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Refugee water supplies in Somalia and Sudan

SUMMARY

The Register of Engineers for Disaster Relief (REDR) has over the last five years sent 70 engineers on missions of three months' duration to 10 countries worldwide for 8 international agencies. The water supplies and to a lesser extent the sanitation programmes in the semi-arid zones of North-western Somalia and Eastern Sudan were just two of the many schemes conceived and implemented by REDR engineers, public health specialists and medical teams from the Non-governmental Organisations (NGO's).

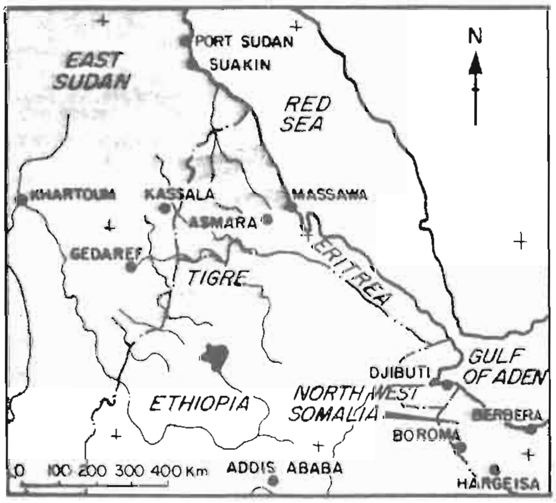

FIG 1. REGIONAL MAP

Both programmes were large scale, each serving around 400,000 and 200,000 refugees respectively, and had to be implemented immediately and progressively, requiring a high degree of improvisation and the sound application of both high and low technology. The "appropriate technology" ranged from hand dug wells sited with information from a small water proving rig, to boreholes drilled using large commercial rigs. Wells were variously equipped with diesel, solar and hand pumps. Polluted surface water supplies were filtered, stored and simply chlorinated. Aquifers were tapped using infiltration galleries, and were enlarged artificially through the construction of "saturated sand storage dams".

The health of large refugee communities can be improved by the development of relatively <u>low cost</u> water supply and sanitation solutions based on the application of <u>'appropriate' low and high technology</u>

For convenience Parts I and II of the paper are subdivided into the three development phases used in the OXFAM Refugee Health Care Guide (1). These are:

(a) Initial Assessment - "To determine the health and nutrition needs ..."
(b) Initial Relief Phase - "To respond to the specific health problems.."
(c) Consolidation Phase -"To set up a health care system which will attempt to maintain an appropriate level of health .. not markedly superior to that available to the local non-refugee population ..".

PART I - NORTH-WESTERN SOMALIA REFUGEE WATER PROJECT

1.1 Introduction

This part of the paper covers the general development of the water supply programme, in the 9 large refugee camps of NW Somalia.

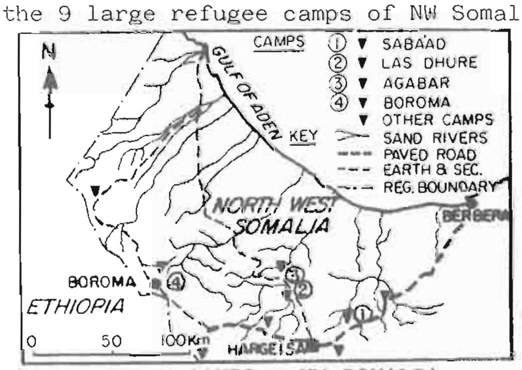

FIG 2. REFUGEE CAMPS - NW SOMALIA

In 1980 the United Nations High Commissioner for Refugees (UNHCR) asked OXFAM to be the implementing agency for water supplies in these camps where the water supply situation was most acute both in terms of quantity and quality. The state of health was described as hazardous.

1.2 Initial assessment

1.2.1. <u>Alternative sources</u>. These were investigated in 81 by a REDR engineer working as OXFAM's team leader.

After eliminating the possibility of making permanent connections to existing town supplies, (townspeople were short of water), or of developing new deep boreholes sources (past experience suggested that a thorough hydro-geological survey would first be required), it was decided in the first instance to consider developing the shallow groundwater in the Wadis (sand rivers) to their fullest potential. These ribbon aquifers were the traditional sources for waterholes and were already being used by the refugees.

1.2.2. Sand rivers as a source The team leader had previous experience of 'sand river' development in Botswana (2,3), was aware of the development of 'saturated sand storage dams' on such rivers in neighbouring Namibia (4,5), and realised their potential, even as a long term source.

