Rural Water Supply Assessment

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Executive Summary

SWALIM conducted a desk study assessment to determine the water supply situation in rural Somalia. The assessment was done in three regions: Puntland, Somaliland and South-Central Somalia. The Somalia Water Sources Information Management System (SWIMS) national database was the main source of data for the study. Reports from previous studies and interviews with key partners in the water sector in Somalia were also very fruitful during the assessment.

The assessment involved review and analysis of available data and literature on existing water supplies. Interviews were conducted in Nairobi, Puntland and Somaliland with key players in the Somali water sector. Field visits to some water points were also made by two consultants, one in Puntland and another in Somaliland, to see the condition of the water sources and to interview operators and water users.

The findings of the assessment were similar in many aspects for the three regions, with only slight differences between them.

In Puntland, the assessment concluded that:

1. Shortages in water supply are not only a function of limited water sources, but also as a result of frequent breakdown of the sources.
2. Rural communities in Puntland try to cope with water shortages by minimizing the amount of water usage per day. In many cases this compromises hygiene standards, creating some health risks.
3. The combined use of water sources by livestock and humans poses evident hygiene risks. Well-head protection is not common for many of the surface water sources and shallow wells. Surface water containing animal faeces runs into open sources, thereby contaminating water.
4. The Puntland authority is unable to support the much-preferred community-based water supply projects, making people more reliant on external donors. Such donors are seen as providers rather than facilitators, a perception which ought to be changed if water supply projects are to be sustained.
5. Community water supply projects are generally more poorly managed than private projects. People are more willing to invest in their own private water supply, but there is mistrust when it comes to communal water sources. Most of the community-owned *berkads* and *wars* are unfinished and lack maintenance. A more commercial approach, such as the Public Privatization Partnership (PPP) utilities for managing rural water supply systems ought to be given a chance to evaluate their success.
6. Women are sidelined in the management of water sources. In the WATSAN committees where women are represented, such women are seldom involved in decision-making.

Conclusions for Somaliland were as follows:

1. More boreholes need to be established in Somaliland as a way of solving frequent water shortages during the dry season. There is however little information available on hydrogeology to identify the best locations for establishment of boreholes. A mechanism should be devised to make boreholes sustainable. Suggested options include the use of wind and solar energy for water pumping to minimize running costs.

The use of mono pumps was also considered viable, as they consume less fuel. Where there are multiple boreholes in the same area, power supply should be centralized to reduce running costs.

2. Shallow well aquifers in rural Somaliland are not well developed. Many of the shallow wells dry up in the *Jilaal* and *Hagaa* seasons.
3. There are many sources with water unsuitable for human consumption, but locals use them either out of ignorance or because they do not have an alternative. More awareness needs to be created regarding water quality.
4. The rate of *berkad* failure is alarming, with over 50% of *berkads* constructed breaking down within five years. The high failure rate is attributed to poor construction and maintenance routines. There is a need for development of standard construction guidelines to be used across the country.
5. Construction of sand storage dams, sub-surface storage dams or weirs, should be encouraged as ways of conserving water for long periods. With sand dams, water loss due to evaporation, which accounts for substantial amounts in open water bodies, is minimised.
6. There is a water policy for Somaliland, but the government lacks the capacity to impose it. Water regulations need to be approved by parliament, and the Ministry of Water and Mineral Resources capacitated for effective management of the water sector.
7. Water sources in rural Somaliland are managed either by committees, or individuals in the case of private sources. For sources administered by the Ministry, communities select the operators and the Ministry trains them and sets the water price. Due to weak governance in the public water sources by the Ministry, cost recovery moneys are always missing.
8. Hygiene facilities in rural Somaliland are limited; people live in poor sanitary conditions. Water availability is explained in terms of quantity, not quality. Much still needs to be done to promote improved hygiene and sanitation practices.
9. There is no proper coordination of public and private water sources in Somaliland. When establishing private water sources, many people do not conduct an Environmental Impact Assessment (EIA) to determine the effects of establishing the source on the environment.

The conclusions for South–Central Somalia include:

1. South-Central Somalia is much advantaged in terms of surface water resources compared to other regions of the country. The two major rivers, the Juba and Shabelle, if well–utilised, can provide most, if not all, water requirements.
2. Underground water reservoirs in South-Central Somalia are not fully exploited. Even though local people prefer surface water for domestic consumption, water from underground sources can be used for livestock and agriculture.
3. Use of water resources for economic development is inefficient due to lack of a water policy. There is a need for the Somali government to regulate water use by developing and imposing a water policy on all stakeholders in the sector.
4. Water quality is a major issue in South-Central Somalia. To the Somali community, due to high scarcity quantity of water available is more important than quality. This has contributed to a large extent to frequent outbreaks of cholera and other waterborne diseases in the region.

- A thorough survey of water sources in South-Central Somalia is necessary in order to determine the exact situation on the ground. The desk study for this region was not all-inclusive, as there was no data available for some regions.

The findings of the assessment were presented to the WASH committee of the Somali Support Secretariat (SSS) for review. Comments raised were incorporated in a comprehensive report of the assessment. The report is intended to be used by donors and development agencies in rural Somalia to make decisions regarding intervention activities on water sources.

Glossary of Somali terms

Berkad	Underground reservoir, lined or un-lined, excavated to store surface runoff
Ceel	Hand dug wells
Deyr	Rainy season between October-December
Gu	Rainy season between April-June
Hagaa	July to September dry and cool season
Jilaal	Dry season from January to April
Mugciid	Underground reservoir storage well with an average depth of 15 meters
Togga	Seasonal river
War	Unlined dug-out (dam), usually 2-3 m deep

List of abbreviations and acronyms

ADRA	Adventist Development and Relief Agency
BWR	Basic Water Requirement
CBO	Community-based Organization
COOPI	Cooperazione Internazionale
E.coli	*Escherichia coli*
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization of the United Nations
GAA	German Agro Action
GRC	German Red Cross
GTZ	German Technical Cooperation
GUMCO	Golden Utilities Management Company
ICRC	International Committee of the Red Cross
IDP	Internally Displaced Person
INGO	International Non-Governmental Organization
ITCZ	Inter-Tropical Convergence Zone
JNA	Joint Needs Assessment
LNGO	Local Non-Governmental Organization
MCH	Mother and Child Health Centres
MDGs	Millennium Development Goals
MPWTCA	Ministry of Public Works, Transportation and Civil Aviation
MWMR	Ministry of Water and Mineral Resources
NCA	Norwegian Church Aid
NGO	Non Governmental Organization
NW	North West Region
NWC	National Water Centre
PET	Potential Evapotranspiration
PHAST	Participatory Hygiene and Sanitation Transformation
PPP	Public Private Partnership
PSAWEN	Puntland State Agency for Water, Energy and Natural Resources
PVC	Polyvinyl Chloride
SRCS	Somali Red Crescent Society
SSS	Somali Support Secretariat
SWALIM	Somalia Water and Land Information Management
SWIMS	Somalia Water Sources Information Management System
SWL	Static Water Level
TDS	Total Dissolved Solids
UN	United Nations
UNDOS	United Nations Development Office for Somalia
UNDP	United Nations Development Programme
UN-HABITAT	United Nations Human Settlement Programme
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UN-OCHA	United Nation Office for the Coordination of Humanitarian Affairs
USD	United States Dollar
WASH	Water, Sanitation and Hygiene committee
WATSAN	Water and Sanitation
WDA	Water Development Agency
WHO	World Health Organisation

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1.0 INTRODUCTION

Situated in the Horn of Africa, Somalia has a total area of 637 600 km^2. It shares the border with Kenya, Ethiopia and Djibouti. The coastline extents from the Gulf of Aden (Red Sea) to Indian Ocean, a total of 3 300 km, the longest in Africa. Figure 1.1 shows the regions and respective districts in the country.

Generally, Somalia has an arid and semi arid climate. About 60% of the country is under savannah woodlands, used mainly as rangelands. Only about 13% of the land can be cultivated, most of which is in the south. The country has rich fishing grounds along the coast, though this has never been fully exploited.

The northern part of the country is mountainous, while the south and eastern sections are characterized by narrow coastal plain and interior plateau. There are extensive undulating plains occasionally interrupted by areas of dissected terrain and isolated hills.

1.1 Overview of Water Resources in Somalia

Water is one of the primary driving forces for sustainable development of any country. Being located in an extremely water-scarce area, the environmental, social and economic development of Somalia is to a large extent dependent on improved water security through effective management of water resources. Water resources in Somalia are limited both in quantity and quality, with frequent droughts and floods further worsening the water security situation in the country. A lot still needs to be done in the rural populations to be able to meet the Millenium Development Goal 7 Target 10, "to reduce by half the proportion of people without sustainable access to safe drinking water."

Before the onset of civil war in early 1991, the main institution in charge of water resources management in Somalia was the Ministry of Water and Mineral Resources (MWMR) through the National Water Centre (NWC). Exploitation of domestic water supplies was the responsibility of the Water Development Agency (WDA), while the ministry of Agriculture planned and operated water for agricultural activities in the Shabelle River. For the Juba River, development was the responsibility of the Ministry of National Planning and Juba Valley Development. Institutional arrangements of water resources management showed fragmentation, without a clear divide between the functions of national and local agencies. With the outbreak of civil war in 1991, much of the water infrastructure in Somalia was destroyed and social services such as health, education, water and sanitation were seriously affected.

UNDP (2003) estimated that about 69% of the nine million Somalis lived in rural areas. The pastoral nature of the rural dwellers requires them to constantly search for water and grassland. With an average growth rate of 3%, there is increasing pressure on available resources both for domestic and pastoral uses. SWALIM undertook this assessment to identify existing water sources, their current status and their ability to meet increasing water demand in rural Somalia.

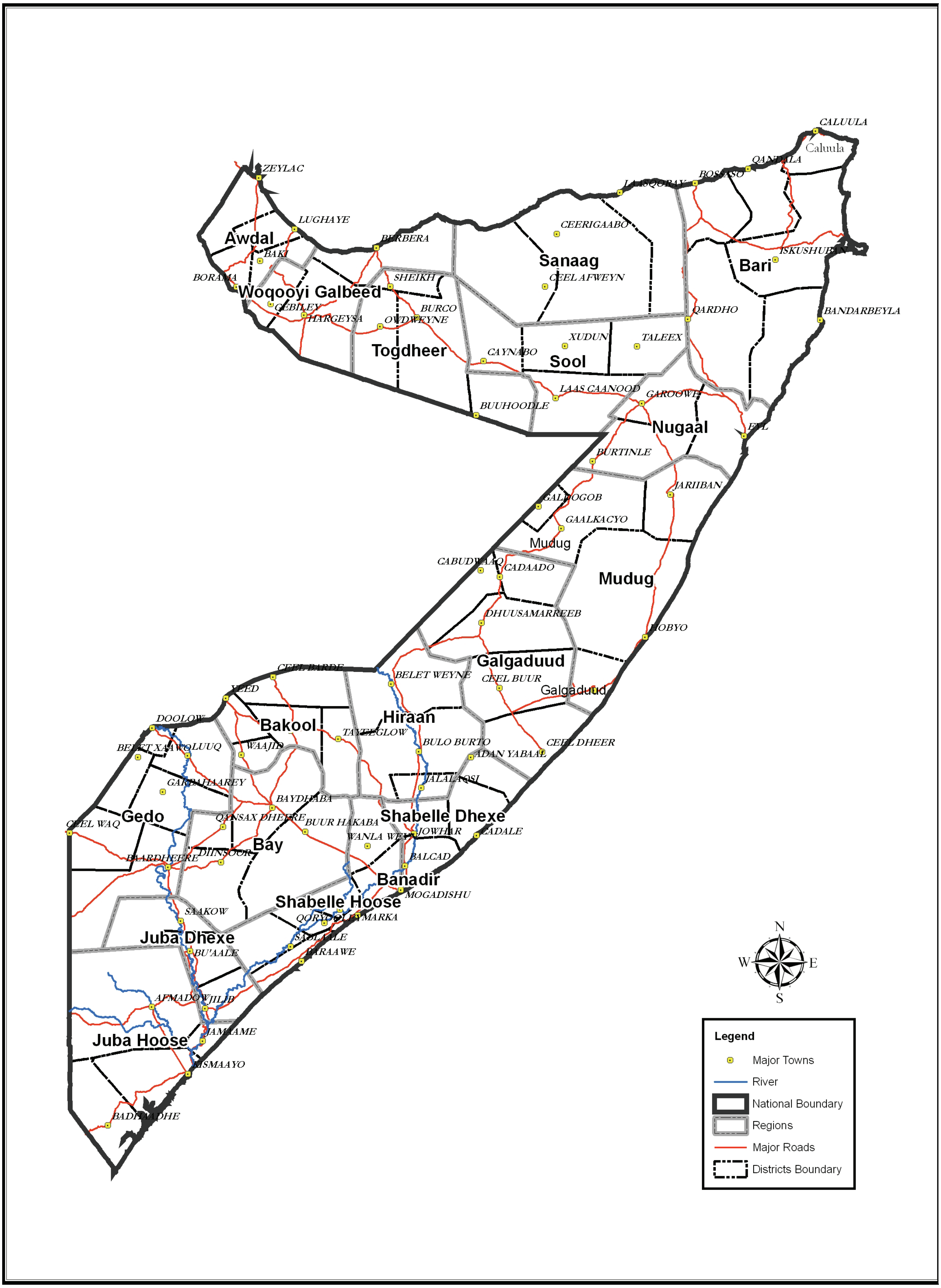

Figure 1.1 Administrative map of Somalia

1.2 Water Quality Guidelines

Unsafe water can lead to disease outbreaks, which are difficult to control considering the limited health facilities and services available to pastoralists and agro-pastoralists living in rural Somalia. In agro-pastoral communities, while people may or may not understand the health hazards posed by consumption of dirty water, they lack obvious mechanisms for improving the quality of water they consume. There is also a general perception that disease and death are pre-determined and unavoidable. Most communities have little knowledge of water-related diseases and modes of transmission, hence awareness training is required. The most common water-related diseases are diarrhoea (especially in children under five years), typhoid, malaria and trachoma, common amongst people living in the vicinity of springs.

Water quality is determined by performing physical and/or chemical analyses. Some tests can be done in the field, such as temperature, pH and electrical conductivity (EC). However, most chemical analyses are more complicated and need to be done in an equipped water laboratory. There are no such water-testing laboratories even in regional headquarters in Somalia. Before the fall of the Somali government, Water Development Agency monitored water quality, but currently, there are no proper monitoring systems and rural populations are more concerned about water quantity than quality. During scarce periods, local people make use of any available water, regardless of quality.

Water quality is to a large extent dependent on the type of water source. Open sources such as *berkads*, dams and shallow wells have a high possibility of water contamination from the surrounding environment. Interviews conducted confirmed that there are many *berkads* and dams where animals and humans obtain water direct from source, further increasing contamination risks from faecal bacteria.

Internationally, there are acceptable standards for water requirements for basic needs, commonly referred to as Basic Water Requirement (BWR). This defines water requirements in terms of quantity and quality for the four basic needs of drinking water; human hygiene; sanitation services; and modest household needs (Gleick, 1996). Table 1.1 gives recommended daily basic water requirements for human needs.

Table 1.1 Recommended daily water requirements

Purpose	Recommended minimum litres/person/day)	Range (litres /person/day)
Drinking water	5	2 to 5
Sanitation service	20 to over75	--------
Bathing	16	10 to 70
Cooking and kitchen	10	10 to 50
Total recommended BWR	50 litre	

Minimal water needs for different climatic zones as discussed by Gleick (1996) in the context of international water laws is summarised below:

Table 1.2 Minimum water needs

Climate Zone	Public stand post (litres capita day)	House connection (litres capita day)
Humid	10 to 20	20 to 40
Average	20 to 30	40 to 60
Dry	30 to 40	60 to 80

Acceptable values of the water quality parameters depend on the purpose for which water is intended. Limits are set by the World Health Organization (WHO). Safe drinking water, for example, should have a pH of 6.8 - 8.5. The acceptable EC values in (micro ohms/cm) are 500 for human, 8 000 for shoats and 12 000 for camels (WHO, 1996). According to SPHERE, the Total Dissolved Solids (TDS) and Electrical Conductivity (EC) for domestic water should be less than 1.0 mg/l and 2000µS/cm respectively. For public water supplies, the WHO recommends a faecal coliform concentration of zero per 100 ml while SPHERE standards recommend faecal coliform concentrations of less than 10/100 ml for domestic water supplies.

A number of the most common chemical contaminants in drinking water originate from the naturally occurring minerals in rocks. Most of these chemicals are however not toxic, unless their concentrations are high. WHO guidelines on the maximum allowable concentrations of these chemicals in drinking water are given in Table 1.3.

Table 1.3 Guideline values for naturally-occurring chemicals of health significance in drinking-water (WHO, 2000)

Chemicals	Guideline value[1] (mg/litre)	Remarks
Arsenic	0.01 (P)	
Barium	0.7	
Boron	0.5 (T)	
Chromium	0.05(P)	For total chromium
Fluoride	1.5	Volume of water consumed and intake from other sources should be considered when setting national standards C[2]
Manganese	0.4	
Molybdenum	0.07	
Selenium	0.01	
Uranium	0.009 (P,T)	Only chemical aspects of uranium addressed

Sources: WHO

Generally, groundwater supplies are more likely to have problems associated with dissolved chemicals, whereas surface water systems are likely to have problems associated with microbial agents. The most common source of microbial contamination is local septic systems. Dissolved iron and corrosion caused by acidic water are also common.

The efforts by the government and private sector to meet the demand for water in the rural Somali should be guided by these standards. Both the quantity and quality water requirements should be met for the rural water supply to comply with the MDGs.

[1] Abbreviations used for provisional guideline values are as follows: P = evidence of a potential hazard but the available information on health effects is limited; T = calculated guideline value is below the level that can be achieved through practical treatment methods, source protection, etc.

[2] C=concentrations of the substance at or below the health-based guideline value may affect the appearance, taste or odour of the water, resulting in consumer complaints.

1.3 Objectives of the Assessment

The objective of this study was to assess rural water supplies for Somalia, and make recommendations to guide the development and donor community in Somalia in prioritizing interventions, rural community assistance and development strategies towards meeting rural communities' water needs.

1.4 Structure of the Report

The Rural Water Supply Assessment report is presented in three main chapters: Puntland; Somaliland; and South-Central Somalia. In each chapter, the general characteristics of the water sources in the region, technologies in use, management structures, water quality, demand and associated problems are described.

2.0 ASSESSMENT METHODOLOGY

To achieve its objectives in assessing rural water supply and demand, SWALIM carried out field visits to selected water points in Somalia, conducted interviews with stakeholders in the Somali water sector, analysed SWIMS national database and reviewed related documents.

2.1 Field Visits

Visits were made to some selected water points in Somaliland and Puntland to assess the operational status of the water sources. Operators, local elders and users of the water sources were interviewed.

2.2 Key Contact Interviews

Further interviews were conducted in Nairobi, Somaliland and Puntland with government and private agencies working in the Somali water sector. Organizations interviewed included PSAWEN, MWMR, ADRA Somalia, GRC, Caritas, UNDP, UNICEF, UN-HABITAT, ICRC, COOPI, CARE Somalia, NCA, Horn Relief, Islamic Relief, Diakonia Sweden and Water for Life.

2.3 SWIMS National Database

The Somalia Water Sources Information Management System (SWIMS) national database was used in determining the spatial distribution and condition of different water sources. However, the database listed only 740 water points, far less than the expected number of sources in Somalia.

2.4 Documents Review

To supplement the SWIMS data, a number of documents related to water supply and demand for Somalia were reviewed. The SWALIM library was a useful source of such documents, both in hard and soft copy. A number of agencies visited also provided valuable documents for the assessment from their libraries and field reports. A list of key references consulted appears in the bibliography.

Information gathered was compiled into a report - *Rural Water Supply Assessment* for Somalia, divided into three chapters; for Puntland, Somaliland and South-Central Somalia. The findings of the assessment were presented to the Water, Sanitation and Hygiene (WASH) sector committee for review. The report was further improved following suggestions from the WASH committee.

PUNTLAND

3.0 PUNTLAND

3.1 Background

The Puntland State of Somalia covers Mudug, Sanaag, Bari, Sool, Nugal and Galgadud Regions. UNDP (2003) estimated the total population in these regions to be about 1 283 722, of which 67% live in the rural areas.

Puntland has a varied morphology, including mountains, valleys, plateaus, sloping plains, coastal hills and dunes The eastern area is characterized by mountainous areas, plateaus and valleys, with the southern part deeply incised by *Togga* Nugal. The total catchment area for *Togga* Nugal is 70 000 km^2, draining the Nugal and parts of the Togdheer and Sool Regions. The central area is marked by a high mountain range running parallel to the shores of the Gulf of Aden, incised by numerous *toggas* flowing towards the Gulf. There is a large plain sloping gently towards the south. The western area is characterized by a large, gently undulating plateau delimited to the north by a mountain range. The northern part of the western area constitutes a sloping plain and coastal strip.

The climate in many parts of Puntland ranges from arid to semi arid, which when coupled with poor soils limits agricultural development in the region. The mean annual rainfall ranges from less than 100 mm along the coast to 450 mm in the mountain ranges (Muchiri, 2007, SWALIM Technical Report No.W01).

The main economic activity for the rural population is livestock grazing. Crop growing is only practiced along the riparian belts of major *toggas*. However, in recent years the use of groundwater for irrigation of alluvial land has increased considerably.

