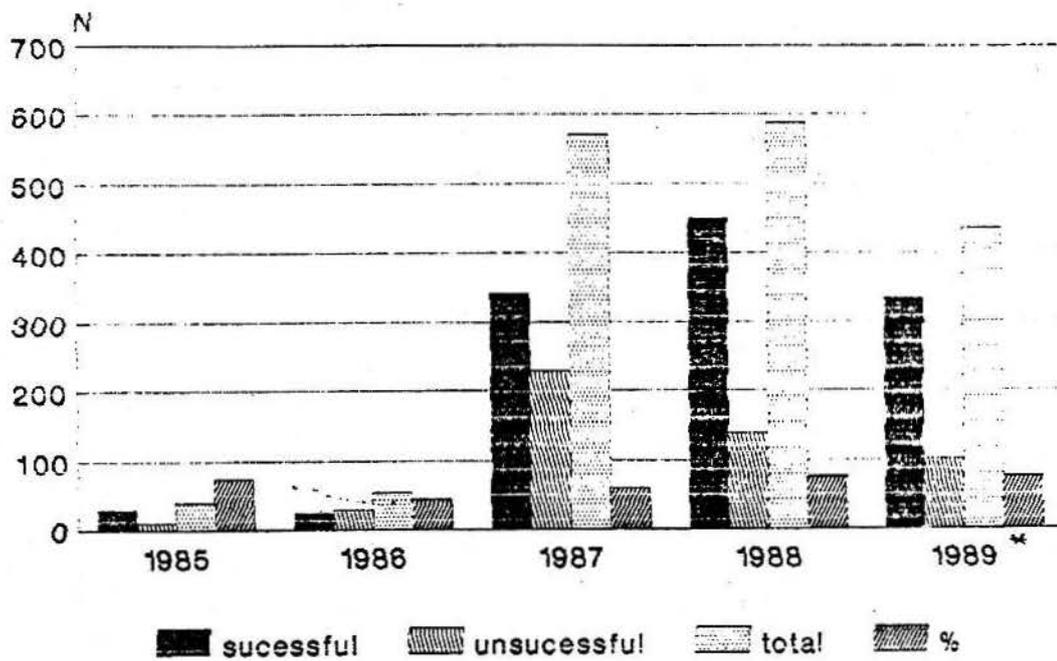
Discussions in the field with the project management and with the EEC representative, suggest that it would be in the best interest of the project and the increased coverage of VIP latrines, if the EEC counter value funds available now for VIP latrine construction, could be converted towards VIP school latrine block construction. Parents could sub-contract the construction of the latrine block and EEC funds would subsidize their initiative. The role of the project would be to provide technical assistance and possible other support.

COST PER SUCCESSFUL BOREHOLE IN US \$

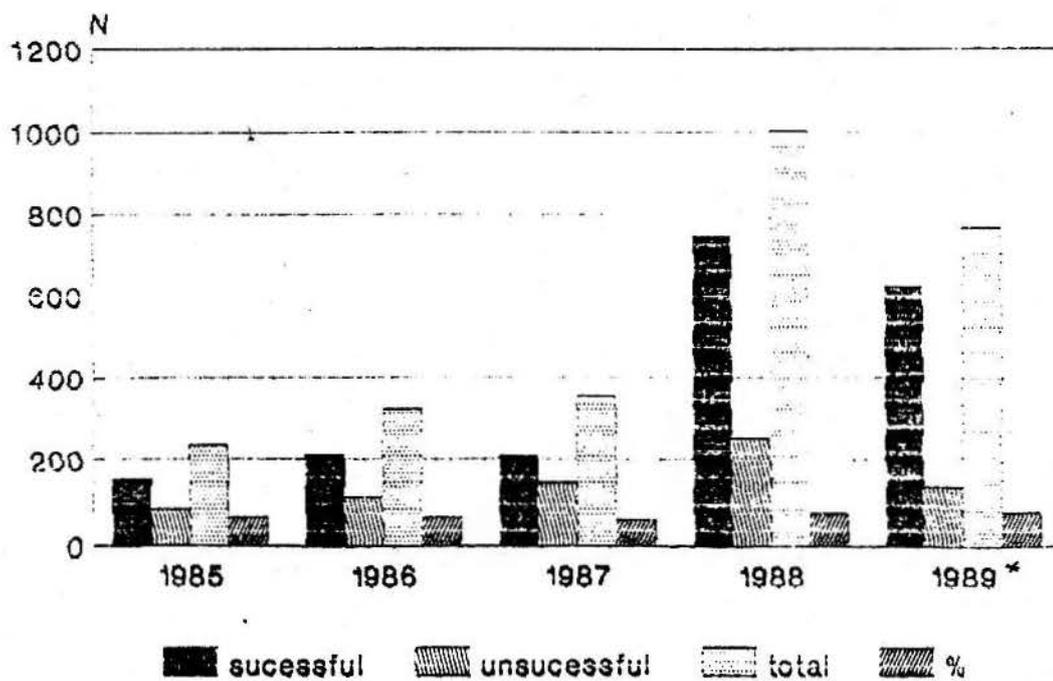
SUDAN (1976-1988)