Although the saturated sand in the ribbon aquifers in NW Somalia was typically only 1 to 3 m thick, thus having low unit water storage and being subject to high evaporation loss, this was compensated by the frequent recharge of the aquifers. Discussions with local people revealed that in the areas of the camps where catchment areas were frequently several hundred km^2 in extent, the sands were recharged by floods several times per year. This was confirmed by a study (6) which revealed that major floods were mainly generated by rainfall 'thresholds' of intensity equal to or exceeding 24 mm/day, indicating on rainfall records of 20 years that there were unlikely to be less than 4 'threshold' events in a year, and that only once in 40 years would the aquifer not receive any usable replenishment at all. Furthermore the aquifers near the camps were recharged over the greater part of the dry season from the sub-surface outflows from extensive aquifers further upstream. The water was generally of low salinity and good bacteriological quality.

It was concluded that a system based on the construction of shallow wells and infiltration galleries along the sand rivers, supplemented by saturated sand storage dams, could supply drinking water to most camps at a rate of about 5 l/hd/d during the most critical drought period in years of normal rainfall.

1.3 Initial relief phase

1.3.1 Developments Immediately after the assessment, the camps were replanned to discourage the pollution of the 'sand river aquifer'. Refugee housing was moved away from these sources, and refugees were directed to use designated 'defaecation fields' or build pit latrines on a family basis.

Typically at camps with populations of more than 30,000, 10 to 15 wells between 2-3.5 m in diameter and 3.5 - 6 m in depth were dug in the river terraces and underlying basalt rocks along a 3 km river frontage. Wells gave an average yield of only 10 m^3/d during the dry season (5 l/hd/d) and it was therefore necessary to control average consumption to this level through a policy of minimum distribution within the camps. After deepening using Pionjar hand held drills, wells were lined with Armco culverting and infiltration galleries made from locally available 200 mm dia rigid plastic pipe slotted by hand. Water was pumped directly to steel and plastic tanks at the wells and distributed to standpipes nearby.

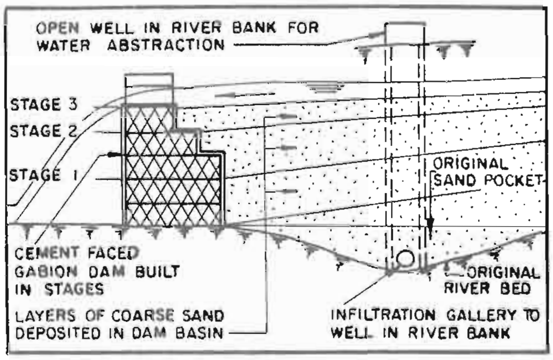

FIG 3. STAGED DEVELOPMENT OF SAND STORAGE DAMS

1.3.2. Sand storage dams These were started in the outlets to the ribbon aquifers Las Dhure and Sabaad camps. They had an immediate beneficial effect, since they were impermeable structures keyed to the existing rock barriers, of diverting the whole subsurface flow to the wells. Later on, the coarse sand and gravel river bed loads built up to cill level over the flood season. Thus the aquifer storage capacity was increased artifically and the water below 1 m depth protected from the effects of evaporation. The reliability of the aquifer as a source increased dramatically even by an initial 1 m heightening of the 50 m wide structures (6).

1.4.1. Consolidation phase. This took the form of the further development of the shallow groundwater using open wells and sand dams, following premature and unsuccessful attempts by others to locate deeper groundwater in any quantity. Diesel pumps were supplemented with 25, SEI 250 solar pumps at times when fuel was in short supply. These units typically delivered 2.5 l/s at a lift of 5m. Evaluations of solar pumping stations for both irrigation and water supply have been undertaken (7, 8), but not in refugee camp situations where they have considerable potential. Simple back-up water chlorination facilities were provided at all camps.

The sanitation systems have been slow to develop for largely social reasons. Fortunately the Somalia sun has been found to be a great steriliser during the dry season.

1.5. Assessment of project

This project confirmed "sand rivers" as potential sources of good quality and moderately reliable quantities of water for refugee water supplies which have to be developed quickly This lead in part to the development of the OXFAM water kit as standard disaster relief equipment (9).

The shallow well programme designed originally for a life of five years has provided water to 400,000 people at an initial capital cost of £2 per refugee, with an annual equipment replacement and maintenance cost of £0.5 per refugee (10, 11).

"Saturated sand storage dams" have exceeded the highest expectations as an aquifer improvement technique.

PART II - EASTERN SUDAN REFUGEE WATER PROJECT

2.1. Introduction

This part of the paper describes the typical problems and solutions associated with the water supplies, and to a lesser extent the sanitation, in the refugee camps of Eastern Sudan and in the adjacent areas in Eritrea and the Tigre province of Ethiopia.