The people of Puntland rely heavily on groundwater for most of their water needs, due to a lack of reliable surface water sources. Both permanent and seasonal water sources exist. The permanent water sources include natural springs, oases, boreholes and some relatively deep hand-dug wells (*ceel*), while seasonal sources comprise man-made earth dams (*wars*), *berkads* and natural depressions.

3.2 Surface Water Sources

3.2.1 Rivers and streams (toggas)

There are several large water catchments draining the Nugal, Sanaag, Bari and Sool areas of Puntland, but there are no perennial rivers. Faillace (1986) noted that there are high mountain ranges parallel to the Gulf of Aden with numerous seasonal rivers (*toggas*) flowing either to the Gulf of Aden or southwards to the sloping plains and valleys in Nugal and Mudug regions. The main water courses are the Nugal and Danor valleys, which transverse the central and southern parts of Puntland. Water along these valleys is found immediately beneath the ground surface. One such *togga* is shown in Figure 3.1.

Figure 3.1 A typical *togga* of Nugal Valley

3.2.2 Dams (wars)

War refers to unlined dug-out, mainly 2–3 m deep with a surface area of hundreds to thousands of square meters. *Wars* are dug by an excavator, which drops the loose materials onto a wall on the downstream parts of the dug-out. Water is led by ditches to the *war*. Figure 3.2 shows a *war* in Nugal Region.

Figure 3.2 A small *war* in Nugal Region

There are few *wars* in Puntland Region, most of which were excavated by Africare in the early nineties. ICRC and other INGOs have also excavated several *wars* in recent years. Water retention time in a *war* is dependent not only on water usage, but soil type and condition as well. Proper site selection is therefore necessary for the *war* to be able to hold water for longer periods. In Qarxis for example, it was confirmed that a *war* in the area kept water for more than a month after the natural depression dried out (NCA, 2006). However in Xiriro, NCA reported that people were less content with the local *war* since it could not keep water longer than most *berkads*, in addition to the water being turbid. Generally, NCA evaluates *wars* as unsustainable water sources because of siltation and maintenance problems. They are also not easy to organize and maintain at community level, especially when initially done by outsiders.

Current technology in development and use of *wars*/dams needs to be improved for enhanced water supply and hygiene. As previously mentioned, dams have higher water holding capacities than *berkads*. If adopted, they could boost rural water supply during the dry season. Dams are however uncommon in Puntland, partly due to high construction costs but also due to the permeable lithology in many parts of the region. Thorough assessments need to be made to identify sites for potential dam construction with minimum water loss due to seepage. Annual evaporation rates in Northern Somalia are also quite high, about 3 000 mm, and need to be considered when identifying suitable dam sites. Some pilot projects have been identified by NCA at Dhadar, Jaceel and Ismadhaqa valleys for dam construction.

For dams to be sustainable, proper design and site investigation are necessary. Proper soil tests should be done to determine their permeability. Sites involving minimal earth-moving are more suitable since they save on earth-moving costs. Other factors to consider are:

- Dam depths should be high enough to compensate for evaporation and leakage loses while retaining enough water to serve the intended purpose.
- Walls are well-compacted with properly designed spillways to avoid dam failure.
- Dams are well protected to prevent direct access by animals, for hygiene purposes.

In the long run, dams are more economical than *berkads*, considering the cost of water purchased when the latter dry out shortly after the end of the rains. Dams constructed next to *toggas* can serve as flood control structures by holding excess water during flood periods, and later releasing the water for use during dry periods.

3.2.3 Berkads

A *berkad* is a catchment for surface run-off. In its most primitive form, this is simply an excavation in poorly permeable soil to a few metres depth. Surface run-off during rainfall is directed to the excavation. As run-off collects in the pool, clayey and silt sediments settle, eventually forming a seal at the base of the *berkad*. Care is taken when desilting *berkads* to avoid destroying the sealing layer.

Modern *berkads* are constructed with concrete and consist of a catch-pool before the main pool to act as a sediment trap. The majority of concrete *berkads* are privately owned and used not only for domestic water supply, but as a source of income as well through sale of water. The most typical concrete *berkads* are rectangular, approximately 20 m long, 8 m wide and 4 m deep. They may be fenced or covered by thorny scrub to deter wild animals and prevent them falling into the pool. During rainy periods, most *berkads* fill in a matter of hours, depending on rainfall intensity. The water does not however last long in the dry period due to the small size of the *berkad* and the large number of users. When *berkads* dry, refilling is usually done from the nearest permanent sources via tankers. Water is fetched from *berkads* using a bucket-on-a-rope system. Contamination from animal excreta and other foreign particles is high, since the top is open. Animals or even people also risk falling into the open *berkads*.

There are only 51 *berkads* within Puntland in the current SWIMS database: 3 in Bari, 6 in Mudug, 23 in Sanaag and 19 in Sool Region. It is common knowledge that there are far more berkads in Puntland, even if not currently documented. Many pastoralists use *berkads* to water their animals and for other domestic water needs, especially soon after the rainy season. Due to limited capacity, the majority of *berkads* do not survive long dry periods, leaving locals to search for alternative supplies.

Even though berkads are common water sources in Puntland, rural communities face many challenges in their use, mainly due to poor construction and unhygienic water extraction methods. Such challenges include:

- High rate of *berkad* failure
- Increased incidences of water borne diseases such as malaria and hepatitis
- High maintenance costs

To overcome these challenges, there is a need to improve on current technology, involving:

- Improving the masonry construction of *berkads* with strong foundations and proper joints. Circular *berkads* with reinforced walls have been found to last longer than rectangular *berkads*.
- Introducing roofed *berkads* to reduce evaporation, as well as curbing mosquito breeding and algal development. Currently, rural people are covering *berkad* tops with tree branches to reduce evaporation.

During the dry period, berkads are filled with water trucked from long distances. The water tankers used for water trucking are privately-owned and most are in bad condition. As many people continue to depend on these trucks for their water supply, it is necessary to investigate how government authorities might in future guarantee distribution without taking over businesses from entrepreneurs. Suppliers need to be educated on how to keep water free of contamination during filling, transportation and distribution.

Text Box 3.1 Selected *berkads* in Mudug Region

1. At the privately-owned *berkad* at Ba'adwayn (Figure a) the price of water for human consumption is 0.07 USD per 20 litre jerrycan. For animal consumption, a 50 litre jerrycan would cost the same amount. The *berkad* owner irrigates a small plot of land adjacent to the *berkad* for cultivation of tomatoes and melons. Inhabitants of Ba'adwayn prefer *berkad* water to the motorised borehole water, despite the high cost of water from the *berkad*, since it is not saline. The *berkad* owner would allow the very poor and needy of the community free access to drinking water (ADRA Rural Water Supply Assessment, 2005).

2. The *berkad* at Qarxis (Figure b) was still two-thirds full when visited three months into the dry period. The owner sold water at 0.07 USD per 200 litre drum (*NB - this may be a mistranslation of "drum" during the interview; the price might be for a 20 litre jerrycan)*. This water is only used as drinking water. Livestock use nearby, more saline dug wells (ADRA Rural Water Supply Assessment, 2005).

3. A water vendor from Marayo village (50 km away from Qarxis) purchases water from the Qarixis *berkad* and sells it from a storage cistern in waterless Marayo at a rate of 4 USD per 200 litre drum or 0.4 USD per 20 litre jerrycan. Marayo imports around 100 drums of water per week, implying a drinking water expenditure by the 300-400 village families of around 400 USD ($1 per family per week). The camels at Marayo drink saline water from local shallow wells. Marayo would be better with its own *berkads*, although construction in the hard gypsum rock would be difficult and runoff would have high concentrations of soluble gypsum.

4. Of the communities visited, Marayo had the highest expenditure on water. Coincidentally, it is also the only locality where significant child malnutrition was noted. This may be related to low availability of hygienic water, or low residual cash available for food purchase (ADRA Rural Water Supply Assessment, 2005).

(a) *Berkad* at Ba'adwayn

(b) *Berkad* at Qarxis

3.3 Groundwater Sources

3.3.1 Shallow wells

Shallow wells are hand-dug, mainly to a maximum depth of 1 m below the water table. The depths of shallow wells vary from region to region, depending on water table levels. There are few wells fitted with pumps, and the main water-lifting device in Puntland is the bucket and rope. Such water extraction method limit the amount of water that can be extracted, which is discouraging to the community using the well but beneficial in terms of sustainability of the aquifer. Once established, maintenance costs of running a shallow well under the bucket and rope extraction method is minimal. As such water is rarely sold, or a fee charged is minimal. In communities with scarce drinking water, shallow wells yielding saline water may be used by livestock while humans use water from *berkads*. However, in many nomadic communities the same dug well is used for livestock watering and human consumption. The sharing of water source between animals and humans, coupled with lack of well-head protection results in very high potential for transmission of faecal pathogens. Well-head protection and the construction of designated drinking water wells in such communities should be the main focus of the WATSAN programs.

There are many shallow wells in Puntland, although the assessment could not establish the exact number in each region. From the SWIMS database, 17 of the 42 existing shallow wells in Puntland are found in Bari region, with 15 in Nugal, eight in Sanaag and 2 in Mudug regions. Text Box 3.2 gives examples of shallow wells in the Qorqolo area, extracted from the NCA assessment report.

Text Box 3.2 Nomads' shallow wells at Qorqolo

1. Dhuur is an area rich in acacia trees and thorny shrubs, where semi-nomadic and nomadic communities live. The location is underlain by permeable limestone and appears to be in a slight topographic depression. There are 20-25 shallow wells serving a population of 5 000-10 000 nomads. Water is slightly salty and used for watering animals (10 000 camels, 200 cows and 40 000 shoats). The wells are owned by the community and the majority dry out during prolonged dry period. Water extraction is by bucket and rope.
2. In Gogobo, many semi-nomadic and nomadic communities live along a broad *wadi*, which is reported to have had meaningful flow only once in the last 45 years. The communities extract water from wells dug along the *wadi*. There is only one permanent dug well, 7 m deep with a diameter of 1.5 m. The well penetrates the water table by about 1 m. and was constructed under the community's own initiative about three years ago. ICRC is reported to have had some inputs as well. The well has concrete rings and the head is adequately protected. The water is slightly salty but potable, serving about 5 000 families with 1 000 camels and up to 6 000 shoats daily. There are usually long queues for water due to the slow bucket and rope method. Other dug wells in the region are not permanent, and require frequent re-digging to reach water levels.
3. Fishing communities living in the beach dunes of Garacad and Kulub were severely struck by the 2004 tsunami. The communities are wholly dependent on dug wells in beach dune sands for water supply. Along the beach, a thin layer of less dense fresh groundwater "floats" on denser salty marine groundwater. Wells are thus excavated to just below the water table to skim off the fresh groundwater.

4. In Garacad a short distance north-east of Hobyo town there is a fishing community of 200 families which was severely hit by the 2004 tsunami, with 20 lives lost, 200 boats washed away and 800 families displaced inland due to loss of beachfront dwellings and livelihood. Sanitation is poor, with defecation taking place in the sand dunes. Water supply is from wells dug in the beach sand just behind the fore-beach ridge, to a depth of about 20 cm – 1 m below the water table. Well heads are mainly protected by car tyres, and the wells are in most cases too close to the shanties erected by tsunami survivors, worsening the already poor hygiene.
5. The situation at Kulub is similar. The beachfront community was devastated by the tsunami (35 people died and 4 000 people lost their homes and were displaced. 5,000 people remain in the old town on the back-beach ridge. More than 85 boats were lost, together with the refrigerated warehouses essential to the fishing export industry. Wells have been dug in the sand area between the fore- and back-beach ridges. Currently the wells yield fresh water and are used for livestock watering and human consumption. They are about 2 m deep, penetrating 30 cm below the water table. They are uncovered and often have to be re-excavated each day (NCA assessment, 2006).

Different types of shallow wells

Modern technology has not yet been fully incorporated in shallow well construction in Puntland, with most wells being unlined and well heads unprotected. The majority of shallow wells are hand dug, making it difficult to penetrate hard calcrete and gypsum layers. Wells lack screens, tending to lower water quality depending on soil/rock types down the profile. In the deeper wells, well-sinkers are exposed to risks of loose boulders. In addition, failure to penetrate the water table to any great depths is a frequent cause of dry shallow wells during the dry seasons. Water extraction is mainly by bucket and rope, making water vulnerable to contaminants.

Lack of proper investigation before digging shallow wells occasionally results in wells being dry despite a lot of time and resources having been expended in establishing them. These are among the challenges faced by the people of Puntland as a result of poor drilling and operational techniques of shallow wells.

There is a need to adopt modern technologies for drilling, operation and maintenance of shallow wells. Detailed exploration such as the use of geo-electric or seismic soundings and use of experienced well sinkers should always be the starting point when establishing wells. Hand-digging of wells should also be replaced with machine drilling whenever possible, to ensure that sufficient depths of water are penetrated to ensure permanent water yield and safety of the well sinkers. Well construction should be standardized across the country, with more emphasis on hygiene standards. This would require covering of all water heads and the use of hand-pumps as a way of protecting the source from contaminants.

A long-term shallow well programme should be based on privately operating well sinkers with inputs from local agencies and communities for sustainability of the project. Standard construction standards ought to be developed to guide the process of well drilling and construction.

3.3.2 Boreholes

Boreholes are the most common permanent water source in Puntland. PSAWEN estimates that about 45 boreholes are currently operational (the same number is reflected in the SWIMS database) across the regions, with 17 in Mudug, 9 each in Sanaag and Mudug, and 8 in Bari region. Some boreholes date back to the 1960s, but most were drilled in the 1980s and mid-90s by international organizations. Borehole depths range between 30 to 300 m, but in some cases water can be as deep as 440 m. The water table varies across the regions. In Bari for example, water can be reached at 30 m, eastern Sanaag at 120 m, Nugal at 160 m and Mudug at 230 m.

Deep motorized boreholes initially appear to be an attractive option for water supply. They ‘magically’ supply large quantities of water without the need for a tedious bucket and rope water lifting system. By tapping into deep aquifer strata, this offers a greater degree of hygiene than dug wells and *berkads*. Motorized boreholes can also be attractive to nomadic herders, generating revenue from sale of water and enhancing trade in foodstuffs such as milk and meat.

There are however some negative aspects of using motorised boreholes for water supply. The large amounts of water they abstract can deplete aquifers, especially in cases where borehole use is not monitored, as is the case in many parts of Puntland. Boreholes are also very expensive to drill and construct. On average, the drilling cost according to SWADCO is about 320 USD/m. Pumps and generators are also costly. Most pumps used in Puntland cost between 2 000 – 3 000 USD, while generators may cost over 10 000 USD. A typical 150 m deep borehole installation could therefore easily cost over 60 000 USD. In cases where there is limited information on groundwater, such an investment goes to waste when, after drilling, water turns out to be of poor quality for human and livestock consumption. Salinity is the most common water quality problem in Puntland.

Development of new motorized boreholes can radically change settlement and grazing patterns in surrounding areas and, in the worst cases, can cause deterioration of grazing lands.

Boreholes owned by communities are regarded as “state property” and are managed by a rather nebulous group of operators or committee of elders. Other boreholes are quasi-privately owned, where borehole operation is entrusted to a small number of individuals in the community. In both cases, water for human consumption is provided free, but a fee is charged on water for animals to recover the running costs. The fee charged on water however does not please many Somalis, since they believe that water cannot be sold for commercial gain. The quasi-private schemes are far more successful than those in communal ownership.

Revenue collected from the sale of water is used to cover running costs, mainly diesel for the generator and paying wages to operators. The revenue is however reported to be inadequate to repair pumps and generators in case of breakdowns, in which event communities have three options:

1. Appeal to the international community or Somali diaspora for assistance.
2. Arrange a major fundraising within the community.
3. Raise their hands in despair that such an unforeseen event has happened, and revert to using dug wells, *berkads* or water tankering from a nearby village.

Many NGOs on the ground associate the frequent failure of boreholes to:

1. High operational costs, which may not be recouped from the sale of water. Water sales depend on the season, and are usually minimal during the wet season when other surface sources are available.
2. Poor management and lack of a strategic economic plan for borehole operation.
3. Income not earmarked to cover pump replacement or generator repair.
4. Occasional lack of spare parts and technical support for operators.

In times of breakdown, boreholes are often seen by local people (especially low-income groups) as an economic burden rather than a social good. The most sustainable options should be evaluated when establishing boreholes. Suggested technologies to minimize breakdown/s include:

1. Use of PVC pipes rather than galvanised steel pipes for underground pipe networks where water is salty, to minimise corrosion.
2. Use of surface-mounted turbine pumps, with a submerged impeller rotated by a motor mounted at the surface with no electrical intermediate stage, as opposed to electric submersible pumps which are difficult to repair.

Borehole drilling, construction and use in Puntland has not been successful in many regions due to:

1. Lack of security in some areas where drilling machines are a target for looters.
2. Cost recovery for boreholes has not been forthcoming, and a series of boreholes are needed in one area for a sufficient supply of water to the community.
3. Limited hydrogeological information resulting in dry boreholes.
4. Over-extraction of fresh water, at times resulting in poor quality underground water.

Existing boreholes are fitted with motorized pumps for water extraction. However, pumps often break, making borehole sustainability a big burden on locals as the majority earn meagre incomes.

There is a need modernise technologies used in borehole drilling and operation, for better performance of the sector. This would involve:

- Effective prospecting techniques (such as geophysics).
- Efficient drilling techniques applicable to karstic aquifers and marly beds.
- Detailed borehole descriptions, including geophysical borehole logging.

- Correct well finishing, including right positioning of screens, well-calculated filter screens, use of plastic casings and screens if possible, and good grouting of upper layers.
- Use of corrosion-resistant materials and other anti-corrosion measures.
- Training of drilling teams and operators on installation, operation and maintenance of boreholes and pumps.
- Standardization of construction, and operation of boreholes and related equipment.
- Production of simple manuals for operation, maintenance and monitoring.

Communities ought to have resources to manage and sustain the boreholes. Currently, they rely more on donors for major repairs and replacements. In future, development programs should look into the possibility of providing credit facilities to communities to facilitate purchase of pumps and spares for generators. Money collected from sales of water can then be used to repay the credit.

Text Box 3.3 Examples of motorised borehole schemes at Bitale, Hingot & Galkayo

1. The public borehole at Bitale was drilled in 1986 with Saudi funding by a German company to replace a broken borehole previously drilled by the Italians. In 2002/03 ICRC constructed an additional reservoir and replaced the generator. The borehole, serving 10 000 people, is 230 m deep and has a capacity of producing 70-80m^3/day. Water is salty but potable. Revenue from sale of water covers diesel and operators' wages, while replacement of pump has been done through community fund-raising. An estimated 50 USD is collected daily from the sale of water (1 000 camels @ 3.5 USD per 100 units and 4 000 shoats @ 0.35 USD per 100 units). The 50 USD is used to buy diesel and pay the operators.
2. The borehole at Hingot was built in 1986 with Saudi funding by a German company, Borehole depth is 239 m (pump originally at 80.9 m). The water is reported to be somewhat salty and used only for livestock. The borehole has not been used for 1½ years due to pump failure. The generator and surface pipes have been removed for "safekeeping" and the borehole capped with concrete. The subsurface galvanised steel pipes were reported to be heavily corroded. According to Mr Nur of ICRC the control panel was stolen for sale in a local market and the pump failure was due to operators coupling the pump directly to the generator output. The community regard the well as "government property" and have no plans for replacement of the pump. As a result of the breakdown many nomads left the village, leaving behind about 2 500 people. The community now use water from *berkads* or water trucked from the Golol area 40 km away. Total daily water use in the village is 20 – 30 m^3 at an estimated cost of 30-45 USD.
3. In Galkayo, there is a 225 m borehole drilled by SWADCO. The borehole is in limestone and the main water table is reported to be 40 m below the ground surface. Water yield is 11 m^3/hr, which is pumped into a raised concrete water tower. Water works are run by a private company, which sell 1 m^3 of water at 0.3 USD.

Motorised borehole

An assessment by ADRA found some sustainable use of motorised boreholes in some places of Puntland. The people of Mudug and Sool Regions were found to have devised some copying mechanisms for water supply despite limited international humanitarian community workers in the region – an indication that there is still hope for Somalis to effectively manage water sources.

3.3.3 Springs

Springs are the traditional permanent water sources in Puntland. Spring water is however easily contaminated, and disappears rapidly into the permeable *togga* beds. The majority of springs in Puntland are found in the Bari and Nugal regions. According to the SWIMS database, there are 13 springs in Bari, 10 in Nugal, 2 in Sanaag and 1 in Mudug Region. In his 1986 survey, Faillace identified the following springs in Puntland:

- Ufayn gravity spring
- Ba'ad medium spring, 10 km from settlement
- Ufayn II, a small spring far from settlement
- Buq medium spring, in settlement
- Dhudo medium spring, in settlement
- Tooh/Qandala small spring, 12km from settlement

Several other springs were developed and/or rehabilitated in Puntland after the tsunami disaster in 2004. These include:

- Suuj, Eldhidir, Falahfalah and Qundheed springs, constructed by NCA
- Dhin kudhac, Kabal, Qulule and Garmale springs, constructed by ADRA
- Marayo spring, constructed by CARE International

Text Box 3.4 Selected spring at Marayo

To alleviate the present and long-term needs for Falahfalah water supplies, mechanized pumping systems were constructed to utilize spring water resources in the town's vicinity. Spring water is expected to yield significant water for both domestic and livestock use. The system at Marayo is designed to lift 5 m^3/hour of renewable fresh spring water for five hours a day. At peak times, Marayo's population is estimated to be about 120 households with 14.4 m^3 of water consumption per day. This leaves about 10.0 m^3 of water from the system for livestock. The exact numbers of livestock are unknown and they vary significantly with time.