Evaluation of Boreholes in North-Kordofan

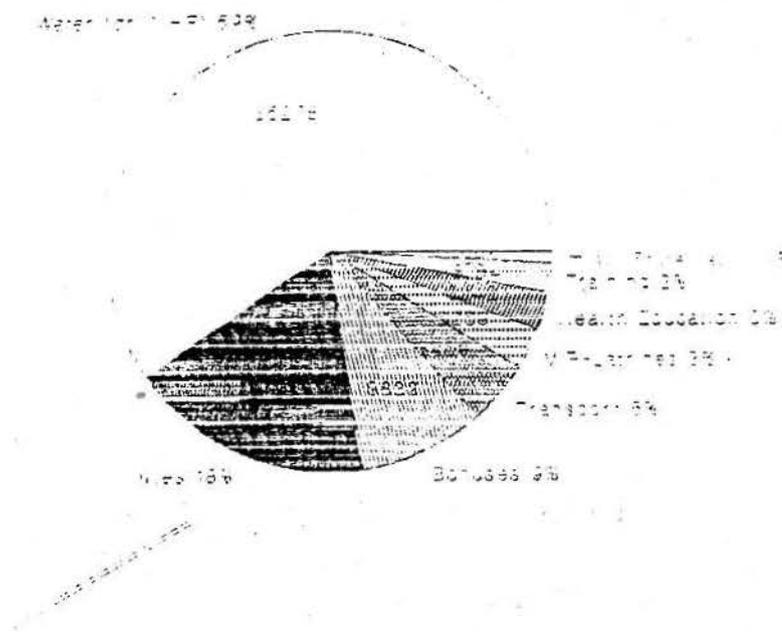


Evaluation of Boreholes in South-Kordofan



1989 includes till Oct.89.

UNICEF-Expenditures in 1987-1989
on the WES-Projects in Kordofan/Sudan
(in 1.000 US\$)



UNICEF Expenditures in 1987-1989
on the WES-Projects in Kordofan/Sudan

| Expenses | *1,000 US\$ | % |
|---------------------|-------------|----|
| Salaries | 1,589 | 18 |
| Bonuses | 832 | 9 |
| Training | 184 | 2 |
| Health Education | 242 | 3 |
| VIP-Latrines | 269 | 3 |
| Water (drill. HP) | 5,278 | 69 |
| Transport | 409 | 5 |
| Misc. (Store, Lab.) | 81 | 1 |

10.0 Conclusions and Recommendations

10.1 CONCLUSIONS

10.1.1. Water Supply

The water programme has set unprecedented records, with 48% of all successful boreholes drilled since the start of the project in Kordofan having been drilled in 1988. The progress of the water programme in 1989 is a replica of 1988. Similarly, latrine construction has begun to show a noticeable acceleration.

The project has achieved its objectives in changing methodology and techniques to reach and surpass its targets by increasing the number of boreholes and reducing the cost per unit borehole.

The National Rural water Corporation (NRWC) in cooperation with UNICEF and Ministry of Health have a remarkable success on the Water and Sanitation and Health Education Project (s) in North and South Kordofan during the last three years and is turning the project to a successful venture.

The project has gone through the slow start-up phase and is presently gaining momentum. The approach of work-sharing, joint financing of the project has been well applied.

The following specific conclusions are drawn from the project documents and the observations and discussion carried out with UNICEF/NRWC officials and field crews.

1- Drilling Operation

The methodology adopted in drilling and completing production wells proved to be effective in accelerating the programme and reducing the cost. It also helped in providing water at a faster, rate that used to be.

2- Well specification and design

The line hole technique and the standardization of procedures and equipment have boosted production.

3- Planning

The sweep approach adopted for completing one area before moving to the next area has reduced cost, and saved travel time lost in moving in all directions.

4- Supervision and Quality Control

Running and supervising the operation from the base camp have upgraded the quality and facilitated the training of additional personnel in the sectors of drilling, pump installation and testing procedures. It also has reduced time loss during the course of operation.

5- Siting and borehole selection

Running the entire operation from a field base camp has enhanced interaction and feedback between the geophysical team and the drilling and testing team. This feedback provided the geophysical team with immediate results that advocated better interpretation of geophysical field data.

6- Familiarity with the geology of area

Drilling in one area at a time have the increased in-depth knowledge of the regional geology, and assisted the drilling and geophysical teams in their operation.

7- Pump Installation and Maintenance

The presence of the installation team (s) in the area during the drilling-installation period have encouraged the user (s) of the newly installed pump to test the installation (s) and report back to the installation team (s) for assistance, if required.

8- Women's Involvement in Maintenance

The community based maintenance system is effective in keeping the pumps in operation. Women's participation in handpump maintenance is an outstanding feature of the programme. Women are virtually never involved in similar activities in other African Rural areas.

9- Standardization

Standardization of the procedures, equipments, and transport vehicles have reduced waste and increased efficiency.

10- Data Collection and Reporting

The data collection and reporting are geared to fill in forms and files. It may be necessary, to go through the exercise to prepare regional hydrogeological map in addition to the geophysics.

10.1.2. Sanitation and Health Education

- VIP-latrines in households

The construction programme of VIP household latrines has gone through a start-up phase and the is gaining more and more momentum.

The following factors have contributed to this effect:

- (1) tying sanitation to the provision of drinking water,
- (2) construction of demonstration latrines in entire villages, so that the campaigns results are clearly visible to everybody.