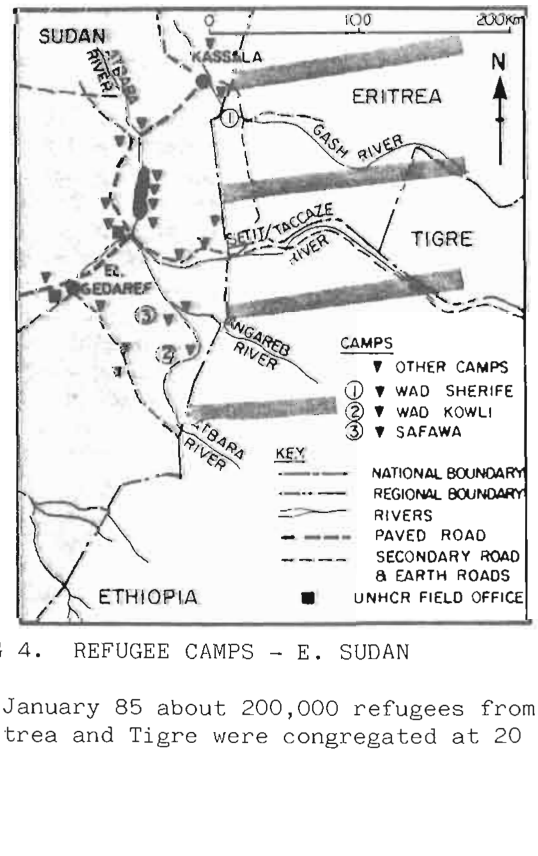

FIG 4. REFUGEE CAMPS - E. SUDAN

In January 85 about 200,000 refugees from Eritrea and Tigre were congregated at 20 camps; 70,000 being at Sherife, 25,000 at Wad Kowli, and 20,000 at Safawa. The camps were initially sited by the first refugees, who, once inside the host country, decided to travel no further than the first available water source.

During February 85, with refugees still in a debilitated state after a three to five week journey on foot to Sudan from a famine and war stricken area, and with these refugees taking water from stagnant pools located in the river bed and having no sanitation facilities, the overall mortality rate at Wad Kowli was 8.6 deaths per 10,000 per day. For children under five, the rate was 22.2 deaths per 10,000 per day. Although it would have been difficult to have distinguished between the mortality and the morbidity attributable to polluted water and/or lack of proper sanitation, it was against this background of crisis that UNHCR and COR (Sudanese Commissioner for Refugees) called in OXFAM to establish and maintain the "best possible water supply systems in the main camps". Similarly the IRC (International Rescue Committee) were asked to initiate a sanitation programme at Wad Kowli.

2.2. Initial assessment

The assessment of the water supply and sanitation situations was undertaken in January 1985 by the OXFAM/REDR and IRC engineers and specialists. At Wad Kowli water was taken directly from polluted surface pools in the rocky river bed, and at Wad Sherife the supplies were dependent on a single borehole and shallow wells supplemented by an unreliable and costly emergency tanker supply from a good quality source 30 Kms away. There was little prospect of 'sand river' exploitation as in Somalia, the area being covered by impermeable black cotton soils

It was decided to speedily develop the local sources of water to supply the whole camp populations at an absolute minimum rate of 5 l/hd/d with water of improved bacteriological quality, and provide basic improvements to both storage and distribution. For this work OXFAM immediately requested a team of REDR engineers to work with associated NGO's to install various packages from the OXFAM Water kits (9) held in store in the UK and airfreighted to the Sudan.

2.3. Initial relief phase

2.3.1. OXFAM water kits. High priority was attached to the installation of packages from these kits. The design population for each kit was fixed at 5000, but larger populations could be served by multiples of these basic package units. The basic capital cost of this system was £2 per refugee per year.

These kits were designed to handle raw water with reported typical faecal coliform bacteria concentrations per 100 ml ranging from 10-100,000 for rivers, 1300-1900 for ponds, 5-10 for protected wells and 0-100 for boreholes. The normal seven packages were as follows:

a) well construction package covering shallow wells up to 10 m in depth to boreholes even greater than 40 m in depth.
b) pumping packages for wells and boreholes.
c) storage package consisting of corrugated steel tanks with butyl rubber liners.
d) floating surface water intake package.
e) sub-surface abstraction package.
f) treatment package incorporating settlement, slow sand filtration and chlorination.
g) distribution package including pumps, pipes and standpipes.

2.3.2. Development of the water sources. At Wad Sherife camp the REDR engineer found that the existing local water supplies comprised one borehole fitted with pump and standpipe giving 8 m^3/h, and hand dug wells. There were also five unused boreholes, two of which were fitted with hand pumps, all situated in a proven aquifer close to the camp consisting of a 20 m thick stratum of sand and gravel overlying the granite basement. The water table was 10 to 20 m down. Despite being capped with a 10 m thick layer of silty clay, the aquifer was recharged annually via a connection from the Gash river. The water quality was good but tended to be slightly saline near the camp.