A typical spring at Marayo

It is not documented how much water is extracted from these springs. Nevertheless, springs are important water sources and any long-term water development plan should include improvements in the use of spring water.

As mentioned, water extraction from springs is not a new technology in Puntland, but it is rarely used sustainably. Most springs are used in their natural form. Efforts to develop and protect springs have not been widely successful, mainly because spring water is taken free and users are not willing to pay for water even when pumped. Water extraction methods are poor, exposing the source to contaminants.

A number of springs in Puntland are permanent, with water flowing even during long dry spells, with great potential in supplying water to rural population for domestic and animal use, if well-utilised. Suggested improvements in the current spring technology include:

- Protection of sources against contamination, as most spring water is contaminated before it enters into a spring box or intake. Springs in *togga* bottoms are highly susceptible to flooding, and should be properly protected.
- When springs are used for multiple purposes such as domestic use, livestock watering, irrigation and tanker supply, care should be taken to prevent contamination of water used for human consumption.
- Installation of water lifting devices where springs lie below settlements. Water users in such situations are expected to pay for water, so that the system can be maintained. However, prices should be maintained at a minimum so that the locals can afford water.
- Piping of water to settlements far from sources, since many springs are found in mountainous zones away from settlements.

3.3.4 Sub-surface dams

Currently, only surface water dams exist in Puntland. However, as technology advances, one might consider alternative, sub-surface types of dams. Such dams would intercept inter-flow in the permeable *togga* beds, with the advantages of reduced evaporation and improved water quality. Such dams are either made of clay wall constructed in a trench, or a masonry wall on top of an impermeable valley bottom. In this case, as the river-bed is raised, an artificial valley fill is created. The dam is then raised in steps until the desired height is attained. Wells are then established in river beds where water is collected. Alternatively, filter tubes (infiltration galleries) are installed near the dam wall, draining water to a reservoir.

The major limiting factor in Puntland is that most *togga* beds are too permeable to hold water for long periods. In other cases, *toggas* are too wide for dam construction, while on the limestone plateaus, soils are clayey and unsuitable for dam construction. Horn Relief identified the Dhadar/Jaceel valley and Ismadhaqa for pilot dam construction, but the dams are yet to be established.

3.4 Management Issues

Until 1991, when civil war broke out in Somalia, the responsibility for water resources was in the hands of the Water Development Agency (WDA). However, this national institute was mainly focused on Mogadishu and surroundings. Remote areas in the north received minimal attention, apart from the cases where boreholes were drilled. During the seventies and eighties WDA developed a water resources development plan intended to guarantee minimum water supplies to both nomads and their livestock. In the early eighties, a network of pumped water schemes was intensified by the Aquater water supply programme. Non-borehole water supply points in Puntland, developed mainly during colonial rule, such as Ufayn, Bander Bayla, Iskushuban and Qandala were rehabilitated by WDA and other non-national agencies. The operation and maintenance of deep well water supply systems was centralized. WDA employed operators mostly from outside the villages where sources were located. A maintenance team regularly inspected water points; local people contributed in a minor way to the operation and maintenance of the water sources, either in the form of labour or cash.

After the civil war, water committees were formed and their roles limited to facilitate and monitor projects funded by INGOs and UN Agencies. Evolving from the former water committee, the Puntland State Agency for Water, Energy and Natural Resources (PSAWEN) was created on 17th December 2000. It became fully operational in 2001 as the sole institution responsible for water, energy and minerals and was established as an autonomous agency under the Office of the President. However, in 2001 a new constitution ratified by parliament abolished the autonomy of PSAWEN, placing it under the Ministry of Public Works, Transportation and Civil Aviation (MPTCA). Currently, PSAWEN has offices headed by water coordinators in Bari, Nugal, Mudug, and Sool Regions, with plans to open more offices in Sanaag Region. In each regional office there are two divisions - one for sales with fee collectors, and the other for regional coordination, with 71 staff members. The current mandate of the agency is to report on the water situation, plan locations for service delivery in collaboration with implementing partners, and implement projects funded by partners through private companies or local NGOs. The water agency participated in the drafting of the Water Supply Policy Green Paper (JNA, 2006).

At present, each village with an operational water supply has established water committees. The Committee employ a care taker for the water source. The function of the committee is to keep the system running, which they manage to do so long as the pump and generator are in good working condition. In the case of a major breakdown there is little the committee can do, since they do not keep aside money for repairs. In most cases, they apply for support from either the government or foreign agencies.

Many people prefer the community-based management structure for the village water supply systems. There are a great number of unemployed skilled people, both technical and managerial, who can offer their services. Most of these are former employees of WDA. The capacity of water technicians in PASWEN is insufficient for them to support communities in development and sustainability of their water supply systems. During a JNA assessment in 2006, it became clear that communities are reluctant to return to centralized regional institutions. They prefer community-based management with privatised service-agencies for support, or Public Private Partnership (PPP) utility management.

There are, however, many shortcomings in the technical capacities of water supply institutions in Puntland. Some of these include:

- Lack of proper design for the water supply system.
- Drilling rigs are few.
- Limited capacity for water quality control in terms of resources and technology. Water treatment plants are absent and the majority of the population rely on UNICEF for chlorination of water sources.
- The water distribution network is limited, mainly due to limited resources.

3.5 Water Quality

For many rural populations of Puntland, water scarcity makes provision of an adequate supply of water at a convenient location from the homestead a priority at the expense of water quality. Hand-pumps are not considered viable because of frequent breakdowns and the lack of spare parts. Rural water interventions should aim at improving the standard of water sources, so as to minimize the risk of contamination.

A study conducted by NCA determined that in the peri-urban areas of Galcayo, 40% of samples collected from 22 different shallow wells had *E.coli* forms measuring below 100/100 ml, while 20% of samples had over 1 000/100 ml of water. All shallow wells sampled had motor pumps for water extraction. NCA (2005) recommended proper protection of shallow wells to prevent significant bacterial contamination. For many in the arid and semi-arid areas of Somalia, the greatest water quality concern is that of salinity, as ground water is often too saline for human consumption.

EC values for groundwater in many regions in Puntland exceed maximum recommended values. In Mudug and Nugaal regions for example, the mean EC value observed during a survey conducted by NCA (2005) was found to be 5,070µS/cm with a standard deviation of 3,721µS/cm.

There is limited information available about toxic substances in groundwater in Puntland. This can be attributed to the lack of water quality laboratories in the region where tests should be done. WHO water quality guidelines recognize that there are a number of sources of naturally occurring chemicals in drinking water, both organic and inorganic. Chemicals are absorbed as water moves through soil and rocks. The approach to dealing with naturally-occurring chemicals is expected to vary according to the nature of the chemical and the source. For inorganic contaminants from rocks and sediments, it is important to screen possible water sources to determine whether the source is suitable for use or whether it is necessary to treat the water. In cases where a number of sources are available, dilution or blending of water containing high levels of a contaminant with water containing much lower levels may achieve the desired result.

Reductions in quantities of water available to individuals directly affects peoples' health. As supplies are reduced, clothes cannot be washed, personal hygiene deteriorates, cooking utensils cannot be properly cleaned, food cannot be adequately prepared and personal water intake becomes insufficient to replace water lost from the body. The reduction in water quantity is reflected in increased incidences of infections, such as diarrhoea.

3.6 Current Water Use and Demand

Water in Puntland is not only a necessity for human life, but a key to the economy and livelihoods as well. Nomadic pastoralists who form the majority population in the rural areas require water in proximity to grazing land for their livestock. For villages with motorized borehole water supplies, income from the sale of water is used for the management and sustainability of the water source. Water can also be the magnet that attracts nomads to villages or towns and opens up the possibilities of trade.

The demand for water in Puntland can either be for domestic use or for livestock and to a minor extent, irrigation. Domestic water needs are a priority, but additional requirements for livestock, other community services and irrigation are equally important for economic development in Puntland. Lack of readily available water provides a limit to the rural population, their stock and economic development.

3.6.1 Domestic water use

The human body's basic water requirements depend on climate, workload and environmental factors. Minimum requirements vary between 3 and 10 litres per day. The amount of water needed for other purposes, including cooking or hygiene, is more variable and depends on cultural habits, socio-economic factors and types of water supply in terms of quality, quantity, availability and convenience. In Puntland, where it is estimated that 65% of the population live in the rural areas, only 8.2% (475 000) of the rural population has access to safe drinking water within a distance of 2 km (JNA, 2005). The rural population consists of pastoralists, semi-settled agro-pastoralists and some permanent village dwellers. Domestic water needs are met by seasonal rivers, springs, rainwater harvesting facilities, shallow wells and deep boreholes. However, rural peoples experience water shortages during the long dry season (*Jilaal*) when water is only available from groundwater supplies such as permanent springs, boreholes and a few permanent hand-dug wells. Drought and internal displacement severely constrain access to water, with supply needs often met through costly water trucking to water storage facilities in permanent settlements or directly to grazing areas (JNA, 2006).

Due to consequences of the war in the south, many people migrated to northern towns and villages, which became overcrowded but whose permanent water supplies did not expand proportionally. Consequently, the high price of water from water tankers caused the population to look for alternatives, some opting to migrate further to urban centres where water supply was better. The need to expand water projects in the rural has remained a priority, to meet the increased demand.

3.6.2 Agriculture and livestock

3.6.2.1 Agriculture

Agricultural development is limited in Puntland due to lack of water, poor soils and lack of tradition. Palm cultivation is practiced near springs (Buq, Iskushuban and Dhudho), while vegetable and food production are found in some mountain zones. Small plots of vegetables are found near some houses and in local depressions. In Mudug and Nugal regions, irrigation farming is done by tapping shallow aquifers in the two regions. According to an assessment made by the Bossaso municipality, the area has more than 42 rural settlements where farming is undertaken on the fertile soils. It is not clear if this is related to the suitability of the geology or to a particular microclimate. Bossaso town provides a ready market for produce (Khadar, 2006).

Considering the factors limiting agricultural production, water shortage is the major factor in Puntland. Water shortage is primarily caused by:

- Erratic rainfall in most areas of Puntland. On average, the annual rainfall is less than 250 mm.
- Limited regional groundwater resources.
- Extensive development of agricultural farming areas on the banks of *toggas*.
- Excessive use of shallow groundwater for irrigated agriculture, due to inappropriate irrigation management.

Water demand for irrigation and the consequent shallow groundwater abstraction in Puntland will rise steadily if more pastoral land is cultivated. It is necessary to analyse actual water use, water use efficiency and salinisation when setting up new agricultural strategies. This would include extensive site survey programmes for water consumption measurements to define surface and groundwater withdrawal for irrigation purposes, and a continuous programme of monitoring water use.

3.6.2.2 Livestock

Animal production is the basis of life for most people in the Puntland Region. Table 3.1 shows the numbers of livestock exported between 2001-2005 from Bossaso Port. Camels, sheep and goats are the most important species, with the sale and export of live sheep and goats being the mainstay of the economy. Milk, skins and hides are other products of the pastoral economy. Clark University (1994) estimated that there were 3 000 000 shoats, 1 000 000 camels and 100 000 cattle in Puntland. The price of a camel is estimated at 600USD, while that of a goat is 50 USD. Prices however vary from season to season, and from place to place.

Table 3.1 Number of livestock exported between 2001-2005 from Bossaso port

Year	Sheep/Goats (head)	Cattle (head)	Camels (head)	Total
2001	3,292,193	434,903	1434	3,728,530
2002	3,283,731	475,279	1,496	3,760,506
2003	2,458,442	72,214	1328	2,535,203
2004	1,161,968	76,753	2817	1,241,538
2005	1,487,101	90,544	7,833	1,585,478
Total	**11,683,435**	**1,149,693**	**14908**	**12,851,255**

Source: Bossaso port

Water supply is of paramount importance for growth of the livestock industry in rural Puntland. Water availability influences pastoralist movements and pasture utilisation. People with large numbers of livestock are forced to make huge investments in the construction of *berkads* for water storage. The lack of fresh water has far-reaching effects.

During the dry season, pastoralists move to the few areas where water is available. This results in rapid degradation of lands around these water points.

3.6.3 Projected water needs

Many rural communities in Puntland have insufficient water sources to meet projected demands. This fact, compounded by the impacts of recent droughts, continues to define and circumscribe economic and environmental well-being and quality of life in the region. This is particularly true in many small communities, which often lack the ability to meet pressing water supply needs and/or meet WHO safe drinking water standards and requirements without outside assistance from donor agencies. An in-depth analysis based on field assessments is necessary to quantify the projected water needs in Puntland.

3.6.4 Socio-economic context

Water is often a source of conflict among pastoral families in Puntland, as they compete for its use. Traditionally, ownership of water wells has been based on families, clan or sub-clans. Use of water is restricted to members of a particular family or clan. In rural Somali societies, the use of water as an economic resource to sustain herds of livestock representing the capital of nomadic families is as important as the use of water for human consumption.

During the regime of the former government before the war, water was seen as a social right, freely accessible to all. After the collapse of the government, water became an economic commodity commanding high prices. A big challenge is to organize revenue from water schemes to cover operational costs and save enough for new investments. Under certain circumstances, water costs are too high for local people to afford and in many communities there are systems in place to support poor people in affording water for their basic needs. In such a system, the wealthy have to pay more and bear the burden of the poor. The only problem occurs when there are alternative water sources which are cheaper, as no one is then willing to pay for water, making it difficult to meet the running costs of the water source.

In the dry season, most *berkads* and shallow wells dry up and families either migrate or individuals (usually women and children) have to travel long distances searching for water, at times walking 5-8 hours/day to fetch water. In some locations, water venders retail a 20 litre container for between 0.075 - 0.125 USD, a price that is too high for the majority of people who live on less than 1 UDS per day.

Many NGO-initiated WATSAN programs have tried without success to focus on women as key elements in the management of water sources in nomadic communities. In Somali societies, men are the main stakeholders in water sources and for sustainability of the water source then they have to be consulted. Where women are integrated into water committees, they seldom make decisions. Future WATSAN programs should seek to integrate women to a greater extent in the decision-making process and the management of water sources. PSAWEN and some INGOs tried to introduce policies aimed at reducing tension within the community, promoting a peaceful environment for sharing and managing water resources. Local authorities signed agreements that enabled implementation of water projects that guaranteed water access to all communities, thereby eliminating any particular individual, clan or sub-clan claiming ownership of the project.

3.7 Analysis of Major Issues

There are limited permanent water sources in Puntland; and where the sources exist, there is a high failure rate attributed to:

- Lack of involvement of the population and local authorities in selection of technology, implementation, operation and maintenance of the water source.
- Over-centralized maintenance and operational structures.
- Lack of finances at the community level for establishment and maintenance of water sources and distribution network.
- Use of sophisticated technology in establishment, operation and maintenance of the water sources, without proper capacity-building at community level.
- Deep water table and poor quality water.
- Lack of hygiene education.

Future projects should try to solve these problems to build up a sustainable water supply.

Where underground water is tapped there is a tendency to over-pump the water, leading to rapid depletion of the aquifer. Motorized boreholes occasionally result in rapid growth of villages around the borehole and can attract large numbers of livestock, resulting in overgrazing. Indiscriminate drilling of major groundwater abstractions should therefore be discouraged and any proposed new source/s subjected to hydrogeological and environmental impact assessments.

Many water-points in Puntland are rainwater catchments (*berkads* and *ballehs*), holding water for only a month or two after the rains. Boreholes and some springs are the main permanent water sources, but are very limited in number. Only 45 boreholes are known to be functional in the whole of Bari, Nugal, Mudug, Sanaag and Sool Regions of Puntland. Some of these boreholes were drilled in the 1960s, and are in poor state of repair, with frequent breakdowns. According to a survey report carried out by UNICEF, 50% of the population in Puntland state use *berkads*, 35% use boreholes, 10% shallow and hand dug wells, while only 5% use springs as their main source of water for human and livestock consumption. The 60% of the population who depend on temporary water sources face water shortage problems during dry periods. An assessment by NCA observed that many communities spend several tens of dollars per day in buying water from tankers. In Qarxis, 30 – 45 USD are spent daily in purchasing water for 2 500 people, while in Kalabayr a total of 57 USD is spent by the 400 families.

Capacity to pay for water is lower in villages than it is in towns. In all the regions of Puntland, there is a culture which rejects the sale of water for profit but accepts that water can be sold to cover running costs such as diesel, oil and operators' wages. Revenue is typically levied from fees charged for watering of livestock. Human consumption is seldom charged from motorized borehole supplies, but may be charged for supply from rainwater *berkads* and tankering. The very poor in the community are not charged at all for water use.

For a motorized borehole scheme to be sustainable there must be demand for water for livestock in sufficient quantities to offset borehole running costs. Fees levied must also be adequate to cover pump and generator depreciation and repair, which is seldom the case. Alternatively, there must be sufficient financial capacity within the community to levy the necessary costs for pump and generator replacement through fundraising. Currently, communities rely more on external donors in the event of a major breakdown in either the pump or the generator. If no assistance is forthcoming, then the water source is abandoned. There is a need to invest income from revenue collected from the sale of water to cover future infrastructure replacement needs. The operation of boreholes should also be delegated to a small group of individuals for better accountability, rather than the current common ownership managed by a committee.

Actual water consumption figures for Puntland are not documented. However, a study carried out by UNDOS in Nugal Region (ETC, 1996) implies that consumption is much lower than the recommended values (see table 3.2).

Table 3.2 Consumption by humans and livestock in Nugal Region (source: UNDOS)

	Consumption	Frequency	Quality (litre)
Cattle	20-25 l/h/d	daily	25
Sheep, goats	1,3 – 1,6 l/h/d	daily	1,6
Camels	9 – 1d2 l/h/d	weekly	80
Humans	5 l/p/d	daily	5

The figure of 5 litres/day for human consumption corresponds to rates given by people interviewed in the assessment, who gave daily consumption rates of between 2–10 litres per day. These rates of consumption are considerably lower than the 15 litres/day and 20 litres/day recommended for refugee/IDP population in the SPHERE guidelines (McConnan, 2000) and the PSAWEN Green Paper, respectively.

Much of the 20 litres/day normally considered adequate for human consumption in rural and per-urban areas is used for non-drinking purposes. In areas of extreme water shortage, non-drinking usage of water is minimized and affected communities have learned ways of coping with shortages. According to local communities the acceptable amounts are subjective, based on available water. Many would appreciate any slight improvement in quantities of currently available water, and a subsequent reduction in water costs.

3.7.1 Environmental, sanitation and health problems

Most water-points in Puntland are unprotected, making them susceptible to pollution. Poor sanitation characterises much of Puntland, where the majority of communities lead nomadic lifestyles. According to PSAWEN, over 80% of shallow wells in Puntland are unprotected and lack lining, exposing them to contaminated inflow. During rainy seasons human and livestock wastes are washed into un-protected water sources, increasing incidences of water-borne diseases like bilharzia, typhoid and dysentery.

Surface water supplies (dams, *berkads*, rivers) are breeding sites for mosquito larvae and contribute to outbreaks of malaria. Miscarriages by women are also a widespread problem in areas where water sources are located at the sea cliffs or at distances far from residential areas (NCA, 2006). The situation is worsened by lack of adequate health services in many rural areas of Puntland.

During drought periods, surface water resources in pasture areas dry up. Pastoralists have to move to areas near permanent water points for their livestock, usually resulting in environmental degradation around water points due to the large numbers of livestock concentrated in a limited area. There is an option of trucking water from other areas where water is available, but most pastoralists cannot afford this service. Animals become emaciated, fetching very little in the market and hence cannot be sold to pay for water. A FSAU assessment identified that there are some areas in Puntland which have not been grazed for two years due to lack of water. This clearly indicates that there is overgrazing in other areas.

3.7.2 Institutional and policy issues

Most water supply project failures can be attributed to institutional, rather than technical inadequacies. Institutions need to be well established and enforced for the success of water projects. There is a clear preference of the people of Puntland to have community-managed water supply systems rather than a centralized system. This means that for water projects to succeed, the approach has to start with the question "Can the tasks be done by the community?". When the answer is "no", the necessary support from outside agencies has to be defined.

For longer-term projects, three levels of institutions are determined. The first level is that of the village water committees, directly appointed by communities. The second level is that of the support-agencies and the third is a regional water authority. For short-term rehabilitation activities the only feasible choices are the first and the second levels of institution. When properly established they guarantee sustainable water supply systems.

The roles of the village water committees are to:

- Take initiative for improvements of community water supply.
- Organize contributions from communities in cash or in kind, towards construction, operation and maintenance of water sources.
- Organize proper operation and maintenance, including supervision of caretakers.
- Keep accurate records of all payments and expenditures.
- Promote hygienic and effective use of new facilities.
- Hold regular meetings to discuss and decide on issues, procedures and problems.
- Inform the community regularly about decisions, and report on revenues and expenditures.

Previously, women were excluded from decisions made regarding management of water sources. However, many of the current WATSAN village committees include women, mainly due to pressure of some INGOs.

The role of support-agencies is defined at different stages during the project:

- In the development phase agencies play a catalytic role, helping the community to reach appropriate decisions on technical and financial issues.
- In the implementing phase agencies play a supporting role, ensuring that supplies and back-up services are available when needed.
- Agencies then monitor operation of ongoing projects, evaluate approaches and modify the type of support provided as necessary.

The regional water authorities are necessary for the success of the long term water projects. However, from the assessment such authorities are not currently operational in Puntland.