- (3) the establishment and effective training of the members of VHC's, who take up the task to mobilize everybody in the village to build VIPs.
- (4) The construction method is clearly explained in a well-designed manual given to the VHC members and village chiefs.
- (5) The VIP respond to their pretenses, that they are virtually free of odours and flies.
- (6) The lining of the top part of the pit is a free gift for everybody who completed digging the first 1 meter. Likewise a concrete squatting plate and a PVC ventpipe are given and installed free of charge to everybody who has dug the pit to 4-7 meters, followed by a subsidy from EEC of half of the homeowners portion when the superstructure is completed.
- (7) The enthusiasm of the NRWC and the MOH to make available a great number of personnel (46 in the region) to compose the necessary promotion and installation teams
- (8) The promotion of the VIP latrines for better sanitation through the health education messages given by Radio Kordofan.
- (9) The provision of heavy trucks to the project to haul sand and gravel to construct the concrete slabs and specially pre-fab centers.
- (10) The favorable soil conditions in the greater part of the project areas.
- (11) Good planning and good management of the WES-project staff.
- (12) The VIP's are accepted. Now people and authorities from villages where no HP are installed yet claim VIP latrines.

Certain constraints have formed obstacles in a faster implementation of the VIP-latrines, identified as follows:

- (1) The population is occupied for at least 6 months of the time with agricultural activities and find little time during such periods to dig or construct VIPs.
- (2) The villagers do not dig the pit simultaneously, yet the NRWC construction team cannot come to line or install slabs for only a few VIPs at one time.
- (3) The VIPs cost money, that the villagers need to have. This will cause delays, e.g. in saving money and obtaining the bricks.

- (4) It was planned that VIP coverage would keep up with the HP installment, this is considered as impossible to achieve.
- (5) The conditions of insecurity caused by the civil war in southern Sudan reduces the coverage in Southern Kordofan.

As the programme continues it is, however important to fine-tune the approach, so that the optimum coverage will be attained.

It can easily be seen that the VIP construction cannot keep up with the water supply component, nor that full coverage of all villages, benefiting from the water supply component can be attained with the present approach. If 50% of the villages of Kordofan can be supplied with handpump water, or 1.6 million people, some 320,000 household latrines would need to be built, and some 20,000 more to serve schools, market places, health centers, government institutions etc. would be required.

However, the project is capable of maintaining the momentum it has obtained and target for the completion of some 40,000 or even 60,000 latrines in the coming five years to reach a latrine coverage of some 20-25% by giving more emphasis to self-help by the villagers.

10.1.3 Linkage and environmental impact

The WES-projects have a good approach to link water and health, but the aim of organizing water supply and sanitation in a similar time frame seems to be unrealistic. The supply of water as such is a technical matter and can be organized in that way. The proper usage of water and sanitation facilities - the community development and the health education cannot be streamlined on the same technical manner.

- The additional "micro-projects", which make use of the provision of water should be continued in form of pilot or model projects, which use the cooperation with other institutions.

- Community Participation

The community at all levels is effectively participating in the project activities in a satisfactory and a promising drive. This is quite evident in making use of WES activities in improving socio-economic and environment status. WES in its present blend presents a practical model for application in similar areas in rural Sudan.

- Environmental Impact

(1) The trend of conserving the environment is gaining momentum, but still slow and needs more attention. People are keen to continue life fencing and realize the benefits of this idea. Home gardening is widely accepted and started to be considered by many families especially those close to HP's where water surplus is drained to these gardens. Nurseries are attached to the pumps in an increasing number of villages.

(2) Most villagers opt for mud-built VIP's, mud house building is on the increase. The cost may be the main limitation.

(3) Environmental and health awareness and practices are steadily improving. The constraints encountered are:

- lack of seeds, training, fund and supervision in planting vegetables, nurseries, etc.
- limited financial resources to promote mud (brick) house building to conserve biomass,
- in relation to health and hygiene many villages have no health assistant to promote their health education and practices.

- Monitoring

The village records on health and environment are insufficient. The influence of the WES-projects on the development of the population is monitored poorly.

10.2 RECOMMENDATIONS

1- Prepare a plan of actions for 1990 based on keeping the:

Present momentum of the drilling operation and pump installations.

2- Investigate thoroughly the advantages and disadvantages of manufacturing the spare parts for the pump, steel pipes, PVC pipes for water wells installation and VIP latrine construction.

Prepare a cost analysis and an estimated budget to evaluate the potential for local manufacturing of each item.

10.2.1 Sanitation and Health Education

The following actions are recommended to fine-tune the VIP latrine construction campaign to boost coverage through more and more self-help, following a two-phase approach.

PHASE I

1. Ministry of Health to identify high risk and low risk areas for the transmission of excreta-related diseases. Usually, high risk areas are public gathering places, such as schools, health centers, market places and commercial areas, urban areas, mosques, flour mills government institutions. Once high risk areas are identified, concentrate on full latrine coverage of high risk areas. A good start would be schools in urban areas as the project already is doing.
2. Decentralize the slab production by establishing pre-fab centers in a selected number of rural councils. Train rural council workers in slab production and assign one truck to 3 rural councils, to haul sand and gravel and deposit slabs in villages that are ready. NRWC provincial staff can train their R.C. counterparts in technical and administration/monitoring aspects during a period of one month and in doing regular calls during first year of decentralization.
3. Test sundried bricks/blocks and mud mortar to replace red bricks with cement mortar in lining first 3 feet of latrine pits.