Unfortunately the potential of this proven aquifer had not been appreciated earlier by the authorities, and largely unproductive efforts had been made to develop alternative sources on much less favourable sites. High priority was given to rehabilitating the 5 unused boreholes originally drilled by the Dutch Government (KADA), and the siting of a further 5 250 mm dia boreholes in the proven aquifer. Also to obtaining the essential compressor, surge plunger, baler, screens and test pumps which had been lacking in the earlier abortive drilling programme.

The existing wells were rehabilited in 6 weeks by KADA, and when fitted with borehole pumps each produced between 30 m^3/d and 120 m^3/d thus ensuring a total of 500 m^3/d to the population (7-8 l/hd/d). The 5 additional boreholes were later drilled to the granite basement at 30 m depth using minimum bentonite, properly screened and developed and fitted with Mono lift pumps to provide the badly needed standby capacity. Since there is always the risk of pumping rates exceeding the natural recharge rate it will be necessary to continually monitor the factors. This is doubly necessary in emergency situations but is rarely appreciated by non-engineers.

2.3.3. Water distribution and sanitation. At Wadi Kowli camp IRC's sanitation specialist found a desperate public health situation. Refugees were taking water directly from pools in the river bed, though chlorine tablets were being added to individual containers as they were carried away. Relief took the form of improving the health of the refugees through feeding programmes, medical services, and clean water and sanitation provision.

Initially water was trucked-in from a relatively unpolluted source 30 Kms away which fed 9 OXFAM storage tanks with a total capacity of 450 m^3. Later water was pumped directly to these tanks from an infiltration gallery set 2 m below the bed of the Atbara river. Using the appropriate packages from the OXFAM water kits this water was filtered, chlorinated and fed to standpipes by gravity and pumped to clinics, hospital and feeding centres.

Sanitation was limited at this stage to the demarkation of 'defaecation fields' and spraying in hospitals, feeding clinics and feeding centres.

2.3.4. Water proving rig for well programme. In the mountain areas of Eritrea and Tigre, on the main migratory routes of the refugees to and from the Sudan, impressive and far sighted programmes of 50 wells, infiltration galleries, sand dams and surface dams have been undertaken. The wells, often 20 to 30 m in depth and 5 m diameter have been excavated using hand tools and explosives in hard precambrian rocks to locate the limited points of fracture and weathering where water might accumulate. Each well has taken months to construct and has often intercepted dry season flows of only 5 m^3/d. A DANDO 110 hydraulic rotary rig, is now being used to prove the supplies of water in advance of the well digging teams to ensure success. The specification for this rig required a coring and down-the-hole hammer drilling capability to 50 m depth in hard crystalline rocks, and an augering capability for the 'sand rivers' down to 20 m - an example of just one of the innovative water resource investigation and conservation techniques presently being tried.

2.4. Consolidation phase

This is in the very early stages at camps like Wad Sherife and Wad Kowli. Plans have however been made to improve all the emergency works, to develop the existing and new sources using the appropriate level of technology, and to train workers to maintain and improve these systems. Environmental health personnel are being trained to encourage the building of pit latrines, garbage collection, clothes washing and delousing.

Limited consolidation has begun in the areas of bordering Eritrea, where steps are being taken to reabsorb refugees returning home after the rains. In parallel with the well programme already described, a parallel programme of deep borehole drilling is underway using a rotary rig with down-the-hole-hammer capability to depths in excess of 200 m.

2.5. Assessment of project

This project illustrated how an NGO like OXFAM with limited technical capability, but with the support of REDR engineers and other specialists, was able to implement a large water programme. The timely availability of the OXFAM water kits was a key factor in the programmes ultimate success.

Drilling programmes must be preceeded by proper hydro-geological investigations so as to avoid abortive work, and once developed must be professionally monitored. Without the water project the earlier life saving efforts of the medical teams would have largely been wasted. Sanitation is recognised as being the most difficult part of any health programme. Regrettably it is often accorded low priority by non specialists, despite the fact that the lack of safe disposal of faeces is a major cause of refugee ill-health and can lead to potential epidemics. Sudan is no exception in that there is a gap between 'recommendations' and the 'approval and implementation' by the authorities.

CONCLUSIONS

These schemes illustrate that there is rarely just one approach to refugee water supplies and sanitation. Plans have to be modified constantly because of changing circumstances, requiring a flexible attitude on the part of REDR engineers. If refugees moved, water points had to move; if existing local interests were threatened by the water abstractions for the refugees, alternative services had to be developed quickly. There were set-backs to the programmes, but these were eventually overcome. Gradually but steadily the water supplies were improved and the sanitation facilities formalised, and in consequence the Works contributed in large measure to the long term improvement in Refugee Health.

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