3.8 Conclusions and Recommendations

The rapid assessment of water supply and demand for Puntland arrived at the following conclusions and recommendations:

1. Rural populations experience water stress in almost all dry periods, and people have devised ways of coping with water shortages. Common remedies include reduced daily water consumption, buying water from vendors and migrating to areas of permanent water sources. Where water trucking is practiced, the study recommends proper handling at the source and during transport, to avoid contamination.
2. Other than boreholes, the majority of water sources in Puntland are not protected which exposes sources to different kinds of contaminants. The priority of the WATSAN projects in Puntland should focus not only in establishing new water points, but on improving existing ones towards complying with MDG standards.
3. Private water sources are better-managed than communal sources, partly because of limited resources but also due to lack of ownership, and mistrust in public sources. For sustainability of projects, rural communities should be well-incorporated into project/s right from inception. Such projects should be community needs-based, rather than donor imposed. External expertise such as in the case of borehole drilling should be supplemental to community efforts. Another approach which can be tried would be a commercial approach to public rural water supply systems, such as the Public Privatisation Partnerships (PPP) utilities.
4. Capacity to establish and manage sustainable water sources in Puntland is lacking. Capacity building is required to equip communities with appropriate technology to manage water sources. These should include training on hygiene standards both at water sources and within homesteads.
5. Existing institutions in the water sector in Puntland are weak. Such institutions should be strengthened at community and regional levels to guide the process of project implementation, monitoring and implementation. A code of conduct spelling out the different tasks of the community and intervening agencies should be developed for better performance of the sector. At regional level, the water authority would perform the following functions:
   i) Develop and promote regional programmes and projects, and evaluate and select communities which fulfil the conditions set for receiving funds and other forms of assistance for an improved water supply.
   ii) Supervise the design and construction of local community water supply systems.
   iii) Facilitate technical and logistical support, such as major maintenance and repair jobs, spare parts supply etc., through regional warehouses, workshops and mobile staff, if this cannot be accomplished through private agents;
   iv) Provide regional training programmes and continued education programmes in technical, administrative and management skills for regional and local staff.
6. The impacts of water-related programmes on the environment need to be assessed to minimize environmental degradation near water sources. A detailed analysis of the balance in pastoral water supply as provided by VetAid (1992) can guide the process, with modifications to suit local conditions in Puntland.
7. The study revealed a low level of knowledge relationships between health, water and sanitation practices. There are hardly any skilled health extension officers in Puntland. It is only recently that UNICEF started hygiene training courses, enlightening health

and sanitation officers and water committees on proper hygiene practices. Once trained, the officers are expected to train the rest of the community.

8. An integrated approach to provision of safe water should be adopted, incorporating other hygiene practices. Covering well heads to protect them from direct infection by human and animal faeces would for example be meaningless if a latrine is established next to the water well. In the beachfront fishing village communities, defecation in the sand dunes is prevalent. The freshwater lens above the brackish water is very near the water surface under these sand dunes, so when it rains human waste is injected into this water lens which serves as a local water source. This water then acts as a good medium for the spread of diseases like cholera, especially during the rainy period.
9. Sharing of water sources by animals and human beings is a common practice in Puntland, posing hygiene risks. Most surface water sources and shallow wells are unprotected, thus increasing the risk of water contamination.
10. There is need for the Puntland authority to increase their support to community-based water projects, to help ensure their success. Currently, many communities are relying on external donors for interventions on water sources. Donors are viewed as providers instead of facilitators, a perception which ought to be changed if water supply projects are to be sustained.
11. Desalination offers, in principle, a good technical solution for enhancing drinking water supplies. Water in the Puntland coastal area has high salinity levels, and desalination would offer a good solution to this problem. The technology is however not currently in use, and may not offer an immediate short-term solution due to the high initial investment and maintenance costs. However, its future applicability is worth investigating, owing to increasing water scarcity in Puntland

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SOMALILAND

4.0 SOMALILAND

4.1 Background

Somaliland is located in the north-west part of the former Somalia. It declared its independence from the rest of Somalia in 1991 after the downfall of Sayid Barre regime. The total area of Somaliland is about 180 000 km^2 with an estimated population of 2 million. About 60% of the population are pastoralists and agro-pastoralists living in the rural areas. The remaining 40% live in urban areas and villages, many of which were established at old traditional water sources such as natural depressions, shallow wells, earth dams and *berkads*. Such towns include Hargeisa, Burao, Borama, Las Anod and Ceerigabo.

The 1988 – 2001 civil war resulted in devastation of water sources and supply networks in Somalia. Most water sources in the rural areas were either destroyed intentionally by the government military or ceased to function due to lack of maintenance. According to the Ministry of Water and Mineral Resources (MWMR), there were nearly 65 operational boreholes in the rural areas of Somaliland before the outbreak of civil war. Many have since broken down, leaving only 25 operational at present. Rural communities have to rely on other water sources, mainly springs and shallow wells in the mountainous areas and the coastal plain, and *berkads*, *balleys* and earth dams at the Hawdi Plateau.

Water availability in Somaliland is dependent more on underground reservoirs than on surface water bodies, as there are no major rivers or other permanent surface waters in the country. However, *berkads* and earth dams contributed significantly to water availability in rural Somaliland before 1991. In the 1980s the Somali government, through the Rural Water Development Project funded by The World Bank, developed six earth dams with plastic pavement which had the capacity to last 3–4 months after the rains. At present, only three dams retain water for long periods. The other three collapsed due to poor maintenance, attributed mainly to lack of technical personnel. Many of the *berkads* could no longer be sustained owing to reduced income of pastoralists as a result of war and prolonged droughts.

The main economic water use in the country is livestock production. However, small-scale irrigation is also practiced in selected areas, mainly for horticultural products. Domestic consumption is also significant, especially in the dry season when water is very scarce. In the succeeding chapters, major surface and sub-surface water sources in Somaliland are discussed.

4.2 Surface Water Sources

Surface water supply in Somaliland is mainly dependent on rainwater in the months of April to June (the *Gu* season), and September to November (the *Deyr* season). The pattern of the rainy seasons is however changing with time, with prolonged periods of rain and drought frequently experienced. Rains can last for several hours, sometimes resulting in flash floods which, if harvested, can provide water for months afterwards. Springs, *berkads* and dams are the main surface water sources in Somaliland.

The local communities in Somaliland have adopted different means of coping with water shortages. In addition to the above-mentioned surface water sources, some agro-pastoralist households harvest and store rainwater in underground ditches with capacities of about 6 m^3 which resemble *berkads*. The ditch is lined with a plastic sheet to prevent water from percolating into the soil. The water is used for household consumption and in some cases for irrigation. Twenty-litre jerrycans are also commonly used to store water in rural areas, as opposed to big plastic drums common in towns.

4.2.1 Berkads

Berkads are the major water sources in the Hawdi plateau since there are no permanent water sources there. Interviews conducted by SWALIM indicated that several attempts by the previous Somalia government to establish boreholes in the area failed due to the deep water table. There are thousands of *berkads* of various sizes in Galbeed, Sool and Togdheer regions, the highest concentration being in the last-named region. Use of *berkads* for water storage started recently in other regions. In Sanaag, ActionAid introduced the technology in the late 1990s, while in Awdal region *berkads* were introduced by COOPI in recent times. The number of *berkads* in each region is summarised below.

Table 4.1 Number of berkads in the Somaliland regions

Region	No. of *berkads*
Togdheer	5000
Sool	2400
Awdal	100
Sanaag	100
Woqooyi Galbeed	40[+]

Source: SWIMS Database and field surveys

The *berkads* in Awdal and Galbeed regions are usually small, with a capacity of less than 300 m^3 while the majority of those in Togdheer, Sool and Sanaag regions are greater than 300 m^3. Unlike shallow wells and boreholes, destruction of the *berkads* during the civil war was limited, especially in Sool region. Figure 4.1 gives an example of a modern berkad constructed with concrete.

[+] Indicated data is only from the current SWIMS database; no figures were obtained in the field; the actual number could be much more.

Figure 4.1 Rectangular berkad with concrete wall

Evaporation accounts for significant water loss from *berkads* due to the high temperatures experienced in Somaliland. To reduce loss, local people cover *berkads* with locally available material e.g. tree branches and shrubs. The practice is however not common in Galbeed, where water scarcity is also not as serious as it is in other regions.

The rate of *berkad* failure is very high. It is reported that in almost all districts less than 50% of *berkads* are functioning. In an interview with GRC, it was noted that in Berbera District of Galbeed Region there are more than 300 broken *berkads*. Figure 4.2 shows cracks on a *berkad* wall, a common cause of failure.

Figure 4.2 Cracks on berkad wall

Several factors contribute to *berkad* failure. GRC identified some of the common causes of failure as:

i) Poor construction, where walls are constructed leaning directly on soil. Any soil movement exerts pressure on the *berkad* wall, causing it to crack.

ii) Corner joints of the *berkad* wall are not well made, leading to leaks.

iii) Pressure from plant roots cause the wall to crack.

iv) The wrong ratio of cement to sand is used, weakening the wall and eventually resulting to cracks.

An assessment done by Caritas (2007) confirmed the same causes of failure. The study identified that before 1970, local people were keen to construct quality *berkads* that would last. However, there was a drastic decline in *berkad* quality starting in the 1970s. People concentrated more on cheap, fast *berkad* construction at the expense of quality.

To overcome the problem of weak corner joints, GRC designed round *berkads* which have proved to be more durable. Leaving a gap between the *berkad* wall and the soil, then backfilling with stone chips is another strategy GRC have adopted to prevent wall cracks due to pressure from soil and plant roots. Building stones are dressed on both sides to reduce plastering costs.

Much *berkad* rehabilitation work has been undertaken since 1992. Mink (2007) estimated the cost of constructing a *berkad* at 1 500 – 3 000 USD depending on size and construction material. The cost of rehabilitating one *berkad* is estimated to be between 1 200 – 2 000 USD, depending on the nature of the repair. Some organizations reported to be working on *berkad* rehabilitation are OXFAM, SWISS Group - Caritas, UNHCR, COOPI, ActionAid, Action Hamber and GRC. However, the rate of *berkad* failure is still high and more interventions are needed to cope with the situation.

The use of *berkads* as water sources however, has associated sanitary problems. Water in *berkads* is easily contaminated, especially in rural areas where sanitary facilities are poor. Human and animal waste contributes to the contamination. In some *berkads* visited, water was found to be yellow-brown in colour. *Berkads* are also breeding grounds for mosquitoes.

4.2.2 Dams

Dams are other surface water sources used in Somaliland. They range in size from small harvesting *balleys* and *wars* to big earth dams of capacity up to 150 000 m^3.

Six high capacity earth dams were built in rural Somaliland in the 1980s. Construction was funded by the World Bank to supply water for pastoralists along the Somalia - Ethiopia border. The dams had generator rooms, attendant rooms, animal troughs and kiosks. At present three of these dams are operational. Smaller capacity dams are also constructed, mainly by NGOs (see Figure 4.3) to boost water supply in rural areas. The SWIMS database shows that GRC have been working on 14 small dams in Awdal and Woqooyi Galbeed Regions, both in establishment and other interventions activities. One such earth dam constructed by GRC near Berbera is a major local supply. It connected to a well, which has a pump for water lifting. Before the establishment of the dam, water supply was very scarce in this extremely dry area.

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Figure 4.3 Unhygienic water collection from a balley (dam)

Dams can hold large quantities of water for long periods, and hence provide a good solution to water shortage in rural areas. However, dams are not very common in Somaliland. According to an interview with GRC, the following factors are a hindrance to the use of dams:

i) Lack of suitable dam construction sites where losses due to leakage will be minimal.
ii) High costs of construction, e.g. the six dams constructed in the 1980s cost between 80 000 – 100 000 USD each.
iii) Limited dam construction machinery in Somaliland.
iv) High maintenance costs due to occasional removal of silt deposits from dams.
v) Land degradation and erosion due to overgrazing, as dams tend to attract settlement in the surrounding areas.

Locating suitable sites for dam construction remains a big challenge, as all the above factors need to be considered.

Water extraction from most surface water sources is manual, using a bucket and rope. Water is then transported either on donkey- or camel-back, and sometimes by women. Manual extraction however has several set backs, which include:

i) Water can be easily contaminated if not properly handled. Risk is higher when animals share the water source with human beings.
ii) People can easily fall into open sources and drown when fetching water.

The use of pumps to draw water from sources is also practiced, as shown in Figure 4.4. Pumps are either manual or run by an engine. In some cases a storage tank and distribution network are also available. The use of a closed system minimises the risk of contamination but increases the chances of over-exploitation of the water reservoir.

Figure 4.4 Water extraction from a balley using a pump

The motor-operated pumps use either fuel or electricity as their power source. There are no solar- or wind-powered pumps in Somaliland. Hand pumps are the most common of all pumps, but they frequently break due to poor handling, lack of spare parts and qualified maintenance.

4.3 Groundwater Sources

The low effective rainfall experienced in Somaliland calls for groundwater development as a viable solution to water shortages. Groundwater movement and availability varies from place to place, depending on the geology and hydrogeology of a particular area. In mountainous regions the water table is only a few meters below the surface, making shallow wells a common source of water. The depth of shallow wells in this area range from 5–20 m. On the plateaus the water table is quite deep, and only boreholes can be used for sub-surface water supply during dry periods. Boreholes can reach depths of 400 m below the surface. There is however not much information available on the hydrogeology of Somalia, which hampers the success of deep drilling projects (SHAAC Consulting Co., 2006).

4.3.1 The geology and hydrogeology of Somaliland

Geomorphologically, Somaliland can be broadly classified into three zones. These are the Guban or Low Coastal Plain; Mountainous Range; and the Hawdi and Sool plateaus.

- The Guban/Low Coastal Plain is characterised by beach sand, coral reefs and gravel deposits, with a great number of valleys originating from the mountains (Faillace, 1986). Between Berbera and Bulahar there are volcanic outcrops of recent age. Average annual rainfall is less than 100 mm. Temperatures are generally high, ranging from 25°C in winter to 42°C in summer.
- The Mountainous Range is a rock formation consisting of limestone of the Aurado formation overlying a basement formation of granites, diorites, basalts and mica schists (Faillace, 1986). The area experiences annual rainfall of about 600 mm.
- The Hawdi and Sool plateaus extend from the foot of the mountains at Sanaag, through most of the Sool Region. The Sool plateau lies in the eastern part of Ethiopia and is characterised by sulphurous limestone (gypsum) outcrops known as the Taleh formation. The Hawdi plateau extends to the Ethiopian border and is characterised by Eocene limestone and sandstone covered by recent sand and clay. Towards the east, the predominant soils are grey to red clay (Faillace, 1986).

Groundwater recharge in Somaliland occurs mainly during the *Gu* season. Runoff from the higher rainfall mountainous areas infiltrates into alluvial fans formed by *toggas* in the coastal plain. Considerable amounts of runoff water are lost through evaporation as the water spreads out in the floodable areas of the coastal plains (Faillace, 1986). Water in the deep permeable layers is generally under semi-confined conditions.

Movement of groundwater from the mountains is in two directions: south to north towards the coastal plain, which coincides closely to the surface drainage; and north to south towards the Sool and Haud plateaus. According to Faillace (1986), both the hydrological and hydrogeological divides coincide to a certain extent. Water infiltrates along the faults and joints in the bare rocks and follows structural patterns. Movement of groundwater is accelerated by the rapid drop in elevation from the mountain areas to the plains. The water is discharged at various elevations through various springs found in the basement complex and the Mesozoic and Tertiary formations.

Investigations done by Faillace (1986) and Sogreah (1983) classified Somaliland into four hydrogeological zones, namely the mountainous zone, coastal belt, sloping plain and the plateau zone.

(i) Mountainous Zone

The mountainous zone is composed of several aquifers over a basement complex, Jurassic and Cretaceous formations, and Tertiary sedimentary, volcanic and alluvial deposits.

Basement Complex - is made up of four complexes with a variety of metamorphic and intrusive rocks. Groundwater is contained within fissures, mainly in upper weathered parts of various rocks. Fissures close up with depth, and hence can only store a small amount of water which seeps out through springs along streambeds and depressions. The basement complex is a major aquifer for springs, shallow wells and drilled wells in Woqooyi Galbeed region. Water from this complex has a wide range of salinities.

Jurassic Limestone - composed of blocks of stratified Jurassic limestone outcrops, down-faulted in the western parts (Borama area) and step-faulted in the escarpment towards the Gulf of Aden. The outcrops are highly fractured, jointed and folded. Groundwater discharge occurs through springs found mainly along deep valleys at the base of the limestone sequence or at the contact with the basement complex. Water from the limestone rock is generally of good quality.

Nubian Sandstone- is mainly found in the western part of the Haud Plateau, south of Hargeisa and Gebiley. It consists mainly of sand and friable sandstone, often cross-bedded. In some cases it is hard and compact and forms rocky barriers across *toggas*. The sandstone is generally dry, except for the lowermost section which yields a little water. Water quality varies from good to marginal. Most of the thermal springs from the sandstone yield water of a sulphate type.

Auradu Limestone - extensively karstified and dissected by faults along a large belt forming the edge of the Gulf of Aden escarpment. It covers Ahl Mado mountain between Bossaso and Ceerigabo, and the Surud Ad mountain north-east of Ceerigabo. Water emerges through springs located on the slope of the escarpment, deep valleys or along the scarps. Yields from the Auradu limestone are higher in the mountain area south-east of Bossaso than in the Gulf of Aden escarpment. The quality of water is generally good.

Taleex Formation - found in scattered outcrops in the mountain zone between Sheikh, Berbera, Ceerigabo and Ahl Mescat mountain southeast of Bossaso. According to Faillace (1986) the contribution of this formation is minor.

Alluvial Deposits - common along the riparian belts of major *toggas*, depressions and alluvial cones in the mountainous zone. Recent alluvial deposits store considerable amounts of water of good quality, used mainly for irrigation along the riparian belts. Water is extracted using large diameter hand-dug wells, 1-2 m deep.

(ii) Coastal Belt

The coastal belt is made up of recent beach sand, coral reef deposits and marine terraces. Small sand dunes 10-12 m high are common along the belt. It extends between 10-80 km in width, and can be divided into two parts - one near the coast formed of sedimentary formations of the end of the Tertiary and Quaternary covered by recent Aeolian deposits, and the other further inland consisting of thick deposits of the alluvial cones formed by *toggas* flowing through the mountains.

Groundwater recharge is mainly by runoff water from *toggas* originating in the mountains. The belt has a continuous layer of fresh to brackish ground water floating over salty water. Faillace (1986) noted that the depth of water along the coast varies from 1-2 m in the terminal section of the streams reaching the sea, to 6-8 m in the alluvial terraces between the streams. Water quality varies from place to place depending on the degree of mineralization, distance from the sea-shore, type of geological formation and the thickness of the aquifer penetrated by the well.

(iii) Sloping Plain

Extends 200 km along the Gulf of Aden, rising from sea level to 300 m asl near the foot of the mountain range. It mainly consists of volcanic outcrops. Investigations done by Sogreah (1983) on different areas of the plain gave the following results: in the *Togga Waheen Sloping Plain*, the aquifer is shallow and supplies little water of poor quality; in the *Biji Sloping Plain*, the thickness of the water-bearing alluvial fan is about 30 m. The plain has great potential for high-capacity wells for irrigation, and water is of good quality, with low TDS. Mineralisation increases towards the coastal belt; in the *Durdur Sloping Plain,* groundwater is generally of good quality, suitable for most uses. Yield is high, about 100 m^3/hr for wells dug in this plain; for the *Togga Sihil*, information on groundwater potential is scarce, but water quality is excellent. Quality deteriorates towards the coast.

(iv) Plateaus

There are two main plateaus in Somaliland namely the Hawdi and Sool, which extend from the foot of the mountains at Sanaag across the Sool region.

Hawdi Plateau - a large, undulating plain covering the north-western part south of the mountainous zone. The southern part is flat, but the mountain area is hilly with several streams. Elevations range from 900-1 300m asl. Water generally has low levels of minerals but salinity increases downstream. The water table is very deep, and where water is found quantities are minimal. Boreholes are generally located near depressions or ephemeral water courses where recharge takes place from floodwater. The extremely deep water table makes boreholes a costly operation. Faillace (1986) suggested exploitation of shallow aquifers along *togga* beds, development of surface runoff water and rain harvesting as feasible alternatives.

Sool Haud and Sool Plateau - the two plateaus form a nearly flat terrain, gently sloping towards the Indian Ocean. Drainage occurs in flat depressions along which occasional floodwaters flow. The climate is very arid and hot, with annual rainfall ranging from 70 – 170 mm. Water resources on the Sool plateau are scarce, mainly in small semi-confined water-bearing limestone layers of the Karkar formation. Water quality is good. The drainage system is virtually undefined, but towards the coast it becomes relatively well developed. Along the northern edge of the Sool Haud plateau, water quality is good according to an investigation by GTZ (1986). The water table in the Sool Haud Plateau is at about 100 m, but in flood areas it is shallow, about 60 m.

4.3.2 Shallow wells

There are two types of shallow well found in Somaliland - those dug along the dry beds of seasonal rivers, and those dug or occurring natural away from river beds. Either type may be permanent or seasonal. In Figure 4.5 water is being drawn from a hand dug well using the bucket and rope method. Next to the well is a water trough for livestock.

Figure 4.5 Shallow well and animal trough

The distribution density of shallow wells in different regions depends on the depth of the water table. In the mountainous regions of Somaliland the water table is generally shallower than on the plateaus, hence there are more shallow wells. It is rare to find shallow wells in the plateau. Along the coast, the water table is shallow but water quality is a major factor limiting use of groundwater. Many people interviewed confirmed that salinity is a major concern for the people along the coast.