Subsequently train VHC's in performing this craft of brick-laying in their respective villages.
4. Start charging nominal fees for squatting slabs and vent pipes, (SUD Pound 10 - Pound 50 to be fixed on basis of market value that is developing).
5. Boost VIP promotion through all available channels and emphasize this activity in schools - through teachers to children and to parents.
6. In order to keep up with the growing demand the slab production, as well as the vent-pipe availability should be increased for the time being by importing more PVC pipe (4" in diameter is sufficient, and can be nested in 5" pipe ordered for the drilling programme, as is already the intention of the project management) fibre glass squatting glass (experiment by project) and more cement, re-bar and wire mesh for concrete slab production.
7. Synchronously with 1-6, obtain technical information about ceramic pipe manufacturing and other vent-pipe alternatives (appropriate technology Ass., London, U.K.)

and or invite consultant, identify clay-rich areas and craftsmen (potters, jar makers) and train interested craftsmen in techniques assist in capital investments and start production and installation of ceramic pipe vent-pipes in pilot area.

At the same time other local solutions can be explored and tested for both vent-pipes (brick chimneys) and latrine pit covers (wooden branches).

8. Investigate the feasibility of local production of PVC pipe in El Obeid. If positive start up production (if necessary with UNICEF subsidy).

10.2.2 Re-orientation of VIP Promotion

9. Once local alternatives as well as imported varieties of vent-pipes and squatting slabs are readily available, re-orient the VIP promotion to self-help.
10. Develop a latrine demonstration parques to show to trainees the different alternatives for effective latrine construction.
11. Provide refresher training to village health committees in technical aspects of VIP latrine construction.
12. As commercial outlets of vent-pipes and squatting slabs are created, possibly still subsidized by UNICEF and self-help is stimulated more villagers will construct their VIP latrines synchronously and VIP latrine coverage will increase to cover all villages in Kordofan.

10.2.3 School Latrine Construction

13. Consider to adopt the construction of double-compartment compost latrine blocks for schools especially in urban centers so that the expensive superstructure can function for 30 years and more. As recommended under (1) and (5) give priority to this activity while considering the following suggestions for improvement and cost-reduction,
14. Consider to apply ferro-cement for the construction of the super-structure and for the lining of the pit major cost savings can be obtained.

10.2.4 Health Education

15. Organize contests between VHC; to boost their spirits and outputs (cleanest village, handpumps best maintained, fenced, VIP latrines all constructed etc..) and award prizes/medals.
16. Boost self-help in health education and stimulate VHC to visit each other. This compliment refresher courses.
17. When new edition of manual is prepared, amend page 30-45 so that all people wear shoes. This stimulates prevention of hook worm and brings also this message across.
18. Organize annual gatherings of VHC's on district level, to exchange experiences and to review the progress made and difficulties encountered.

ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACT RECOMMENDATION

- Further extension of WES to hydrologically favorable areas. Seeking possibility to extend sanitation/health component into areas not covered by HP and having a reliable water source (Urban is option.)

Village data files to help in monitoring of environmental changes and device corrective measures to ensure environmental sustainability and provide ready data for effective evaluation.
- Further effort in life fencing, HP gardens household gardens, reforestation, (malnutrition) school, gov. dept. latrine to minimize health hazards.
- Encourage Department of forestry to contribute to a forestation making use of WES service in provision of fruit, shade trees and A. Senegal plantation.
- Encourage mud and other non-biomass material in house, VIP etc building.
- Further and active effort to be made in environmental monitoring within the whole project monitoring programme.
- Water as an element of production, environmental improvement in rural areas should be properly used and managed regularly through a carefully worked out monitoring programme. The monitoring should be consider the charge and discharge of the HP water as a water conservation measure.

10.3- TIME TABLE

As a result of the short duration of the allowed time on the project and the extensive size of it, it is not possible to prepare a realistic and meaningful time table as stipulated in the Terms of Reference, nevertheless the following tentatively prepared time table.

It is advisable that NRWC in cooperation with UNICEF-Sudan prepare a time table based on their long involvement and accessibility to the details of the projects.

It is suggested therefore that NRWC in cooperation with UNICEF-Sudan prepare, as part of the exercise of Plan of Action preparation to set a time table to provide all communities with the time frame of the project.

However, as a guidance, the project management team should device and develop a time and procedure to act on the recommendation as stipulated in the report and in accordance with the proper ranking of priorities which are normally developed during the execution.

SUGGESTED IMPLEMENTATION TIME TABLE

| Activity | Executive Agent | Time Frame |
|--|-----------------|---|
| WATER SUPPLY | | |
| 1- Identify feasibility of local production of Hayati pump | :NWRC/UNICEF | :Within next 3 months |
| - Consumable parts, such as such cups, leather or compatible material | : | :When feasibility is proven positive, start production. |
| - Seals, rubber or compatible material | : | : |
| 2- Identify feasibility of local production of complete Hayati pump and proper quality control | :NWRC/UNICEF | :Within next 12 months |
| | : | :when feasibility is proven positive, start production. |
| 3- Identify feasibility for manufacturing of tubes, steel casing | :NWRC/UNICEF | :Within next 12 months |
| PVC* pipes | : | :when feasibility is proven positive, start production. |
| PVC* screen | : | : |
| *or compatible material | : | : |
| 4- Upgrade filing, reporting compilation, analysis and assimilation of data of hydrological and hydrogeological data to evaluate water budget/ water balance and define ground water regimes in Kordofan | :NWRC/UNICEF | :Within next 6 months |
| 5- Develop a coarse grid ground water model for Kordofan through obtaining appropriate computer soft ware and training of a number of professionals of NWRC-Kordofan | :NWRC/UNICEF | :Within next 12 months |
| 6- Provide additional laboratory facilities for chemical/physical and bacteriological water quality analysis for North Kordofan: 1 Health kit with 1 incubator to be compatible with units already in use in South Kordofan. | :NWRC/UNICEF | :Within next 12 months |