The SWIMS database and information collected from partners in the field, showed the distribution of shallow wells in Somaliland to be as follows:

Awdal Region: There are approximately 300 shallow wells dug along dry riverbeds (*toggas*) in this region. Most wells are found along alluvial deposits in the mountainous areas and along the coast. The average depth of shallow wells is approximately 5-6 m. About 25% of wells are lined, and 10% fitted with hand pumps. The quantity of water extracted could not be established, but water is used for domestic purposes, livestock and small-scale irrigation.

Gabeed Region: It is estimated that there are about 465 shallow wells in Woqooyi Galbeed. Most wells are dug along dry riverbeds and banks, some having water all year round. Not all the wells are functional, as some were abandoned after drying out. Average depth of the wells is 8 m, 20% of which are lined with concrete rings. There are many INGOs and UN Agencies doing intervention on water sources in this region. ActionAid has lined 35 wells in Hulug, Arabsiyo, Agamsad, Bitiji, Dhalaad and Cell Giniseed areas. Water from wells is used for domestic purposes, livestock and small-scale irrigation.

Sanaag Region: Approximately 250 shallow wells are found in Sanaag Region. They are used to water livestock and for domestic purposes. Wells are on average 4 m deep. Few of them are protected, e.g. out of 10 wells found in Ceerigabo district, only three are protected, while one out of four wells in El-Afwein is protected. Along the coastal areas, wells are common in the alluvial deposits along dry riverbeds.

Togdheer Region: The number of shallow wells in this region is approximately 980, most wells being found in the dry bed of the Togdheer River. Water use includes both domestic and livestock, and in some cases small-scale irrigation particularly in the Beer, Burao and Odweine areas. The number of wells used for irrigation is estimated to be about 10%. There are several wells dug along embankments of old earth dams in Odweyne and Dhoqosaye areas, the wells extracting water seeping from the dams. Both human and livestock use water from these wells. Average depth of wells range from 3 - 8 m. Lining is generally done traditionally, using logs and tree trunks.

Sahil Region: Most shallow wells in Sahil Region are concentrated within the coastal plain, in Quaternary alluvial deposits. They are used by nomadic peoples during migration to the coastal plain in winter. According to a UNICEF (1999) survey, about 30% of wells were reported to be lined and fitted with mechanical pumping systems. Some wells have ceased functioning due to lack of spare parts and maintenance.

As is the case for all other water sources, analysis on distribution of shallow wells in Somaliland is based on available information and it is expected that there may be many more. A detailed survey of water sources in the rural Somaliland would give a more accurate figure of the number of water sources and their status.

Shallow wells need to be protected in order to improve sanitary conditions. This is not usually the case, as the majority of the wells are left open. Many wells are also unlined, due to the high cost of the exercise. Some NGOs interviewed estimated the cost of lining a well with two-inch diameter concrete rings up to 10 m depth to cost between 1 800 – 2 200 USD.

The technology used to lift water from shallow wells is at times dependent on economic activities in an area. For the shallow wells used by pastoralists, most water extraction is done manually, using a rope and bucket. Hand pumps are used to lift water from lined shallow wells. The most common type of hand pump in Somaliland is the Ardev model. UNICEF, OXFAM GB and other organizations installed many hand pumps. The pumps were installed from the late 1990's, but surprisingly the majority are no longer working. The main cause of failure is improper handling by the users, lack of spare parts, and lack of technical expertise to maintain and repair them.

Where irrigation is practiced, shallow wells are mainly fitted with centrifugal pumps, the most common type being the Robin model, which is available in the local market. Submersible pumps are mainly used in boreholes, Grandfos and Caprari being the most common models in Somaliland.

Management of water sources is usually done by local committees. Whenever a water source develops problems, either with the pump or generator, then the management committees are not capable of undertaking repairs. They turn to the Ministry of Water and Mineral Resources or other intervention agencies for assistance.

4.3.3 Boreholes

Boreholes in Somaliland are machine-drilled, with a common practice to line boreholes and put in the necessary screens. Where extra funds are available, the borehole is connected to a reservoir and distribution system.

The MWMR estimates that before 1988 there was a total of 205 boreholes in urban and rural Somaliland. Some boreholes were drilled by the Somali government, while the majority were drilled by other agencies, mainly INGOs and UN agencies. The regional distribution of boreholes is as shown in Table 4.2 below.

Table 4.2 Distribution of boreholes in Somaliland by region

Region	USERS			
	Rural	Urban	IDP Camp	Total
Awdal	19	20	-	39
Galbeed & Sahil	12	55	20	87
Togdheer	8	33	-	41
Sool	7	8	-	15
Sanaag	9	14	-	23

At present, only 25 (45%) of the 55 boreholes in rural Somaliland are operational. The names of current operational boreholes in each region are given in the table 4.3 below.

Table 4.3 Operational boreholes in regions of Somaliland

Region	No. of boreholes	Name/s of boreholes & distances (km) to other permanent sources
Awdal	5	Jidhi (30), El Gaal (30), Kalowle (50), Kadhodhle (50), Lanta (30) & Dilla (30)
Galbeed & Sahil	3	Geed Baladh (40), Dameero Boob (40), Jifto (-).
Togdheer	4	Kabadheer (15), Livestock (15), Sabakti (12), Gawamo (40).
Sool	5	Qabri Huluul (50), Wadamo Go (50), Oog (50), Gadka (80), Awr Bogeys (90).
Sanaag	8	Lanqiciye (15), Darar Weyne (90), Yube (65), Xingalool (60), Carmale (35), Bargta Qol (40), Dhahar (40), El Buh (35).

Broken-down boreholes are either under rehabilitation or are totally abandoned. Annex 1 shows the locations of some of the broken down boreholes according to the MWMR. Some boreholes fail right from the drilling stage. According to the MWMR, several factors contribute to unsuccessful drilling, among them being:

i) Lack of sufficient hydrogeological data of underground aquifers before commencing the drilling exercise. Boreholes are abandoned after they turn out to be completely dry, or produce too little water to justify the drilling cost.
ii) Lack of required experience in operation and maintenance of drilling rigs. Some private companies buy drilling rigs which they do not have the necessary skills to operate. Such companies use the rigs without registering with the MWMR. Although

the ministry does not have drilling rigs, it has experienced staff who could assist companies if the two cooperated.

iii) Poor condition of some drilling rigs imported to Somaliland. Some rigs are not designed to drill in reverse circulation, whereas most areas of Somaliland have cavities which require this method of drilling. The rigs end up breaking during drilling, or lose the drilling bits and pipes which leads to abandonment of the borehole.

iv) Lack of required materials, spare parts, drilling accessories and tools during the drilling operations, resulting in unnecessary delays or complete abandonment of the exercise.

In cases where a drilling exercise has to be abandoned halfway, heavy losses are incurred. According to UNDP the cost of drilling one meter of borehole is between 100 – 120 USD, excluding the cost of casing. It would save time and resources if drilling was to be done only after verification of the aquifer and equipment.

Apart from the above-mentioned public boreholes, there have been many private developers drilling boreholes from the late 1990's. In Togdheere region for example, there are more than 15 private boreholes used mainly for irrigating farms, and those near Burao for water-bottling industry. Borehole depth in this region range between 145–180 m, with static water level ranging from 95-120 m.

In the dry season, boreholes are quite useful to rural communities for water supply as they are the main permanent water sources in Somaliland. Tankers are used to ferry water from boreholes over long distances. The cost of trucked water is however too high when compared to locally available water. A 20 litre jerrycan costs between 0.05 and 0.1 USD when water is locally available. When water is trucked for a distance of 60-90 km, the same amount of water costs 0.4 USD, an 80% increase which is significant, considering that pastoralists may have many animals requiring watering.

4.3.4 Springs

In Somaliland, springs occur mainly in the Sahil, Awdal and Galbeed regions. There are approximately 20 perennial springs in Sahil region, most of which are located in the mountainous areas.

Text Box 4.1 Major springs in the Sahil Region

- Giyo Gure spring, which used to be the main source of water for Berbera town and the nomadic population living in the surrounding. However, in recent times water from the spring is being diverted to irrigation farms and livestock at the expense of the domestic supply to Berbera town.
- Dubaar, a hot spring used to supply water to Berbera town by gravity flow. It is also one of the major water sources for pastoralists and their livestock. There are a few farms irrigated by water from this spring.
- Bihin spring, located 50 km south of Berbera. It is used mainly for irrigation and is a source of water for the pastoralists.
- Las Cidle, a thermal spring located 70 km north-east of Berbera. It is the major source of water for pastoralists during winter.

In Awdal region, eight springs are recorded in the SWIMS database. A UNICEF (1999) survey also identified six of these springs in Awdal. The springs are found in the mountainous regions of Baki and Lughaya districts. Both humans and livestock use the spring water directly from source, which increases the chances of water contamination.

Galbeed region has a total of eight springs: seven in Hargeisa and one in Gebiley district. The springs are situated in mountainous areas and none are equipped with a pump. They are used mainly for livestock and domestic use. The assessment could not establish the current status and capacity of individual springs.

4.4 Water Quality

Water quality is a major concern in the rural Somaliland. During water scarce periods, many people appreciate any available water, disregarding the quality. Water-related diseases are common while the health facilities are not well developed in the region. The rural communities receive health services from scattered Mother and Child Health centres (MCH), numbering less than ten in every region. The MCH receive medical drugs every three months from UNICEF and the Somaliland Red Crescent Association. Only district capitals and major towns in Somaliland have hospitals.

The majority of the water sources in Somaliland are open, making them susceptible to all sorts of contaminations. There is no well organised system of checking the quality of water from these sources. In the whole of Somaliland, only one laboratory exists at the MWMR Hargeisa, the capital of Somaliland. Many of the *berkads* and dams are risk contamination from faecal bacteria. Figure 4.6 shows green-coloured water in a *berkad*.

Figure 4.6 Poor quality water in a berkad

To be able to meet the MDGs related to safe drinking water, many of the open sources need to be covered and installed with pumps for water extraction. Further, frequent water quality tests need to be performed on the water sources to determine the suitability of water for human and even animal consumption. This calls for consolidated efforts amongst the different stake holders to build the capacity for monitoring water quality and proper hygiene standards. SWISS Group introduced the PHAST training approach, which is reportedly successful.

4.5 Current Water Use and Demand

Water in rural Somaliland is used for domestic consumption, watering livestock and in some cases for irrigation.

4.5.1 Domestic water use

The international water requirements are not applicable to rural communities in Somaliland, due to extreme water scarcity. The basic water requirement may be as low as 4 – 6 litres per day. Water use is minimal, particularly in the *Jilaal* season when water has to be brought by trucks from permanent water sources.

During and soon after the rainy season, girls and their mothers fetch water from ponds and dams. They either carry the water in jerrycans themselves, or use donkeys. The distance travelled to the water sources and back is usually 5–10 km during the wet season. However, as the dry season approaches, surface water sources and some shallow wells start drying up, increasing distance travelled to water sources to as much as 20 km. Distance to the water source is mainly governed by pasture availability. Men and boys go to distant water sources for livestock watering and domestic uses in the dry season, using camels to transport water. Sometimes agro-pastoralists and their livestock are required to make a 36 km or more round trip to reach water points such as the Geed Balaadh, Dameeroboob, Qabrihuluul and Xingalool boreholes, in the *Jilaal* season.

4.5.2 Livestock

The main source of income among the citizens of Somaliland is livestock. More than 60% of citizens live on rearing and selling of livestock and their products. The national economy is dependent on the exportation of livestock to the Gulf states. There are no exact figures on the number of animals exported each year from Somaliland, but it is estimated that on average 1 095 000 shoats, 6 500 camels and 73 000 oxen are exported annually through the port of Berbera.

Surface water sources rarely meet the demand for livestock water, especially during the dry season. Interviews indicated that establishment of new permanent water points in the grazing plateaus, which are purely pastoralist areas, are resisted because the owners of existing *berkads* want to make a living through the sale of water. There is also a fear that permanent sources will attract permanent settlement and irrigated agriculture at the expense of grazing land.

4.5.3 Irrigated agriculture

Irrigated agriculture is practiced in all regions of Somaliland. Most farms are small in size, between 0.5–2 ha. Irrigation farms are mainly concentrated in the mountainous escarpments (northern and southern parts), along the banks of the dry riverbeds and the coastal plain in Sahil Region where water is extracted from the alluvial deposits with some aquifers and springs. Major crops are vegetables, onions, carrots, tomatoes and watermelons. Fruits grown are oranges, guavas and limited quantities of mangos. They supply the local market in the major towns.

Water extraction for irrigation is between 1–10 m^3/hr. Most farms use centrifugal pumps, though manual extraction is also common.

For large farms of 20–35 ha., significant amounts of water are required for irrigation, and a different water source from the communal system is used. In Burao, over 15 new boreholes were established for irrigation agriculture.

4.5.4 Price of water

Water costs vary from one region to another, as does the question of who should pay for it. In many cases, water prices depend on season and the relationship between the source owner and user. During wet periods, family members and friends often get water free of charge. However, in extremely dry periods they pay reasonable amounts, depending on their economic status.

For the *berkads*, people coming from outside a village who are not known by the owner are charged for water. According to Mink (2007), charges are initially low, since the *berkad* owner does not know their economic status. After making investigations lasting two to three weeks, the owner adjusts the price accordingly. Water prices range from 0.03–0.1 USD per 20 litre jerrycan; when tankers are used, costs go up to 0.25–0.42 USD for the same 20 litre jerrycan.

The cost of water bought for livestock is proportional to the amount of water consumed. As a result, the wealthy end up paying more than the poor since they have large numbers of animals. Extremely poor people are either charged very little or nothing at all. Normally, it is the owner of the source who makes decisions on whether users pay for water or not. However, elders also discuss the issue and determine who is poor enough to be exempted from paying for water.

4.5.5 Projected water needs

Projection of water demands requires data on existing water-use patterns, household incomes, preferred service levels and willingness to pay for them. The current water sources are stressed, and an increase in numbers of livestock and opening of new land for irrigation would worsen the situation. Increases in human population are also expected to contribute significantly to increasing water demand.

4.5.6 Socio-economic context

Water is highly valued in Somaliland. During British rule, there was a strictly-administered law on water and grazing used to solve pastoralists' disputes. Water points were previously owned by a tribe or clan, but the law was changed to allow private ownership which led to the construction of many private *berkads*, shallow wells and boreholes.

After the fall of the Sayid Barre regime in 1991, many existing water sources were destroyed by clan members themselves, in the fear that other non-clan member pastoralists would be attracted to water sources. The "foreigners", according to the pastoralists, would bring parasites and cause land degradation through excessive grazing. Efforts by some organizations to revive destroyed boreholes did not yield any fruits. UNICEF for example rehabilitated a borehole in Wariidad village in 1995 following a request by a local NGO. The clan then made arrangements to have the generator looted. One year later OXFAM rehabilitated the borehole, but the generator was again looted with the full consent of the clan.

In 2003, OXFAM in its drought mitigation program tried to re-drill a borehole at Qordheer after a request by the regional authority and some town elders. Soon after the rig arrived, armed militias were organised by the pastoralists belonging to that clan to prevent drilling from taking place. Long discussions were held with the regional administration, but no agreement was reached. The drilling was abandoned, despite the area being one of the areas most affected by drought.

Poor communication and failure of project implementers to engage community members at all stages of the project cycle seriously undermine chances of success. It is common practice by international development agencies to initiate projects without involving the local community. Some agencies are located away from the community, and there is no proper means of communication between them and the locals. Locals in return do not trust the agencies, no matter how good the project is, as they regard it being imposed by foreigners. Again, locals do not get an opportunity to interact with agencies and gain required skills for operation and maintenance of water sources. The role filled by agencies is never appreciated, and eventually the water project is abandoned.

4.6 Analysis of Major Issues

Environmental and institutional issues identified in the assessment are discussed below.

4.6.1 Environmental, sanitation and health issues

Somaliland, like many other developing countries, does not have clear hygiene and sanitation policies. Such policies are written, but the lack of structure and coherence makes them ineffective. Hygiene and sanitation standards are poor in rural Somaliland due to limited facilities, and water sanitation practices are seldom observed. The availability of water is explained in terms of quantity and not quality. Much still needs to be done to promote hygiene and sanitation practices.

4.6.2 Institutional and policy issues

The Ministry of Water and Mineral Resources (MWMR) is the governmental entity responsible for regulating the entire water sector and its various actors. The ministry developed a regulatory framework for the water sector with the following elements:

- *The National Water Policy* - a general statement of principles and guidelines to indicate the proper way to develop the water sector and thus to conduct interventions in the sector.
- *The National Water Strategy* - objectives, priorities, detailed measures and role-sharing that allow the policy to be implemented.
- *The Water Act* - establishes the legal framework supporting the strategy (or translating the strategy into legal provisions and institutional arrangements), defining organisations, mandates and responsibilities, as well as procedures, obligations and interdictions in a general way.

The National Water Policy expresses the will of the government for the development of the water sector, and must be considered by anyone involved in the sector as the directive framework for their actions. Any action undertaken in the water sector in Somaliland must comply with this policy and the rest of the regulatory framework developed for the sector.

Water sources in rural Somaliland are managed either by committees, or individuals in the case of private sources. For sources administered by the ministry, the community select the operators and the ministry trains them and sets the water price. Operators are supervised by the elders on behalf of the ministry. Money collected from water sales is divided into three: salaries of the operators; operational costs such as fuel and oil; and cost recovery collections. Unfortunately, the cost-recovery money is always missing due to weak governance by the ministry. In case of breakdowns the elders report to the ministry for action to be taken.

4.7 Conclusions and Recommendations

From the desk study assessment of the rural water supply and demand for Somaliland, the following is a summary of the key findings:

- Water is a major concern for the rural Somaliland, with 90% of the rural population having no access to safe drinking water.
- *Berkads*, earth dams and open shallow wells are the major sources of water for rural communities. Unfortunately, the same sources have the highest risk of contamination.
- During the dry season the majority of village water sources dry up. About 60% of the population depend on water from tankers during this period.
- There are many sources of water unsuitable for human consumption, but locals use them either out of ignorance or because they do not have an alternative. More awareness is required regarding water quality.
- Boreholes in Somaliland have high running costs due to high fuel costs, and wages for attendants. Nothing is put aside for borehole repairs in case of breakdown.
- The rate of *berkad* failure in Somaliland is very high. More than 50% of the existing *berkads* across the country cannot retain water.
- Massive livestock losses during the drought of 2000-2005 affected the economic stability of the rural communities, making it difficult for locals to establish new water sources or rehabilitate new ones.
- Little information is available on the hydrogeology of the rural areas of Somaliland.
- Lack of training and skills is a major cause of pump failure across Somaliland.
- Shallow well aquifers in rural Somaliland are not well developed. Many shallow wells dry up during the *Jilaal* and *Hagaa* seasons.
- Rainwater harvesting is not fully utilised in Somaliland. Earth dams and roof catchments are some areas suggested for consideration.
- Government water policy needs to be imposed by the MWMR and the water regulation approved by parliament of Somaliland for the water sector to perform efficiently.
- An inventory of water sources in Somaliland and their status is necessary to evaluate supply and demand of water in rural Somaliland.
- There is no proper coordination of public and private water sources in Somaliland. In the establishment of the private water sources, many people do not conduct an EIA to determine environmental effects of establishing the source.
- The establishment of permanent water sources affects available grass areas, and hence does not always meet with favour from pastoralists.

From these findings, it is clear that the water sector in rural Somaliland needs to be improved to be able to meet the MDGs. Different approaches are required for each source type:

<u>Boreholes and shallow wells</u>:

1. Lining of shallow wells and well-head protection should be practiced when establishing new water sources and renovating existing ones. This would reduce chances of water contamination from the surface.
2. Sharing of water sources by humans and animals should be discouraged for reasons of hygiene . Where the same source has to be used for both purposes, then animal water intake points should be kept a safe distance from human intake points.

3. More boreholes need to be established in Somaliland as a way of solving frequent water shortages during the dry season. A mechanism should be devised to make the boreholes sustainable. Some viable mechanisms would include:
   i) The use of solar energy to pump water. There are 12 hours of daily sunshine in Somaliland throughout the year, which can be used to save on generator fuel costs. A pilot project by UNICEF in central Somalia showed good results.
   ii) Use of wind as an alternative source of energy for running pumps. British meteorological records showed that the wind intensity is high enough to operate windmills.
   iii) Installation of mono pumps. Such pumps have low fuel consumption, minimizing running costs. The use of these pumps at Erigabo town was successful.
   iv) Centralizing power supply to reduce running costs where there are multiple boreholes in the same area.

<u>Dams and *berkads*</u>

1. Where possible, construction of sand storage dams, subsurface storage dams or weirs should be encouraged as a way of conserving water for longer periods. With sand dams, water loss due to evaporation is minimised.
2. *Berkad* construction methods need to be revised to minimize failures. Standard construction guidelines need to be developed and implemented.

<u>Springs</u>

1. Spring waters need to be tapped and conveyed in a safer way than at present. Communities need to be enlightened as to the usefulness of these free water sources and the need to invest in their development.
2. For springs originating from mountainous areas, the establishment of pipe networks to convey water down-slope might be an expensive but worthwhile course of action, as it would not only convey water to specific points but improve sanitary conditions as well.

The assessment recommends institutional and organization capacity building through:

1. Upgrading the capacity of the MWMR to enforce water regulation and fulfilment of the ministry's obligation in the water sector.
2. Establishment of a water and sanitation committee at national, regional and district levels. These committees would have the mandate of monitoring the performance of the water sources and enlightening the community on the best operational and hygiene standards.

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Appendices

Annex I. Inoperative boreholes in Somaliland

No	Location	Source type	Financing organization	Failure date
1	Waridaad – Sool region	Borehole	UNHCR	1994
2	EL-Gal- Awdal region	Borehole	UNDP/OPS	1995
3	Jidh – Awdal Region	Borehole	UNDP/OPS	1995
4	Qalah- NW region	Borehole	UNDP/OPS	1996
5	Dameerboob.NW region	Borehole	UNDP/OPS	1996
6	Salahlay – NW region	Borehole	UNHCR	1998
7	T. Wajaale –NW region	Borehole	COOPI	1998
8	Geel Lookor – Sahil region	Borehole	COOPI	1998
9	Carmale – Sanaag region	Borehole	UNHCR	1998
10	Buloxaar- Sahil region	Test well	COOPI	2001
11	Laalays- sahil region	Borehole	COOPE	2001
12	Koosar Burao	Borehole	UN- Habitat	2001
13	Burao Orphanage- Togdheer region	Borehole	UNHCR	2002
14	Gawamo – Togdheer region	Borehole	Oxfam GB	2004
15	Sharmaarke – NW region	Borehole	Gibb Africa	2004
16	Agabar Borehole	Test well	Gibb Africa	2004
17	Slaughter house Hargeisa	Borehole	UNDP	2005
18	White sand village	Borehole	Private	2005
19	Jiifto – Sahil region	Borehole	SRCS	2005

Source: MWMR

Annex II. Descriptions of selected boreholes in Somaliland

Yube Borehole

Dug by the Chinese government in June 1987 to a depth of 160 m., this borehole is tapped in the Taleh formation of Gibson anhydrate, which is characterised by brackish water. The borehole has never been equipped with a pump.

Darar weyne Borehole

The borehole was dug by the Chinese government in 1987 to a depth of 220 m. Static water level is 105 m, and well yield is 3 m^3/hour. It is tapped in the Taleh formation of Gibson anhydrate, characterised by brackish water. The borehole operates 22 hours/day in both the *Hagaa* and *Jilaal* seasons. Twenty litres of water is sold at 0.15 USD. The well is used by pastoralists and their livestock; the only animals watered are shoats due to the limited yield.

El Afweyne borehole

The borehole was dug by the Chinese in 1987 and rehabilitated by UNICEF in 1997. The generator was looted one month after rehabilitation. In 2004 the community re-installed the generator. The borehole was to supply water to El Afweyne town. However, the pipeline provided by UNICEF is insufficient to carry water to the centre of the town. Tankers fetch water from the borehole during extreme dry seasons. Water price is not fixed, and tankers pay according to their agreement/s with the watchmen of the boreholes.

Lanqiciye borehole

The borehole was drilled by the British in 1959, and was the first borehole in the area. It is tapped in Aurado limestone with fresh water. Borehole depth is 124 m, with the static water level at 94 m. It yields 12 m^3/hr. During drilling, the EC value of water was 1 090 µS/cm. Initially the borehole was drilled to supply water to Erigabo town, but the supply has been extended to include pastoralists and agro-pastoralists living in the surroundings. Twenty litres of water are sold for 0.08 USD. The borehole is currently not functioning due to a damaged pump.

Hingalool borehole

The 113.35 m deep borehole is said to have been drilled in 1985 by the Chinese government. The static water level is 59.93 m. |During the dry season the borehole produces about 155 m^3/day. According to the operator the pump (housed in a 6" casing) stopped functioning in July 2004. There are four generators in the generator room, two Listers which are functioning, and two Dutz which are not functioning. The current source of water is another borehole drilled by villagers but the salinity is very high and has a very low yield. Conductivity was measured at 6.38 mS. A 200 litre barrel of water is sold at 0.3 USD. However, when water is trucked from the closest borehole sources at Ceelbuh (60 km), Dhahar (70 km) and Buran (90 km), the same 200 litre barrel costs 3.6 USD. The borehole is connected to a water tank of 2 000 m^3 capacity. The previous tank of 10 000 m^3 has broken down.

Lithological profile of the Hingalool Borehole

Depth (m)	Description of lithology
1-13m	Arenaceous clay, with limestone debris
30m	Mudstone, grey with content of gypsum and calcareous.
42.97m	Mudstone, grey with content of calcareous and gypsum crystal.
49.25m	Limestone grey with calcareous contents.
56m	Mudstone, grey with brown red bands.
68m	Limestone, grey with brown- red bands.
75m	Mudstone, grey with brown- red bands
83m	Muddy limestone, grey- green, small karst hole at 81.56m
95m	Mudstone grey –green with bedding on bottom.
109m	Dolomitic limestone, grey with karst holes at 95m
120.19m	Mudstone – grey- green.

Beragaha qol Borehole *(N: 9°33'32.43" E: 48°29'24.28")*

The borehole is in Dhahar district, with a population of approximately 9 000 persons. There is an abandoned borehole in the neighbourhood, 200 m deep with the static water level at 130 m. The borehole was reported to have been drilled by Aqua Company in 1987, but stopped functioning in 2003 due to a faulty pump housed in an 8" diameter casing. The generator house has an earthen floor. There are two inoperative 27 kVA generators. According to the operator, one generator has a faulty dynamo while the other has a problem with its regulator. There is a cracked masonry ground tank of 15 m^3 capacity next to the borehole. There is a tap stand feeding from the tank but the connecting pipes are rusted and broken. Existing animal troughs are neither in a reusable state nor are they connected to a feeder pipe.

Dhahar Borehole *(N: 9°45'22.74" E: 48°49'22.45)*

This borehole was drilled by the Somaliland government in 2004 to a depth of 170 m. It is tapped in Gibson anhydrate know as the Taleh formation, and yields 30 m^3 of water/hour. Water from this borehole is hard, but no chemical analysis has been done. It supplies water to both urban and rural communities living in the surroundings of Dhahar village. Thousands of head of livestock receive water from this borehole during the *Jilaal* and *Hagaa* seasons.

Lithological profile of the Dhahar Borehole

Depth (m)	Description of lithology
0-15.57m	Arenaceous clay, yellow- brown with sand and gravel
22m	Dolomite limestone grey hard brittle,
58m	Muddy limestone, grey, close brittle.
70m	Limestone, leakage at 66.56m.
98.99m	Interbedded with mudstone and limestone.
113.00m	Limestone grey hard leakage at 108.47m
123.0m	Mudstone yellow, with grey green mudstone
141.47m	Limestone yellow with grey green mudstone.
164.60m	Mudstone, dark grey light grey with clam and conch fossils.

El Buh borehole

This borehole is 164.35 m deep, with a static water level of 137 m. It yields 39.42 m^3/hour. There is a metal 8m^3 water tank. Water is used for both human and animal (shoats) consumption. It was rehabilitated by UNICEF in 2002.

Lithological profile of the El Buh Borehole

Depth (m)	Description of lithology
0-5m	Arenaceous clay, yellow- brown loose with limestone broken stone
27m	Mudstone, mixed with red and white pellite, harder , intercalated with thin layer of conglomerate.
46m	Limestone, grey, looser texture, developed into small hollow dissolution holes 2-5 cm in diameter.
53m	Mudstone, yellow, fine and smooth, close harder
60- 78m	Argillaceous limestone, grey, smooth on bedding surface with chert nodules.
68.17m	Limestone, white, loose, small hollow dissolution holes can be fin 1cm in diameter.
85m	Argillaceous limestone, grey yellow, grey with pellite and small chert nodules 2cm diameter holes.
90.42m	Limestone, white , close hard brittle.
98m	Muddy limestone, with smooth and high content of fossils.
152m	Mudstone, grey, fine and smooth with high content of fossils.
156.50m	Limestone grey hard brittle.
169m	Interbedded mudstone and limestone black grey with fossils.
176m	Mudstone, black-grey with clam fossils.
185.50m	Dolomitic limestone, white, hard and brittle.
213m	Mudstone black grey, fine and brittle developed bedding with fossils.

Kabadheere Borehole
This borehole is located 5 km south of Burao town and was drilled by the Chinese to a depth of 185.61 m. The static water level is 90.29 m, with a screen at 114.25-180.94 m. Well yield is 242 m^3/day; TDS- 1.03g/L; pH-8.1.

Lithological profile of the Kabadheer Borehole

Depth (m)	Description of lithology
0-25m	Arenaceous clay, yellow brown ingredient, quartz, feldspar limestone debris, loose.
28m	Arenaceous rock with gravel
48m	Pellitic limestone with sand , grey ingredient of sand quartz and feldspar.
68m	Mudstone- red- brown and mixed colours with fine and smooth strain-slip section
86.7m	Politic limestone with sand , sand gravel, good roundness
109m	Limestone of chert nodules, rich in chert nodules on the top, hard 5-10 cm in diameter.
112m	Shale, yellow, developed foliation.
123m	Sandstone, grey, medium sized sand, quartz feldspar, with small content of gravel.
185.71m	Sandstone, grey medium sized sand ,mainly fine gravel fine gravel occasionally

There are two boreholes drilled recently, one by OXFAM GB (Gawaano borehole) and the other by UNDP (Lanta Morhida borehole). The cost of drilling a new borehole is between 120-200 USD/meter. The cost of drilling a 150 m deep borehole with casing and pump test would cost approximately 35 000 and 40 000 USD using percussion rigs and rotary rigs respectively.

Jiifto borehole
GRC established a borehole (Jiifto borehole) 25 km from Berbera town in April 2005. This is the only permanent water source in the area. A previous borehole in the same area was vandalised during the civil war, leaving only water tankers supplying water during dry periods. It serves nomadic people and their livestock in the rural areas of Berbera. It is mainly used in the January to March period (*Jilaal* season). In the *Hagaa* season (July to August) the temperatures are too high for the animals to survive there, so they are migrated to other areas. It provides water for camels on transit to the airport for export as well. The use of the borehole for domestic purposes is limited by high salinity levels, but locals have been reported to use the water for domestic purposes when they do not have other sources. The borehole is 86 m. deep with static water level at 81.6 m. The hydrogeological survey done before the drilling had recommended the depth of the borehole to be about 100 m so as to penetrate into a potential semi-confined aquifer, while at the same time avoiding seawater intrusion if the borehole was too deep. Drilling was done by a TOGSOL contractor, between 7th January 2005 and 15th April 2005. Water quality tests after drilling was complete gave the following results: PH of 7.6; colour <2.5 Mg pt/l; turbidity <2.5 M/T/l; EC (25^0C) 2700 S/cm. GRC fitted the borehole with a KSB pump, a pump house, a guard house, distribution network with a storage tank of 15 cubic meters, pipe outlets and animal troughs.

The Jiifti borehole was handed over to Berbera municipality upon completion for management. Initially, locals refused to pay for the water, but later resolved to pay for animal, but not human, consumption. The Berbera municipality pay 300 USD per month to the water agency for the maintenance and regular inspection of the borehole. However, failure by the municipality to pay for a period of one and half years caused problems, and somebody went and short-circuited the pump. The pump replacement was supposed to be shared by GRC and the municipality. GRC provided half the funds, but the municipality was unable to raise the other half. An NGO offered to replace the pump, and the money contributed by GRC was refunded.

UNDP boreholes*:* UNDP was mandated to oversee the drilling of 13 boreholes across Somaliland, awarded by the Sheek Zaid Foundation. Hydrogeological and geophysical surveys were carried out by SHAAC consulting company to determine the best sites. An EIA was done for the proposed sites and eight boreholes were contracted for drilling.

Thirteen locations for proposed UNDP boreholes

No	Location	Region	District	Geographic coordinates (decimal degrees)	
				Longitude	Latitude
1	Farodeero (Berbera)	Saahil	Berbera	45.08448	10.24065
2	Sheekh	Saahil	Sheekh	45.19078	9.93171
3	Zaylac	Awdal	Zaylac	43.47442	11.35235
4	Laagta Morohda	Awdal	Zaylac	43.26202	10.84678
5	TogWajaale (Geed Balaadh)	Northwest	Gabiley	43.43114	9.48456
6	Faroweyne	Northwest	Faroweyne	43.67054	9.33311
7	Bali Gabadle	Northwest	Bali Gubadle	44.00031	8.99921
8	Salaxlay	Northwest	Salaxlay	44.2069	9.02877
9	Xaaji Saalax	Togdheer	Oddweyne	45.24145	8.59012
10	Yagoori	Sool	Caynabo	46.9656	8.75274
11	Lafaweyne	Sool	Hudun	47.42626	9.07401
12	Hadaaftimo	Sanaag	Badhan	48.1051	10.76187
13	Carmaale	Sanaag	Ceerigabo	47.96029	10.47855

Cosob Drilling Company was contracted to drill the boreholes. Three have so far been drilled (Farodeero, Laagta-Morohda and Zeyla). A fourth borehole is underway at the time of this report, and a fifth was commissioned for drilling on 29th January 2007. Cost of drilling a borehole estimated at 100 – 120 USD per meter. This does not however cover the cost of casing, if required. After drilling, UNICEF provides the other facilities (pumphouse, generator, pump, pipeline, storage tank, etc).

Farodeero borehole
Samples collected at two-meter intervals during drilling gave the following geological results.

Lithological log for Farodeero borehole

Depth (m)	Description of Lithology
0 - 4	Top soil medium to fine sand
4 - 6	Fine Sand with gravel
6 - 10	Coarse sand with gravel
10 - 14	Gravel with thin layer of clay
14 - 16	Coarse to medium sand
16 - 20	Gravel small grained well rounded
20 - 40	Coarse gravel of different origin
40 - 48	Dark grey highly weathered basement
48 - 60	Dark grey compact and hard fresh basement

Discharge test
The discharge test of the borehole was characterized by a fairly steady yield with an average discharge of 19 m^3/hr and a specific capacity of 0.88 m^3/hr/m. Recovery rate was also very fast, 95% within the first 14 minutes after switching off the pump. Full recovery was achieved in 40 minutes.

Water quality analyses
Tests done on water after drilling showed good quality, as summarised in the table below.

T (C)	PH	EC us/cm	TDS (mg/l)	Total hardness (mg/l	Fe (mg/l)	Cl(free) (mg/l)
40	7.82	940	450	320	0.15	0.2

Laagta-Morohda borehole
Well lithology tests done during drilling gave the results below.

Depth (m)	Description of Lithology
0 - 6	Reddish brown fine texture silty clay top soil.
6 - 20	Red clays. Heavy clays with sand.
20 - 56	Coarse alluvial sand with fragments of rock.
56 - 70	Gravel with sand.
70 - 86	Coarse sand with fragments of rocks.
86 - 98	Coarse gravely conglomerate of different origin (alluvial gravels). The conglomerate consists of reworked rock fragments such as quartzite, gneiss, schist.
98 - 106	Coarse sand with fragments of rock.
106 - 120	Very dark gravel coarse-textured formation. Conglomerate – consisting of gravel and pebbles of Precambrian basement rock with fragments.
120- 148	Red heavy clays. Layer consists predominantly of red clay.
148- 162	Medium sand alluvial (1^{st} Significant Aquifer).
162- 166	Black coarse gravel – basalt sample fragment.
164- 175	Grey coarse alluvial sand with gravel.
175 - 178	Black coarse gravel – basalt sample fragment.
178 - 192	Coarse alluvial sand with gravel.
192 - 194	Black coarse gravel- basalt sample fragment.

Discharge test
Tests gave a fairly steady yield with an average discharge of 12.73 m^3/hr and an average specific capacity of 5.59 m^3/hr/m. The recovery rate was fairly fast.

Water quality analyses for Lagta-morohda borehole
A water sample obtained at the end of the constant discharge test and analysed for water quality gave the results below. The water was found to be of good quality, though temperature was high.

T (C)	PH	EC µS/cm	TDS mg/l	Total hardness mg/l	Fe mg/l	Cl(free) mg/l	S04 mg/l	NO3 mg/l	Fluorite mg/l	Calcium hardness mg/l
40	7.5	1285	634	310	0.2	No	173	142	0.14	170

Zeylac borehole
Tests done on well lithology during drilling are summarised in the table below.

Depth (m)	Description of Lithology
0 - 6	Reddish fine texture silty clayey top soil.
6 - 10	Reddish medium grained size sand.
10 - 16	As above bur texture much coarser with highly siliceous fragments and predominantly of red clay boundary/interface between the upper layers of clay and lower layer of sand
16 - 24	Reddish coarse sand with small gravel reworked rock fragment as quartzite and gneisses.
24 - 32	Red grey coarse gravelly conglomerate (alluvial gravels) originating from basement with sand alluvial.
32 - 37	Black coarse gravel – basalt sample fragments mixed with fragments of sands and small gravel medium texture red color.
37 - 42	As above but sand cleaner (highly siliceous) and material texture is relatively coarser.
42 - 56	Black/dark gravel coarse textured formation consisting of gravel and pebbles of highly weathered Precambrian basement rock with small sand grain size reduces.
56- 67	Black coarse gravel – basalt sample fragment with reddish relatively coarse sand (First Significant Aquifer)
67- 70	Reddish/ochre red coarse sand with gravel from quartzite
70- 73	Black medium gravel – basalt sample fragment with red sand material less than above layer

Discharge test
The discharge test gave a fairly steady yield with an average discharge of 8.03 m^3/hr and an average specific capacity 1.23 m^3/hr/m. Recovery rate was very fast, with 92.4% of the total drawdown obtained within the first 35 minutes.

Water quality analyses
Water quality monitored during drilling and testing of production boreholes were not different. EC measurements obtained during drilling was 1 210 uS/cm – 1 360 uS/cm, average TDS was 788.6. The water temperature ranged between 32^0- 35^0C.

SOUTH-CENTRAL SOMALIA

5.0 SOUTH-CENTRAL SOMALIA

5.1 Background

South-Central Somalia covers ten administrative regions: Galgadud, Hiraan, Bakool, Bay, Middle and Lower Shabelle, Middle and Lower Juba, Gedo and Banadir Regions. UNDP (2003) estimated the population of South-Central Somalia to be about 4.8 million, 64% of which live in the rural areas. The region incorporates the two main rivers in Somalia, the Juba and Shabelle.

5.1.1 Land use

Land use in most of central Somalia consists mainly of grazing and wood collection for fuel and building. In the south both rainfed and irrigated agriculture are practiced, especially in the riverine areas of the Juba and Shabelle rivers. The relatively high rainfall in the southern regions contributes to the rainfed agriculture. Crops grown under this system include sorghum, millet, maize, groundnuts, cowpeas, beans, cassava and other minor crops, and are grown twice a year during the *Gu* and *Deyr* seasons.

There are many small-scale irrigation fields along the Shabelle and Juba river valleys, where maize, sesame, fruit trees and vegetables are grown. Most of the large-scale irrigation projects growing sugarcane, bananas, guavas, lemons, mangos and papayas collapsed after the outbreak of civil war in 1991.

Flood recession cultivation in natural depressions is practiced on the Juba River flood plain, where sesame, maize and vegetables are grown. Several *wars* exist in the region, supplementing river water for domestic and agricultural use. Shallow wells and boreholes are also common groundwater sources used by people living in the rural areas of South-Central Somalia.

Rangelands in South-Central Somalia support livestock, mainly sheep and goats, cattle and camels. Livestock is privately owned, but rangelands are communal which makes it difficult to regulate range use.

Water resources in South-Central Somalia are to a large extent dependent on the two major rivers, the Juba and Shabelle. The total area of the Shabelle river basin is approximately 307 000 square kilometres, the larger part of which is in Ethiopia. The Juba has a basin area of 233 000 square kilometres shared by Ethiopia (65%), Somalia (30%) and Kenya (5%).

Even though most of Somalia's fresh water resources exist in the Juba and Shabelle rivers, both river basins are hydrologically water deficient. Water supplies for domestic purposes are unreliable and not well distributed due to poor infrastructure. Groundwater potential is limited due to limited recharge rates. Water supplies since the outbreak of the war in 1991 are run by unregulated private entities with no common vision or coordination. The environment is at risk due to water pollution.

Water potential in South-Central Somalia is much better than in northern Somalia. The establishment of water sources is a combined effort of the former government of Somalia, local communities, UN agencies and NGOs. A survey done by ADRA in Bakool region for example, established that 93.6% of water sources in the region were initiated by communities and families, with the government and Italians developing the other 6.5%, mainly boreholes.

5.2 Surface Water Sources

The Juba and Shabelle rivers are the main contributors to surface water in South-Central Somalia. Other traditional surface water sources which rely on direct rainwater for recharge are *wars*, *balleys* and *berkads*.

5.2.1 Shabelle River

The Shabelle River originates in the eastern Ethiopian highlands at an approximate altitude of 3 000 m above sea level. Annual rainfall in the highlands is about 1 000 mm. The river flows across arid lands on the Somali plateaus. Potential evaporation over the entire basin is much higher than the average annual rainfall. The total length of the river is 1 500 km, of which 600 km is within Somalia. The Shabelle is perennial, ending in a depression where it disappears in the sand east of Jilib near the Juba River. It does not enter the Indian Ocean except in exceptionally heavy rains when the river breaks the bank and joins the Juba River, eventually reaching the ocean. Water from this river is used for domestic as well as agricultural production.

5.2.2 Juba River

The Juba River originates in Ethiopia, with three large tributaries - the Gestro, Genale and Dawa - meeting near the border with Somalia. The average annual rainfall in the highlands is about 500 mm, but can reach as high as 1 500mm in some areas. The total length of the river is 1 100 km, of which 550 is in Somalia, entering the ocean at Kismayu. The river is an important source for the riverine community for agricultural and domestic water supplies.

In addition to the two rivers, other surface water sources exist, mainly *war* dams, *berkads mugciid* and springs. *War* dams are surface water rain-fed structures built on clayey soils that retain water for approximately 3-4 months. *Mugciids* are underground reserve storage wells with an average depth of 15 m which are mainly used when all other sources are depleted.