| | | |
|--|------------------|---|
| SANITATION | : | : |
| 1- Decentralize prefab centres for slab production from districts to rural councils and use trucks for various rural councils on rotation basis: | :NWRC/UNICEF | :Compete in next 12 months |
| 2- Obtain pertinent technical information to manufacture locally ceramic pipe and other local solutions to serve as vent pipe. | :NWRC/UNICEF | :Soonest after pertinent technical data have been received |
| 3- Setup arts and crafts workshop to develop ceramic pipe based on 2- with assistance of of external consultants | :NWRC/MOH/UNICEF | :Soonest after pertinent technical data have been received |
| 4- Reorient VIP promotion to more self help, recommending, ceramic pipe, wooden squatting slabs etc, Once experiments have been concluded | :MOH/UNICEF | :As soon as experiments have proven positive with local materials |
| 5- Start charging for concrete slabs and PVC vent pipes Sud. Ls.10-50, gradually increasing to Ls.50-100 till cost price attained | :NWRC/MOH/UNICEF | :Soonest |
| 6- Experiment with replacing red brick lining of pits with sundried mud bricks and mud mortar | :NWRC/UNICEF | :Soonest |
| 7- Boost VIP promotion through health education in schools teacher training, teachers to children, children to parents. | :MOH/UNICEF | :Within next 3 months |
| 8- Identify feasibility for manufacturing of PVC pipe or compatible material | :MOH/UNICEF | :Within next 12 months. When feasibility is improved positive, start production |

| | | |
|--|---|----------------------------------|
| 9- Obtain pertinent information from other UNICEF offices and reorient school latrine construction in urban centres to compost latrines. | :UNICEF/NWRC | :Within next 3 months |
| 10-Train VHC's in installing squatting slabs and vent pipes (masonry courses) to support self-help. | :UNICEF/NWRC | :Within next 6 months |
| 11-Obtain technical information from other UNICEF offices to construct school latrines by applying ferrocement | :UNICEF | :Within next 3 months |
| HEALTH EDUCATION | | |
| 1 In new edition for reference training manual, add photos to all persons on pages 30-45 to emphasize proper hygiene | :NDWRC/MOH/UNICEF | :Soonest |
| 2- Organize contests between VHC's to boost their spirits and outputs, and award prizes/medals etc. | :MOH/UNICEF | :Within 6 months |
| 3- Boost self-help in organizing refresher events of VHC's by stimulating/organizing VHC's to visit each other | :MOH/UNICEF | :Within 6 months |
| 4- Organize annual gatherings of VHC's on district level, to exchange experiences and to review the progress made and difficulties encountered | :MOH/UNICEF/MOE :District Executive :Office | :Soonest for selected districts. |

| | | |
|--|-------------|-------------------------------|
| MONITORING | : | : |
| | : | : |
| | : | : |
| 1- Develop and introduce data files starting at village level up to provincial level, and set up simple distribution collection, and recording system in a number of selected rural councils | :MOH/UNICEF | :Implement within 3-6 months |
| | : | : |
| | : | : |
| | : | : |
| | : | : |
| 2- Introduce simple evaluation techniques starting at village level in a number of selected rural councils | :MOH/UNICEF | :Implements within 3-6 months |
| | : | : |
| | : | : |
| | : | : |

APPENDIX (1)

LIST OF RESOURCE PERSONS
THE EVALUATION TEAM MET

KHARTOUM:

NAMES

TITLES

UNICEF:

| | |
|----------------------|------------------------------------|
| Mr. Farid Rahman | - UNICEF Representative |
| Mr. Mohammed Darwish | - Chief, Planning Section |
| Mr. Ahmed Mussana | - Chief, Urban Services Section |
| Mr. Thomas Ekvall | - Chief, WES Section |
| Mr. Ismail Al Azhari | - Ass. Project Officer |

MINISTRY OF PLANNING:

| | |
|----------------------|---|
| Mr. Dr. A/Rahman | - Acting Under Secretary |
| Mr. Dr. Omer A/Salam | - Deputy Under Secretary Director of Energy Sector |
| Mr. Ms. Al Sham | - Ass. Director of Energy Sector |

NATIONAL RURAL WATER CORPORATION (NRWC):

| | |
|------------------------------|---------------------------|
| Mr. Mohammed Salih Al Bakhit | - Acting Director General |
| Mr. Hamid Hassan Abdel Hafiz | - Reg. Director Kordofan |
| Mr. Abbas Abdel Hafiz | - NGO Co-ordinator |

EL OBEID:

NAMES

TITLES

NATIONAL RURAL WATER CORPORATION (NRWC)

| | |
|--------------------------|-----------------------------|
| Mr. Hamid Hassan | - Director General NRWC |
| Mr. Yossif Adam Mustafa | - Project Executive Manager |
| Mr. Abu Bakar Abd Ella | - Geologist |
| Mr. El Doma Adam El Duma | - Senior Geologist |
| Mr. Hamad, Adam Khatir | - Senior Driller |
| Mr. Amal Idris | - Engineer/VIP latrine |
| Mr. Ahmed Mohamed Ali | - Engineer/VIP supervisor |

PLANNING DEPARTMENT:

| | |
|------------------------|-------------------|
| Mr. Willem Rodhart | - EEC Coordinator |
| Mr. Mirgani Saloud | - Planner |
| Mr. Gabr El Dar El Nur | - Planner |

HEALTH:

| | |
|---------------------------|------------------------------------|
| Mr. Awad Mukhtar | - Regional Public Health Inspector |
| Mr. Tumsah Nasir | - Health Education Officer |
| Mr. Abd El Rahman Babiker | - EPI Regional Director |
| Mr. Salma El Taib | - Nutritionist |

OTHERS:

| | |
|--------------------|----------------------------------|
| Mr. Ibrahim Hassan | - Director-Youth Training Centre |
| Mr. Mohamed Gubara | - Radio Section |

REGIONAL GOVERNMENT OFFICIALS:

| | |
|-----------------------------------|--------------------------------------|
| H.E. Mohamed El Sayed Abd El Daim | - Dupty Governer |
| H.E. Hassan Gabriel El Zebeir | - Commissioner North Kordofan |
| Mr. Mohamed El Amin | - 1st Executive Officer OED/District |
| Mr. Abd El Rahman Badwi | - Admin Officer -Abu Zabad R.C. |
| Mr. Mustafa Ahmed | - Admin Officer-El Rahad |

UNICEF/EL OBEID:

| | |
|---------------------|----------------------------|
| Mr. Jan Van Manen | - Regional Coordinator |
| Mr. Willem Hyjestik | - WES Coordinator-El Obeid |
| Mr. Robinson Kizza | - Driller |
| Mr. Mustafa Babo | - Social Mobilizer |

KADUGLI:

NAMES

TITLES

UNICEF:

| | |
|------------------------------|--------------------------------|
| Mr. Mohamed Al- Fatih Yousif | - WES Project Coordinator |
| Mr. Joseph Maker | - WES Project Master Driller |
| Mr. Hamoon Chol Deng | - WES Project Social Mobilizer |
| Mr. Robin Morelli | - WES Project Mechanic |

NRWC:

| | |
|----------------------|--|
| Mr. Mansour Nasir | - Executive Manager, NRWC S.K. |
| Mr. Izz-el-Din Jeddo | - Resident Geologist, NRWC S.K. |
| Mr. Osman Al Nur | - Chief, Irrigation Section, NRWC, S.K. |

MINISTRY OF HEALTH:

| | |
|----------------------|-------------------------------------|
| Mr. Ahmed Musa Haren | - Chief, Health Education, S.K. |
| Ms. Rajabia Basharia | - Director, Nutrition Dept.S.K. |
| Dr. Ali Adam | - Director, Health Service, S.K. |

COMMISSIONER AND DISTRICT RURAL COUNCILS:

| | |
|-------------------------------|---|
| Mr. Abdel Wahab Siddig | - South Kordofan Commissioner |
| Mr. Yousif Mohammed Osman | - First Executive Officer (Al Dilling) |
| Mr. Babiker Al Radi Ali | - Al Sanut Rural Council (Abu Zabad) |
| Mr. Hassan Musa | - Dubibat Rural Council (Al Hamadi) |
| Mr. Abdel Moneim Gamal El Din | - Health Inspector (Al Dilling) |
| Mr. Maki Ahmed Al Tigani | - Health Inspector (Kadugli) |

LIST OF BACKGROUND DOCUMENTS

(made available by UNICEF -
Khartoum)

1. Situation Analysis
2. UNICEF Master Plan of Operation and Plan of Action by Government of Sudan 1987-1991
3. WES Plan of Action for 1989
4. Project Manual
5. Sectoral Reports covering:
 - Borehole Drilling and Handpump Installation
 - Social Mobilization Activities
 - V.I.P. Latrine Construction
 - Health Education
 - Village Handpump Maintenance
6. Financial Implementation Report
7. Draft Cost Analysis
8. Environmental Impact Assessment of UNICEF's Handpump and Sanitation Programme in Kordofan
9. Recommendation of and Report on National Conference on Rural Drinking Water
10. Cost Effectiveness Water and Sanitation in Sudan
11. Joint Evaluations of the UNICEF supported drinking water projects in Kordofan and BAhr el Ghazal LRegions.
12. Report on Activities in North an South Kordofan
13. Plan of Action - North Kordofan 1988
14. Plan of Action - South Kordofan WES Project 1988

APPENDIX (3)

TRANSPORT AND EQUIPMENT

The projects operate the following vehicles and equipment:

| <u>DRILLING RIGS</u> | | | <u>NUMBER</u> |
|----------------------------|-----|--|---------------|
| Atlas Copco Rotamec 50 | | | 3 |
| Atlas Copco Aqua Drill 461 | | | 2 |
| Hands England 75 | | | 1 |
| Atlas Copco 606 | | | 1 |
| <u>TRUCKS</u> | | | |
| Mercedes Benz 1513 | 4x4 | | 26 |
| Mercedes Benz 1313 | 4x4 | | 3 |
| Bedford | 4x4 | | 2 |
| Austin | 4x2 | | 2 |
| Scania 111 | 6x4 | | 5 |
| <u>LIGHT 4X4 VEHICLES</u> | | | |
| Toyota Land Cruiser | 375 | | 33 |
| Land Rover | 110 | | 14 |
| <u>COMPRESSORS</u> | | | |
| Atlas Copco HCRHS | 350 | | 1 |
| Atlas Copco HCRH | 350 | | 1 |
| Atlas Copco HCR | 350 | | 2 |
| Atlas Copco HCR | 210 | | 5 |

In general the project's vehicles, trucks, rigs and compressors are considered appropriate, except for the crawler mounted Atlas Copco 606 blast hole drilling rig and silenced, trailer mounted Atlas Copco XRHS 350 compressor. It is understood that these two units have been added to the projects, free of cost, from the UNHCR project. Presently suspended UNHCR Project.