5.2.3 Wars and berkads

Unlike northern Somalia where *berkads* are very common, southern people prefer to use *wars* for rainwater harvesting. The main reason for this is the favourable clayey soil type for the construction of *wars*. However, *berkads* are still used, mainly in Hiraan and Gedo regions, for domestic water storage. The capacities of *berkads* range between 10 – 100 m^3 (ICRC, 2002). They are constructed mainly in areas where there are no dug wells. Water from *berkads* is either used for domestic consumption or sold to outsiders. Where water is sold *berkads* are better-maintained, with fencing to keep out animals and, in some cases, covered with shrubs or iron sheets to reduce evaporation,

Clayey soils favour the construction of *wars* as shown in Figure 5.1. However, sometimes they have to be lined up with plastic sheets to prevent water loss through seepage. In cases where the source is lined, the storage period is known to increase by up to two months due to reduced seepage. The sizes of *wars* vary depending on manpower available in villages for their construction. Water can last up to six months, depending on the lining material and consumption rate.

Figure 5.1 War (dam)

Wars in Bakool region are mostly used by small settlements where there are no dug wells and soil characteristics favour their construction. They vary in capacity from 1 500 – 8 000 m^3. Water lasts for two to three months after the rains, but with plastic lining the storage period can be increased to four to six months. Silting was singled out as the major problem faced by communities using *wars* for water storage. In areas where the predominant rock formation is limestone, limited *wars* are constructed due to high water loss through seepage. Under such conditions, water lasts two months or less.

In Bay region, *wars* with a storage capacity between 1 500 – 50 000 m^3 are built to store water for two to six months, depending on the consumption rate. Plastic lining is commonly used to minimize water seepage. In Baidoa district, communities have constructed about 200 small *wars* with capacities between 1 500 – 10 000 m^3. However, a 1999 UNICEF survey found that out of these, only 20 were in use, the main cause of failure being silting. In Kansadere district, *wars* are common in that there are 20 or more units for each settlement where the soil allows their construction. In Bardale district, the survey identified approximately 25 large *wars* with storage capacities of over 10 000 $m^{3,}$ and another 250 smaller *wars* constructed within farming areas. On average, settlements in this district have up to two *wars* each. In Burhakaba district there are about 50 *wars* constructed in the main villages and several other smaller ones in the settlements. In Dinsor district, 14 large capacity *wars* with a capacity of 50 000 m^3 constructed by the former government were identified. Initially they all had plastic lining, which was later looted together with the installed equipment. Currently, smaller *wars* constructed by the community exist.

The sizes of *wars* in Hiraan region vary from 1 000 to 5 000 m^3. They are common in Belet Weyne, Bulo Burti and Jalalaqsi districts, and can hold water for about three months.

5.2.4 Mugciid

Mugciids, which are underground reservoir storage wells with an average depth of 15 meters, exist mainly in Bakool region. There are more than 1 700 *mugciids* in the region, mainly in Hoddur, Teyeglow and Wajid districts. Many *mugciids* are constructed in clusters, with each family owning two to three units. Water lasts for two to three months.

Water extraction from surface water sources is mainly manual, using a bucket and rope technique. However, extraction from the Juba and Shabelle rivers for irrigation is done using motor driven pumps.

5.3 Groundwater Sources

The populations of South-Central Somalia living away from the Juba and Shabelle Rivers depend on underground water for their permanent water supply. The occurrence of ground water aquifers is depended on hydrogeology, which varies from Central to the South.

5.3.1 Hydrogeology of Southern Somalia

The main geological basin in the south stretches towards the north into Ethiopia and west into Kenya. It is sub-divided into two - the Xuddur-Bardheere which consists of Cretaceous and Jurassic rocks, and the Coastal Basin consisting of sediments extending from the Lower Jurassic to Quaternary (Faillace, 1986).

There is a well-defined hydrogeological province (Buur area), which due to its position and structural characteristics has some influence on the movement of groundwater in the Xuddur-Bardheere and Coastal basins. The occurrence and movement of groundwater is affected by faults and folds created as a result of the uprising of the basement complex. Along the Coastal Basin, groundwater movements in alluvial and fluvio-lagunal deposits are determined by the Bandar-Jalalaqsi Fault, which extends more than 500 km parallel to the coast.

Basement Complex

Rocks found in the basement complex are mainly granites, quartzite, micaschists and marble. Mantle of red lateritic sand resulting from deep weathering of underlying rocks and alluvial formations deposited by numerous streams are also common. Recharge occurs by rainfall and from runoff water along *toggas*. Little recharge occurs in large areas covered by black alluvial clay, and water found in such clays is usually salty. The majority of groundwater is found along the *toggas* in alluvial deposits and weathered basement where recharge conditions are good. Groundwater flows mainly along the major surface drainage patterns. Groundwater bodies are small and discontinuous, most of which are locally recharged. Small amounts of water can also be found in rock fractures, though salinity is generally high.

Xuddur-Bardheere Basin

Recharge in this basin occurs along the Baydhabo escarpment through the joints of stratification and the karstic areas through the dolines and sinkholes where rainfall and runoff water infiltrate rapidly (Faillace, 1986). Recharge is good in areas covered by the Baydhabo Jurassic limestone, and almost zero in areas covered by residual clay which is impermeable. Underground flow starts from the Baydhabo plateau and continues in north-easterly and north-west directions. In the upper parts of the Juba valley flow is from east to west, and from north to south. There are numerous springs along the Baydhabo escarpment due to the draining of the narrow belt of limestone formation cut by several small faults. Underground flow is locally inverted towards the escarpment by the small faults.

Two discharge zones are found in Gedo region: one located on the western side of the Juba valley where groundwater seeps out through several small springs along the riverbeds of major *toggas*, and the other found in the north-west of Garbahaarrey, draining the Cambar and Garbahaarrey formations.

The Baydhabo Formation which surrounds the Basement Complex to the west, east and north has a high groundwater potential. The depth of water increases from the edge of the escarpment towards the north. At Baydhabo, water level is 5 m whereas at the contact point with the Canoole Formation the level is 50 m. The levels are 70 m and 120 m for Ufurow and War Caasha respectively. Water quality in the Baydhabo is generally of good quality, with EC values ranging between 650 – 1 500 µS/cm. The other formations with water potential are Garbahaarrey, Cambar and the Main Gypsum Formations.

Coastal Basin
Groundwater recharge in the coastal basin is as a result of direct rainfall, the Juba and Shabelle rivers, underground flow from Kenya, runoff and underground flow from the basement complex. Major recharge occurs only in certain areas where there are sand or sandy clay deposits. Flow in the Shabelle valley area is influenced by the Bandar-Jalalaqsi fault. Recharge occurs also from the irrigation canals of the Janaale-Buulo Mareerta agricultural area. In the Juba recharge mainly occurs in the areas of Liboy, Bilis Qooqani, Hosingo and south Hosingo. Recharge is good and groundwater is of fairly good quality. Sand deposits exist to a depth of 200 m. Groundwater flow in the Shabelle is north to south, while in the Juba valley it is north to south in the northern part and northwest to southeast in the southern area.

5.3.2 Hydrogeology of Central Somalia

Most of Central Somalia falls under an arid and semi-arid climate. In the northern part mean annual rainfall is as little as 100 mm, but towards the south the amount increases to about 500 mm. The rainfall pattern is however very irregular. Temperatures range from 20-35°C in the northern and southern parts respectively.

There are five main geomorphological features in Central Somalia according to Faillace (1986). These are the Shabelle Alluvial area, a flat plain extending down a narrow belt along the Upper Shabelle River Valley; the Upper Shabelle Valley with low undulating hills and steep slopes; a gentle undulating plain along the inner side of the coastal belt with stabilized dunes; a Coastal Belt with features ranging from gentle slopes to very steep slopes with gulleys and drifts; and a Central Plateau characterised by gentle micro relief with sand cover and hard caliche patches sloping to the east.

Direct precipitation accounts for most of the ground water recharge in Central Somalia. Runoff water flowing in depressions contributes to recharge of shallow aquifers, and later infiltrate into deeper underlying permeable layers. In the deep aquifers, groundwater movement occurs from the main recharge belt, under unconfined conditions. In the alluvial plain in the southern part, groundwater moves towards the coastal zone, while along the riparian belt of the Shabelle River groundwater movement is along the river regime. In the rainy season the river recharges the water bearing alluvial sand along its banks while in low river flow the shallow riparian aquifer discharges along the river bed.

The discharge zones are not well defined in Central Somalia. Most groundwater discharge occurs along the coastline. The main hydrogeological provinces and aquifers in Central Somalia are:

Upper and Middle Shabelle Valley: The Upper Shabelle is characterised by a broad valley delimited by geological formations composed mainly of limestone, gypsum, marls and sandstone. The Middle Shabelle valley consists mainly of clay and sandy clay overlaying gravel and clay layers. The main formations are Cretaceous Formations which supply water of marginal to salty quality, and the Alluvial Deposits which yield good to marginal quality water.

Mudug-Galgadud Plateau: This is an eroded, featureless plain covered by caliche, gypsum and red sand. The plateau exists at elevations between 50–400 m, and consists of several formations: the Yasoomman Formation which is believed to have the best groundwater in Somalia (TDS generally less than 1.5 mg/l); the Karkar Formation where attempts to drill several boreholes had to be abandoned due to cavities, but water is of good to fair quality at depths greater than 100 m; Oligocene-Miocene Suites where water from limestone ranges from good to fair quality, whereas water at the Mudug beds is highly saline; Plio-Pleistocene Gypsiferous Deposits where the depths of water range from 20-25 m around Gaalkacyo to 2-3 m in the terminal flood plain. Water quality in this formation changes gradually from the areas close to the border towards the terminal floodplains, whereas salinity varies through out the year in relation to recharge regimes during the rainy season.

Coastal Belt: Constitutes a variety of rocks of varying age. There are stabilized, semi-stabilized and shifting dunes of sandstone, coral limestone and white beach sand spread along the coast. Freshwater lenses are very thin and deteriorate rapidly when subjected to intense withdrawals using simple skin buckets. Groundwater along the coast has sodium chloride except in Mogadishu where water is of the bicarbonate type. Water salinity increases with depth.

5.3.3 Shallow wells

Shallow wells are common sub-surface water sources in South-Central Somalia, many of which dry out during prolonged drought periods. They also have high levels of organic contamination due to poor construction and shared outlets for livestock and human use.

In Bakool region, a survey by UNICEF (1999) identified a total of 770 shallow wells, both permanent and seasonal. A small percentage of the wells were functioning, while the majority had broken down. Average depth of shallow wells in the district is 12 m. Some are lined with concrete, but the majority have traditional timber logs as lining. Shallow well distribution across the districts is uneven. In El Berde district only ten shallow wells were identified, the low number being a result of a sub-surface formation of fragile limestone intercalated with siltstones that tend to cave in with depth, therefore making it difficult to construct dug wells.

The number of shallow wells in Bay region are estimated to be 610: 250 in Baidoa; 50 in Kansadere; 60 in Bardale; 90 in Burhakaba and 160 in Dinsor districts. Depths of shallow wells vary across the districts, but are generally in the range of 8-10 m. Almost every household in the rural communities has a shallow well, whereas in urban centres they are commonly constructed in clusters with the wells less than 300 m apart. The wells generally have stagnant water, cracked platforms and lack proper drainage.

There are more than 200 shallow wells constructed in Hiraan region, both communal and privately owned. Most wells are constructed either in limestone depressions and areas covered by gypsum, or along the rivers. Several shallow wells are also constructed along the main drainage system in karstic limestone formations, though they tend to dry up during the dry period. The majority of the dug wells in this region have low recharge rates as a result of inadequate water columns and caving in at the bottom due to upwelling of sands mainly along *togga* beds and alluvial and sandy formations.

Gedo region has around 40 shallow wells (ICRC, 2002). The population served by these shallow wells is in excess of 140 000 families, both permanent and nomadic. A good percentage of the wells are in poor condition and need rehabilitation.

A number of shallow wells also exist along the Juba and Shabelle catchments. From the SWIMS database, the Lower Shabelle has at least 58 shallow wells, while in Middle Shabelle the number of wells is 52. Lower and Middle Juba Regions have three and one wells respectively, based on the SWIMS database. The actual number could however be much higher than this.

Construction quality of dug wells is poor which leads to cracked platforms, allowing runoff water to seep back into the wells. Many lack well heads, while those that have been rehabilitated have concrete lining only to a maximum depth of 10 meters with the rest of lining being either timber or natural stone.

The use of pumps, both hand and motor driven, practiced in shallow wells, although use of the traditional bucket and rope method is the most common in extracting water. Hand pump technology is however not sustainable, as evidenced by the high rate of pump failures. Looting and lack of spare parts were noted as the main causes of pump failure. Wells are usually lined with traditional timber logs. Where there are private wells used for commercial purposes, motorized pumps are common.

It was established that UNICEF in collaboration with other partners is promoting the use of hand pumps in shallow wells. Water for Life also reported that their organization introduced solar-powered pumps for a pilot study in Jenale. The performance of such pumps was found satisfactory. The organization is promoting the use of solar pumps to reduce running costs, but the technology is not very popular among local communities who claim they are unable to raise the initial installation amount required, which is about € 1 000 for a complete set of pump and solar panels.

5.3.4 Boreholes

The only permanent water sources in South-Central Somalia are boreholes and the Juba and Shabelle rivers. Boreholes provide water throughout the year, and for communities living away from the two rivers they are the only source of water during prolonged drought periods.

A survey by UNICEF (1999) identified boreholes, alongside shallow wells and *mugciid*, as the main water sources in Bakool region. There are a total of 31 boreholes in Bakool region. Only three, representing 10% of the total boreholes are functioning as indicated in the table below.

Table 5.1 Status of boreholes in Bakool Region

District	Functioning boreholes	Non-functioning boreholes	Abandoned boreholes	Total boreholes
Hoddur	0	0	11	11
Teyeglow	2	4	3	9
Rabdhure	0	2	2	4
El-Berde	0	0	1	1
Wajid	1	2	3	6
Total	**3**	**8**	**20**	**31**

Source: SWIMS database & UNICEF 1999 Inventory of Water Sources

Average borehole depth varies from 90 m at Teyeglow district to 220 m at Hoddur. As a result of civil strife in Somalia, many boreholes have been filled with stones and their power and pumping units looted. Both Rubdurre and El Berde districts have limited boreholes due to low-yielding aquifers at great depths, leading to acute shortages of reliable water. Most structures accompanying boreholes such as water tanks, animal troughs and stand pipes, were destroyed.

A total of 144 boreholes existed in Bay region by the year 1999. The distribution of the boreholes per district is shown in the table below.

Table 5.2 Distribution of boreholes in Bay Region

District	Functioning boreholes	Non-functioning boreholes	Abandoned boreholes	Total boreholes
Baidoa	8	25	52	85
K/dhere	10	2	8	20
Bardale	9	6	5	19
B/khaba	0	2	5	7
Dinsor	1	3	9	13
Total	**27**	**36**	**81**	**144**

Source: SWIMS database & UNICEF 1999 Inventory of Water Sources

The water table is fairly deep across the region - average borehole depth is about 120 m. However the Static Water Level (SWL) varies from place to place. In Baidoa district, SWL is estimated at 63 m, while in Dinsor it is 73 m. In both cases the water yield is approximately 12 m^3/hr.

Borehole failure rate is high, as can be seen from Table 5.2. Only 27 of the 144 boreholes are functioning, which is less than 18%. Most non-functioning boreholes are as a result of faulty pumps and generators, whereas many of those that have been abandoned had their casings filled with stones during the civil war. Some boreholes were never equipped after drilling, as in the case of Botis and Gof-Gadud boreholes.

Civil structures (storage tanks, animal troughs, water kiosks, etc) of the majority of boreholes visited by UNICEF required rehabilitation, both minor and major, varying from patching of animal troughs to complete installation of water tanks.

In Hiran region, borehole drilling started as early as 1915. A summary of the number of boreholes in each district is presented in the table below.

Table 5.3 Boreholes in Hiraan Region

District	Functioning boreholes	Non-functioning boreholes	Total boreholes
Belet Weyne	2	6	8
Bulo Burti	6	3	9
Jalalaqsi	4	2	6
Mahas	5	1	6
Mataban	1	1	5
Total	**18**	**16**	**34**

Source: SWIMS database & UNICEF 1999 Inventory of Water Sources

The average depth of boreholes in Hiran region is about 96 m, with the actual range identified as between 60 – 250 m. Average yield is estimated at 10 m^3/hr.

Unlike many other regions with high borehole failure rates, 18 out of the 34 boreholes (53%) in Hiran were functioning in 1999. The non-operational boreholes had the pumps and/or generators destroyed or looted during clan conflicts. About 60% of borehole civil structures were found to be in good working order and the majority of the remaining 40% required only minor repairs such as replacement of taps or minor cracks on animal troughs. Only 10% of structures were completely destroyed.

According to ICRC (2002), there are six operational boreholes in Gedo region. Four of these are also reflected in the SWIMS database. These boreholes serve a population of over 3 800 permanent families and 42 000 nomadic families. Three of the boreholes are in good condition, two in fair condition and only one in bad condition. The average depth of boreholes in the region varies between 50–100 m., depth increasing with height above sea level. However, water quality according to ICRC is a major constraint to borehole drilling, as large areas have water which cannot sustain people and livestock.

In the Middle Juba and Middle Shabelle Regions, the number of boreholes identified from the SWIMS database were 19 and four respectively. The number of functioning boreholes could not however be established, which calls for a field survey to determine the operational status of the boreholes, not only in the two regions but the entire South-Central Region.

Almost all boreholes are installed with a pump after drilling. Experiences with pumps are however discouraging, with the majority operating for less than a year after installation. The main cause of pump failure is lack of maintenance and lack of spare parts in the case of breakdowns. Looting of generators is also reported as a common practice in South-Central Somalia. Water from wells is temporarily stored in tanks and distributed to water kiosks, animal troughs and other outlets.

5.3.5 Springs

Springs are not common in South-Central Somalia. Two springs are however known to exist in Bay Region, Baidoa district. These are the Manas and Isah, the latter being used mainly by communities from Baidoa town. During the UNICEF survey, indiscriminate use of water in the spring was noted upstream, mainly car washing and bathing of children.

5.4 Water Quality

Water quality is an issue for both surface and sub-surface water sources in South-Central Somalia. The sanitary condition of most sources in the region is generally poor. Water uses contribute to the sanitary condition of the source. Where water demand for livestock consumption is high, sanitation surrounding the water source is poor, with animal waste mixing with stagnant water at the watering point. Figure 5.2 shows camels taking water from a trough next to a shallow well.

Figure 5.2 Camels being watered next to a shallow well

Since many water sources are not protected, contaminated water eventually finds its way back to the well. The case is only different where the water source is used purely for domestic or livestock uses. Condition is also better at privately owned sources. Generally, traditional shallow wells used for both domestic and livestock consumption are noted as having the poorest sanitary conditions.

Salinity in many boreholes visited by UNICEF was found to be high. In Huddur and Teyeglow districts for example, EC values ranged from 3 500 – 15 000 μ/cm and 4 900 – 2 400 μ/cm, while pH ranged from 7.3–7.8 and 6.9–7.5 respectively. Stagnant water mixed with animal waste is also common around boreholes.

Most traditional shallow wells lack protective headwalls, well platforms and drainage systems. In Burhakaba district, salinity and bitterness (quinine-like) are a big problem for domestic water use. Only six out of the 90 wells visited during the UNICEF survey in 1999 had potable water. Cracks as a result of poor construction allow water mixed with animal waste to flow back into the well. High turbidity levels were also observed in many shallow wells.

For *wars* and *mugciids*, water is polluted from human and animal waste in the catchment around the water points. *Mugciids* have a common outlet for both livestock and domestic use, which contributes to contamination by animal waste. Bathing and washing of clothes are also done inside the reservoir.

Within Gedo region, the quality of ground water is related to the nature of the sub-surface formations. High base flow salinity along the *toggas* in the region is as a result of high saline water-bearing layers along the seasonal riverine belt due to high deposits of gypsum

(ICRC, 2002). The quality of water in seasonal rivers fluctuates greatly over the course of the year. The highest EC values are obtained during the first flow after long dry periods due to the soluble salts deposited in the dry riverbed and on the land.
Generally, there is a lack of awareness of required sanitary conditions among communities. Interviews conducted by UNICEF in 1999 showed that about 60% of communities were unaware of the relation between sanitary conditions and water-borne diseases, while 75% of operators had not undergone any hygiene education training.

UNICEF and WHO keep monitoring water quality in South-Central Somalia, where there are very few water-testing laboratories. UNICEF purchased two water testing equipment sets which are currently in Jowhar. Twenty people from local and international NGOs were trained in the use of water quality test kits. Mineralization is reported to be a major concern in underground water, the most common mineral being calcium carbonate and gypsum, especially along the Somalia-Ethiopia boarder. As the water passes through gypsum areas it absorbs salts, making it saline. For surface water, silting and debris are major concerns. Germs collect in water sources which also act as breeding sites for mosquitoes. Locals however prefer surface water to underground water, claiming that it tastes better. While appreciating the good work by UNICEF and WHO, Water for Life were concerned that the locals might end up using an over- or under-dose of chlorine on water since they do not do much analysis before chlorinating.

Along the coast there is a layer of fresh water overlaying salty water. Extra care is needed when drilling boreholes in this region so that the salty layer is not extracted. A brackish water layer exists between the fresh and salty layers.

5.5 Current Water Use and Demand

With the collapse of major irrigation schemes in South-Central Somalia, livestock now consumes most of the water. During the dry season, animals move from pastoral land to the rivers in search for water. In many cases, these animals end up damaging crops grown by the riparian communities, hence creating water use conflicts. Previously, irrigation used to take a major share of available water, especially in the riverine areas where the main economic activity is irrigated agriculture.

Average domestic water use is 10–16 litres/person/day. However, due to water shortage problems in Somalia, local people have learned to use water very economically, reducing demand to between 2-12 litres/person/day.

When selecting suitable sites for drilling boreholes, the linkage between the sites and communities that will be utilizing them is a major consideration. A good number of boreholes were originally drilled along seasonal nomadic routes. With the outbreak of war in the early 1990s, many nomads settled in the more sedentary areas of central and southern Somalia alongside rural and urban communities. The struggle over limited and scarce rainfed water sources and shallow well water supplies within a few hours walking distance of the villages, has placed much stress on existing and newly rehabilitated structures, thus necessitating rehabilitation of additional boreholes that are generally in or near villages, or in close proximity to a cluster of settlements. These additional resources will give the population and their livestock an all-year reliable water supply.

5.5.1 Socio-economic context

Ownership of water sources is both individual and communal. Communal water sources are managed under traditional laws. There are community management committees structured by traditional norms with the elders or village chiefs and operators playing an active role in the operation and distribution of water. The elders make decisions on behalf of the community, in most of the cases without consultation. Some decisions made by elders might therefore not be favourable to the community. The operators collect revenue and handle the operation and maintenance of the water source including purchase of fuel, oil and filters. The operators were noted to only keep records of fuel used, but not for sales of water and other revenue earned. At most water sources there are no logbooks.

The management of communal water sources was found lacking in most cases. Where the well is used for commercial purposes management is usually by men, whereas for sources used for domestic purposes women are given the responsibility of managing the source. Apart from the daily running of water sources, committees are mandated to create community awareness on sanitation and hygiene education. Revenue collected can be quite substantial, but there is no proper system of accounting for it. There is very little reinvestment made on the equipment.

Maintenance and hygiene are generally better for commercial water sources where water is sold to outsiders, mainly for livestock watering. There is additional revenue which is reinvested in the system for maintenance and equipment. However, for communal water sources maintenance is poor since water is distributed free of charge and there is no money available for maintenance. When major maintenance and/or repairs are required, funding is generally sought from agencies implementing the project or from community contributions which cause long delays in repair work.

In Hiran region, management of boreholes has been under the responsibility of community elders and operators since the breakdown of the central government in Somalia. Water, Environment and Sanitation committees (WES) are established for some water sources to oversee their management. Members of the WES committee are usually selected by the elders and are representatives of clans living around the water points. They constitute the chairperson, two pump operators, two health promoters, an accountant and four members, of which two or three are women. The operators are responsible for operation of the water system, collecting revenue from water sales and using it for operational costs and salaries, and for completing logbooks. However, from the UNICEF survey meter readings were found to be omitted at all water sources. The accountant has the responsibility of checking the logbooks and recording meter readings as well as keeping sales records, but for most of the sources the operators were found to double their work with that of accountants. The chairman has the responsibility of coordinating water distribution and mobilization of the community to donate funds for major repairs where no agency funding is available. The other members support the chairman in his duties.

For most wells, the operator is the one who determines the effectiveness and efficiency of the operation of the water source, while the elders ensure security of the water source as well as reducing tension between different clans living around it.

Communities usually complain of mismanagement of funds obtained from water sources. Two types of revenue management exist: revenue collected and handed over by operators to the village elders committee; and revenue collected and kept by the operators for operational costs and payment of salaries. However, the lack of financial institutions in both rural and urban areas hinders saving of funds from revenue collected.

Women are not actively involved in decision making, and are rarely consulted in matters regarding management of water sources. They are given the responsibility for hygiene of the family and the community, but have limited participation in water source development and management. However, when trained, women perform better than men in management and maintenance of community water sources. They administer funds more honestly, and are less likely to migrate. WES committees for water management incorporated three women members to guarantee their representation, although the direct role of the women in the operation and maintenance is limited to:

- Participating in cleaning of well heads
- Carrying stone and sand during repairs
- Cooking for masons
- Teaching children and other women about proper hygiene practices at the wells and environmental sanitation at homesteads

There are no major conflicts in the use of water in the wet season. Water collected in the ponds is used for domestic consumption. The local community prefer pond water to borehole water since it tastes fresher. The ponds last 1-3 months, after which there is high competition for water from the permanent water sources. Outsiders are particularly discouraged from using the water sources by the local community.

In principle, nobody is denied water in Somalia (ADRA interview). Small charges are imposed for the maintenance and repair of water facilities. The cost of water is dependent on season. The cost is usually minimal during the wet season, but is higher in the dry season when water is scarce. The communal committees organize the distribution of water in the dry season. Where salinity and bitterness are a problem as is the case in many shallow wells in Burhakaba district, fresh-tasting water is sold at exorbitant prices, 1 USD or more for 200 litres which would otherwise cost only 0.2 USD. In Dinsor district, the only functioning borehole at Missire sold high-cost water to communities who had to walk for 20 km in search for water. In times of scarcity, water is sold as high as 2 – 2.5 USD for 200 litres.

Lack of spare parts for both motorised and hand pumps was identified as a key limitation to maintenance of water sources. Lack of adequate technical skills and trained manpower were also contributing factors to the poor performance of the water sources especially in the rural areas. Technically-trained manpower was reported to have moved either to the urban centres in search of jobs, or out of the country. In some cases, operators are familiar with generator set and pumping units installed at water sources, but do not adhere to required regular maintenance procedures. Maintenance tools were also found to be lacking. In the urban areas where water was sold during all seasons, maintenance was found to be better, as was the case with privately-owned sources. At some communal sources, no revenue was collected at all, making maintenance almost impossible. Ignorance also contributes to a certain extent on the failure of water sources. ADRA reported that some boreholes in Bakool region stopped functioning after children filled them with stones, believing that this would bring the water to the surface.

5.6 Analysis of Major Issues

5.6.1 Institutional and policy issues

Somalia did not have a water act before the outbreak of civil war in 1991. There were however institutions for managing water in the country before the collapse of the government. The main institution in charge of water resources management and development was the Ministry of Water and Mineral Resources (MWMR) and the associated National Water Centre (NWC). Exploitation of underground water resources for domestic water supply was under the Water Development Agency (WDA). Water for agricultural activities along Shabelle River was under the Ministry of Agriculture, while that for Juba River was under the Ministry of National Planning and Juba Valley Development.

The current situation is worse than it was before 1991. There is no centralised system for managing the water sector. Some customary water laws have been applied, especially to communities living along Juba and Shabelle rivers. However, such laws are not widely acceptable as they deny access to water for those who are not living along the water course, and are not sustainable. Again, there is a considerable lack of awareness and understanding of traditional and customary rules relating to water rights since they are undocumented (SCWE, 2000).

Local committees have been set up to oversee the operation of water sources, mainly boreholes. However, the operations of such committees was found wanting. They are not regulated, at times making decisions that are unfavourable to the local people. There is no accounting for money collected from the sale of water, thereby giving room for mismanagement. As a result, many water sources have collapsed or been abandoned even for minor breakdowns. UNICEF has been supporting WASH management committees by training borehole operators. The onus is on the government of Somalia to set guidelines and impose them on all stake holders in the water sector.

5.7 Conclusions and Recommendations

1. The desk study assessment for South-Central Somalia was limited to availability of data/information, with some regions not represented. A more detailed field survey of water sources in all the South-Central regions would reflect the real situation on the ground.
2. South-Central Somalia is much advantaged in terms of surface water resources when compared to other regions of the country. The two major rivers, the Juba and Shabelle, if well-utilised can take the country towards meeting national water requirements for both domestic and agricultural uses.
3. Underground water reservoirs in South-Central Somalia are not fully exploited, although surveys carried out by various agencies indicated that local people prefer surface water to that from underground sources for domestic consumption. Underground sources can nevertheless supplement surface sources in meeting water demands for livestock and agriculture.
4. There is a need for the Somali government to regulate the use of water by developing and imposing a water policy on all stakeholders in the sector. This would ensure efficient use of water resources for economic development.
5. Water quality is a major concern in South-Central Somalia. UNICEF and WHO have done much in the region to address the problem, but more needs to be done. The Somali community needs to be sensitised so as to stop viewing water availability only in terms of quantity, but quality as well. Such an approach would alleviate the regular outbreaks of water-borne diseases.

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Appendices

Annex: Selected Interviews

UNICEF Interview

- Water availability dynamic; open wells are submerged during flooding
- UNICEF promoting the use of hand pumps; in collaboration with other partners, mainly NGOs.
- Two water testing equipment in the South-Central Somalia, kept at Jowhar.
- 20 people, from the local and international NGO were trained on the use of water quality test kit. Training was done by UNICEF and WHO. The security situation deteriorated soon after, leading to evacuation of the trained staff.
- WHO made a commitment to monitor water quality across the entire country, but the activity has not yet started.
- UNICEF is committed to setting up task forces in the field with partners and provide equipment for water quality evaluation.
- UNICEF currently supports digging of dug wells, but information from the filed needs to be consolidated before sharing with SWALIM.
- Considerations are made on drilling of boreholes.
- Management: Most of the hand dug wells are managed by the local committees, headed by the elders.
    - Boreholes are managed by the WASH management committees, trained by UNICEF. 2 operators are trained for each borehole. There is however a problem that the trained technicians keep moving, making training a continuous process.
    - Water is sold at 0.2 USD per 200 litre drum. In the dry season, water become scarce, and more expensive.
    - Money collected from the sell of water is used on diesel and salaries for the attendants. No records are kept on how the money is spent, neither are there savings made for repair and maintenance of the system.
- Conflicts: There are no major conflicts in the use of water during wet season. Water collected in ponds is used for domestic consumption. The local community like pond water more than the drilled water since it is fresh. The ponds can last 1-3 months after the rains.
- Mineralisation is a major concern in the underground water. The common minerals are calcium carbonate.
- In the dry season, there is competition on the use of the permanent water sources, mainly boreholes. Outsiders are discouraged from using the source.
- Livestock consume most of the water. However UNICEF concentrates more on domestic water.
- Irrigation is mainly practiced in the riverine areas.

In addition to the above, every year UNICEF Somalia undertakes health and nutrition surveys to gather statistics and data on diarrhoea cases and malnutrition levels throughout the region. Based on this, and other known factors gathered from surveys, UNICEF plans the rehabilitation of water sources to make clean water sources more available to the population.

Factor to consider in identifying suitable sites for boreholes:

- Firstly, is the linkage between the sites of boreholes and communities that will be utilizing them: Many of the identified boreholes were originally drilled along seasonal nomadic routes. With the outbreak of war in the early 1990s, many nomads have settled in the more sedentary areas of central and southern Somalia, alongside rural and urban communities. The struggle over limited and scarce rain fed water sources and shallow well water supplies within a few hours walking distance of the villages has placed much stress on existing and newly rehabilitated structures, thus necessitating rehabilitation of additional boreholes that are generally in or near villages, or in close proximity to a cluster of settlements. These additional resources will give the population and their livestock an all year round reliable water supply.
- Second, is the linkage between the new boreholes to be rehabilitated and disease incidence: Many of the water supplies currently in use, particularly open water catchments, are polluted by animal excreta as animals invariably tend to wade into these water sources, to drink and to wash. This contaminated water is very often the source of diarrhoea and other diseases that can be seen among the populations. The rehabilitation of the new boreholes gives the target communities direct access to a clean water source that is not utilised or shared with animals, thereby reducing the risks of the population to the incidence of water born diseases.

ADRA Somalia Interview

Project areas:

ADRA Somalia is currently running three projects in Southern Somalia (Bakool, Bay, Mudug and Hiran regions). These are:
- Emergency Water Livelihood Support Project (EWLSP)
- Emergency Water Assistance Project (EWAP)
- Water and Sanitation Mudug Region (WSM)

- Bakool Region
  - Current project is EWLSP, funded by USAID for 1 year.
  - The project concentrates on rehabilitation of water sources rather than establishment of new sources.
  - ADRA shared with SWALIM data on sources so far rehabilitated.

- Bay Region
  - Current project in the region is EWLSP, started in February 2007. There was a delay in the start of the project due to security concerns in the South.
  - Project period is 1 year.
  - Another project, EWAP, also running in the region starting February 2007, for 6 months.
  - EWAP is funded by ECHO.
  - The project aims to construct berkads and water catchments, as well as rehabilitation of shallow wells
  - The water table in Bay region is very deep, thus hindering drilling or boreholes.

- Mudug Region
  - WSM project runs in Mudug region under the funding of the Norway Ministry of Foreign Affairs.
  - Mudug Region has been neglected by many organizations. ICRC did some rehabilitation work on shallow wells in the region, but this was long time back.
  - The project has two main targets:
    - Provision of water to people of Mudug district
    - Capacity building of a local CBO known as Somalia Community Development Organization (SCDO) e.g. in the construction and rehabilitation of water points.

- Hiran Region
  - A proposal for a project for the provision of water for schools in the urban and rural areas was submitted to UNICEF and UNOCHA. The six months funding by UNICEF would cover hand pumps while UNOCHA would contribute towards flood response for 3 months.

Most water sources are communal, though there are few which are privately owned.

The problems associated with water in the four regions include:
- Water use conflict between domestic and livestock needs
- In the dry season the water table is too low for most shallow wells to yield any water
- Water is usually collected by women, sometimes at the expense of schooling for the young girls
- Many of the underground water sources are saline with a lot of minerals. People prefer using water from surface catchments for cooking and other domestic purposes since it is sweet and does not contain minerals. Most of the catchments keep water for a period of 2-3 months after the rain.
- Water collected in the rain water catchments has a lot of debris and silt. The water is dirty and contains a lot of germs and acts as breeding ground for mosquitoes.
- Due to its importance and scarcity, catchment water is usually very expensive during the dry period. In times of scarcity, a 20 litre jerrycan can fetch as much as 0.6 – 1 USD,, far much higher than a 200 litre drum of water from the well which costs between 0.3 – 0.4 USD.
- The are no laboratories for testing water quality in many parts of the South-Central Somalia

ADRA trains local people on chlorination of water for all the rehabilitated water sources. Chlorine is provided by UNICEF.

Bakool Region

Physiography and Geology

Bakool Region is generally flat with a southward gentle slope. There are various incisions of dry streams and stabilized hills with deep gullies on the gentle slopes and sheet erosion structures in the lower lying areas. Jurassic formations, which are the oldest sedimentary rocks in the area overlay the basement system rocks. The upper Jurassic formations are sub-divided into four units: the Baydabo, Canoole, Waajid and Garbahaarrey formations.

The main water sources in this region are:

- Shallow Wells: the most important water sources; usually unlined; open with logs and stones arranged around the mouth. Many have broken down due to over-use, improper use and lack of maintenance.
- Mucsid: unlined underground man-made tank or cavity below ground that serves as water reservoir
- Berkads: concrete lined underground water reservoir with or without roofing
- Boreholes: machine drilled, usually lined with steel casings; located mainly in major trading centres; drilled either by government or donor agencies; depth vary between 40 and 175 metres; engines, generators and pumps looted; children filled the open hole of the borehole believing that water would come to the surface; yields range between 5 and $10m^3/hr$.
- Catchment: ground level reservoirs excavated by hand by the community or by earth moving machines by the government or agencies; commonly referred to as balleys
- Wharo: Natural open ground catchments usually without lining; supply water for 1-2 months after the end of the rainy season; water quality is extremely poor, with people and livestock using water from the same source
- Roof Catchments: ground level or underground concrete or sand walled tanks connected with gutters to collect water from rooftops; mainly for the well-to-do people in market centres.

Survey done by ADRA indicated that 93.6% of the water sources in the region were initiated by the communities and families, with the government and Italians developing only 6.5%, mainly boreholes.

In principle, nobody is denied water in Somalia. Small charges are however imposed for the maintenance and repair of the water facilities. WES committees took care of wells by directing and controlling the way people used water and handled wells. Hand pumps were usually attended by women and children with little intervention from elders.

In the case of boreholes, there were water committees that employed operators to operate and maintain water yards and collect revenue. The committees oversaw the management of borehole yards with a team consisting of a manager, cashier and operators. ADRA issued the WES committees which had yards with basic tools, oil, fuel and air filters, and 200 litres of diesel per yard to kick-start the operations. Records' keeping is poor, making it difficult to track revenue and expenditure.

WES committees had three women as members. Though, the direct roles of women in the operation and maintenance was limited to:

- Participating in the cleaning of well heads
- Carrying stone and sand during repairs
- Cooking for masons
- Teaching children and other women about proper hygiene practices at the wells and environmental sanitation at homesteads

Women were not involved in the management of boreholes. The actual removal of debris from inside the wells was done by men.

Maintenance practices observed by the communities are different for each source type:

Hand-dug wells: regularly maintenance practice; inside of the wells are cleaned before the rains, either annually, after six or three months; livestock troughs cleaned each time before the livestock took water as a safeguard against diseases.

Boreholes: maintenance done regularly by the operators though no records are kept to ascertain the information.

There are no cash transactions at the shallow wells, but community members make contributions when need arises. The contributions and fines from offenders are used for maintenance of the system and the rest goes to the local authorities. The fines range from 1.6 – 2.5 USD, or a 3-year old goat. If the offender becomes adamant then the fine is increased to 8.3 USD.

Cost of rehabilitating wells is influenced by the quality of workmanship, materials used and the curing of concrete. The cost is estimated at 1,600 USD for the hand wells and 55,000 USD for the boreholes, which include water yard construction.

The average domestic water use is 10 – 16 litres/person/day. Water pH in the region is broadly within the acceptable limits. EC values range between 1,300 to 5,000 µS/cm. However in some cases it gets as high as 9,000 to 11,000 µS/cm. Fluoride levels are within specified limit of 1.5mg/l.

Water for Life Interview

Water for Life (WFL) was previously working in many regions in Somalia before the break of war. Currently, they have projects around Jenale towards the north.

- WFL has rehabilitated more than 100km of primary canals and over 200km of secondary canals through food for work program
- 36km of Primo Secondario have also been rehabilitated
- CEFA took over some of the previous projects done by WFL
- Some grants have been sourced for expansion of the irrigation network
- There is lack of corporation at the ground, which makes it difficult to run the irrigation projects
- There is a lot of gypsum at the Somali boarder with Ethiopia. As the rivers pass the gypsum they absorb the salts, making the water saline. The salts are retained in the soil, making it unsuitable for farming.
- The Togga Suru is long, reaching almost the Juba river from the Shabelle. The river can be used to divert water from the river, therefore preventing floods. Diverting the waters to the togga can also stop pastoralists from moving to the Shabelle river, which interferes with irrigation fields near the river in dry periods.
- Germans did a hydrogeological survey about 25 years back, and suggested that water drilled near the coast comes all the way from the rivers, since it was of good quality. They suggested the water to be drilled and pumped upland for consumption. However, this cannot be true since the soils between the river and coast is clay. There is a layer of fresh water overlaying salty water along the coast. But extra care needs to be taken when drilling the borehole that the drilling does not reach the salty layer. An interface (brackish water) exists between the fresh water and the salty layer.
- Alluvial plane is common in both Juba and Shabelle
- The soil has high clay contents (70 – 80%), and some silt, but sand is scarce along the two rivers.
- The clay layer is very deep, sometimes going up to 100m deep.
- Thin aquifers exist with salty water
- Shallow wells are fairly shallow 2-3m, and are recharged by the rivers
- Water in many cases is salty and polluted
- The locals prefer river water to the shallow wells, claiming that it tastes better.
- WFL undertook a study for UNHCR in 1980, for refugees coming from Ethiopia.
- The study found out that there are different deposits, including sand, up to the area approximately where the coastline is. Big aquifers exist at 25 – 30 meters depth. The aquifers are confined, with water rising up to only 5meters below the surface (SWL). The strip with these characteristics extends for long distances, over 100km.
- Three wells dug in this area have a depth of 33, 17 and 25 meters. Water from the three wells is of best quality.
- WFL introduced solar powered pumps, and is promoting the use of solar both for water pumping and lighting.
- Moving animals destroy small canals, requiring frequent rehabilitation.
- There is no water authority in the south. However, such an authority should be there and very strong especially to control and manage the water gates at canal entry points. It is important to close the gates and let water flow don to the sea the first 10 days of rainfall onset. This allows salt to be washed down the river before the water is diverted to the canal. The closer of the canals should also be well timed so that excessive water is not allowed into the canals, which would cause floods to the fields.
- Most of the available wells in Southern Somalia are open and without pumps. Initially there were pumps, but the rate of breakage was very high; for example out of 200 pumps visited in a survey in

1980s, only 4 were found to be operational after only one and half years of installation by SWISS Caritas. Most of the pump breakages occur at the valve.

- The local people are highly encouraged to adopt the solar powered pumps, as they are cheap to maintain. However, many are not able to raise the initial investment, estimated at 1,000 Euros. This cost includes both the pump and the solar panels, which can even be used for lighting the house.
- Due to the water shortage problems in Somalia, the local people have leant to use water very economically. The water demand per person is less than 20 litres per day. For many places, the demand varies between 2 – 12 litres per day.
- Ownership is both private and public. However, many people are opposed to the idea of paying for water. WFL lets the management of water to sheikhs of mosques
- During the dry season, animals move from the pastoral land to the rivers in search for water. They in many cases end up damaging the crops grown by the riparian communities, hence creating conflicts on the use of water.
- Water quality is not a big issue for the people in the Southern Somalia. They are not bothered much so long as water can tastes good. UNICEF and WHO do regular water quality tests. They however end up chlorinating the water without doing much analysis.
- With proper management, the available water resources would almost meet the demand for water in the Lower Somalia.