The present policy of standardization of transport and equipment has yet not been fully implemented as is evident from the above

table. Neither are light vehicles, trucks or plant sold after 3, 5 and 10 years respectively as was planned.

The planned life span or depreciation time frame is reasonable under the conditions in the project area. On the other hand it could be argued that depreciation would be better calculated on usage basis i.e. km on hour used.

Operation, maintenance and spare parts stock keeping would be facilitated and the overall project cost reduced would the standardization and disposal plans be put into effect. When considering the severe climatic, and road conditions under which the projects are operating is of paramount importance and should be realized as soon as possible.

It is understood that the major constraint for sale of vehicles and equipment that has come to an end at their economic life, a prerequisite for implementing the replacement policy, is the bureaucratic process within the Government of Sudan. Only once have obsolete vehicles and equipment been sold, and some equipment have been awaiting sale, for over a year.

NRWC and UNICEF need to make a concerted effort in resolving this issue. The prevailing unfavorable currency exchange rate and anticipated high resale value are additional important factors for urgently resolving this issue. The proceeds from the sale would be utilized for procurement of replacement vehicles and equipment through UNICEF's reimbursable procurement system.

Compressors are presently standardized to one make. The projects operate 4 different models which must be considered unnecessary. Efficiency and speed of the operations may be improved if the model been standardized to say the XR 350. This size of compressor is needed for operating the Aqua Drills and would improve the efficiency of the hydraulic rigs.

The compressors being the most sensitive piece of equipment necessitating stand-by capacity, however to have two stand-by units, which now is the case, is considered excessive. One XR 350 may be shared between the two projects, North and South Kordofan

The drilling rigs while appropriate could also be standardized and configuration "sub-structure" be improved. The following improvement and changes are recommended:

- Provide a sub-frame for the Atlas Copco 606 rig and have it mounted on a Mercedes Benz 1513 truck.
- The trailer mounted compressor XRHS 350 have it installed on a Mercedes Benz 1513 truck.
- Reduce the number of drilling rigs by selling the odd Hands England rig.

The regular maintenance and repair of the vehicles and equipment are professionally and correctly carried out, however day to day care of particularly light vehicles could be improved. A number of minor unattended to faults on light vehicles were observed like mal-functioning door locks, missing rear view mirrors, broken tail lights, cracked wind screens etc. The bonus scheme recently introduced for drivers who look after and care for their vehicles may well improve this situation.

The project policy of having overhauled replacement units in stock like spare engine, gear box, alternators, starters, etc. is good, as it reduces down time on vehicles and equipments as well as cost of spare part stock keeping. When a unit is replaced, the old one is overhauled and kept as spare and only the actual parts needed for the overhaul are ordered and fitted.

In general workshops and spare parts stores are tidy, well equipped and organized. Staff appear to be well trained and motivated. However it was noticed that parts like filters were not always well protected and in some cases directly exposed to dust. This should be corrected and all filters protected in plastic bags. Also there were cases of the same stock item being stored in different section of the store. It would facilitate store management if this was corrected.

The 9 Bedford, Austin and Scania trucks should all be phased out as they are all beyond their economic life, as well not being compatible with the standardization policy. These trucks should be replaced by Mercedes 1513 as soon as the financial resources of the projects would allow.

The 14 Land Rovers that have or shortly are coming to an end of their economic life, should likewise be replaced by Toyotas within the coming year.

Transportation of imported supplies from Port Sudan to the project sites, reportedly pose major problems in ensuring uninterrupted project implementation due to the unreliable railway transportation system. It is believed that most of the inland transportation constraints would be overcome, would the projects have capacity to transport most of the urgently need supplies from Port Sudan to Kordofan with their own fleet of trucks. The railway would then only be used for bulk supplies like cement, casing, bentonite, pipes and pumps. For this purpose some 4 additional trucks may be required.

The cost of implementing the above recommendations is estimated as follows:

| <u>ITEM</u> | <u>COST ESTIMATE</u> |
|---|------------------------|
| Truck Mounting of the 606 rig and XRHS 350 compressor | US\$ 150,000 |
| Replacement of 9 Bedford, Austin and Scania trucks | US\$ 500,000 |
| Replacement of 14 Land Rovers | US\$ 240,000 |
| Provision of Fleet for inland transportation | US\$ 225,000 |
| | ----- |
| T O T A L | US\$1,115,000 ===== |

The sale of the obsolete equipment and vehicles could add substantially especially with the present exchange rate, to the amount of hard currency when converted through the UNICEF reimbursable procurement system. Approximations below are based on the earlier sale of vehicles and equipment.

| <u>To be Sold</u> | <u>Approximate resale Value</u> |
|---|---------------------------------|
| Hand England 75 with mud pump and and compressor | US \$ 280,000 |
| The 9 Bedford, Austin and Scania trucks | US \$ 270,000 |
| The 14 Land Rovers | US \$ 110,000 ===== |
| T O T A L= | US \$ 660,000 ===== |

Consequently the actual additional cost of reaching full standardization as well as providing inland transportation capacity would be in the range of US \$ 450,000 a reasonable amount considering the expected benefits this would accrue to the projects in ensuring uninterrupted operations, lowering vehicle and equipment maintenance costs and increasing overall output.

TABLE (a)

ACCEPTABLE AND ALLOWABLE CONCENTRATIONS OF
CHEMICALS AND PHYSICAL SUBSTANCES IN DRINKING WATER

| Substance - Chemicals | Limit mg/L | |
|---|----------------------|--------------------------------------|
| | Standard | Maximum Acceptable |
| Total Dissolved Solids | 500 | 1500 ^a |
| Colour | 5 units ^b | 50 units ^b |
| Turbidity | 5 units ^c | 25 units ^c |
| Taste | unobjectionable | - |
| Odour | unobjectionable | - |
| pH Range | 7.0 - 8.5 | Less than 6.5 or greater than 9.2 |
| Calcium (Ca) | 75 | 200 |
| Magesium (Mg) | 50 | 150 |
| Sulphate (SO ₄) | 200 | 400 |
| Chloride (Cl) | 200 | 600 |
| Magnesium + Sodium Sulphate | 500 | 1000 |
| Iron (Fe) | 0.3 | 1.0 |
| Manganese (Mn) | 0.1 | 0.5 |
| Copper (Cu) | 1.0 | 1.5 |
| Zinc (Zn) | 5.0 | 15 |
| Ammonia (N) ^d | 0.01 | 0.5 |
| Nitrate (NO ₃) ^e | 10.0 | 10.0 |
| Flouride (F) ^f | | |

(a) Maximum allowable under Canadian Drinking Water Standards and objectives 1968 is 1000mg/L.

(b) Platinum - Cobalt scale.

(c) Turbidity units.

(d) Canadian Drinking Water Standards and Objectives 1968.

(e) Canadian Drinking Water Standards and Objectives 1968. High nitrate concentrations are significant due to potential dangers to health when using the water for infant feeding.

(f) Canadian Drinking Water Standards and Objectives 1968 state that the concentration of naturally present flouride in water should not exceed 1.5 mg/L constitute grounds for a dental health survey and consideration for defloridating the water. The presence flouride in concentrations more than 2.4 mg/L shall constitute grounds for rejection of the supply (Ministry of the Environment Ontario, Canada).

ALLOWABLE CONCENTRATION OF TOXIC SUBSTANCES

| <u>Toxic Substances</u> | <u>Maximum Allowable Concentration, Mg/L</u> |
|-----------------------------|--|
| Arsenic (as As) | 0.05 |
| Barium | 1.00 |
| Boron * | 5.00 |
| Cadmium | 0.01 |
| Chromium (as Cr hexavalent) | 0.05 |
| Cyanide (as Cn) | 0.20 |
| Lead (as Pb) | 0.05 |
| Selenium (as Se) | 0.01 |
| Silver (as Ag) * | 0.05 |

* Canadian Drinking Water Standards and Objectives 1968

Table (c)

BACTERIOLOGICAL QUALITY STANDARDS

The standard used for the evaluation of the microbiological quality of drinking water is the total coliform method. Both multiple-tube fermentation technique resulting in the most probable number (MPN) and the membrane filter (MF) technique, may be used to enumerate coliform bacteria for the purpose of assessing water quality.

The limits of total coliform organisms in drinking water enumerated by the MPN multiple tube fermentation methods are set out in the International standards for drinking water as follows:

"In 90 percent of the samples examined throughout any year, coliform bacteria shall not be detected or the MPN index of coliform micro-organism shall be less than 1.0. None of the samples shall have an MPN index of coliform bacteria of 10."

As the analysis of a single sample can indicate no more than the conditions prevailing at the moment of sampling, the quality of a water supply can be assessed only by a series of samples over a period of time. The frequency of analysis should be established by the regulating authority(ies). It is suggested that the minimum number of samples to be collected from any borehole supply system and the frequency of sample collection be as follows:

BACTERIOLOGICAL SAMPLING FREQUENCY

| <u>Population Served</u> | <u>Minimum Number of Samples Per Month</u> | <u>Minimum Frequency Sampling</u> |
|--------------------------|--|-----------------------------------|
| Up to 100,000 | 8 + 1 per 1,000 population | Weekly |
| House hold | Seasonal | Seasonal |

List of Figures

- Map of Sudan
- Map of Kordofan
- Map of Sudan with WES-Projects

- Organogram of the South Kordofan WES-Project
- Organogram of the North Kordofan WES-Project

- Evaluation of boreholes in North-Kordofan
- Evaluation of boreholes in South-Kordofan

- Analysis data of water (WES-Project Kadugli)

- Cost der successful borehole
- Accumulated successful borholes in Kordonfan Region/Sudan
- Monitoring of handpumps in Dubeitat Town
- Project target viz achievement
- Number of village health committee
- Number of VIP-latrines

- Number of cases of diarrhoe in Kazgail and Khortagquat (Sheikan) between July 1988 and June 1989
- Number of diarrhoe cases in Sheikan village in 1988-1989
- Incidence of selected environmental diseases in Tumaïd Village /North Kordofan in one month, selected March, dry season
- Sketch of an epidemiological model of the complex influence of water onto the health of a population
- The effect of women's time allocation on nutrition
- Hand pump, sanitation, economy and landuse interaction proces

List of Abbreviations

| | |
|-----------------|--|
| WES (WATSAN) | UNICEF-assisted Water, Sanitation and Health Education Project |
| NRWC | National Rural Water Corporation |
| NCDRWR | National Corporation for the Development of Rural Water Resources |
| MFEP | Ministry of Finance and Economic Planning |
| MOH | Ministry of Health |
| VHC | Village health committee |
| VIP | Ventilated Improved Pit-latrine |
| EPI | Extended Program on Immunization |
| HP | Handpump |
| ORS | Oral Rehydration Solution |
| NMRDP | Nuba Mountain Rural Development Project |
| NGO | Non Government Organization |
| EEC | European Economic Community |