Water Resources of Somalia

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Disclaimer

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Last but not the least; I would like to thank FAO, Rome and FAO-SWALIM for giving me this opportunity to undertake this water resources assessment study for Somalia.

Executive Summary

Introduction

Water and land development need reliable data and information on available resources. Somalia Water and Land Information Management (SWALIM) are trying to recover lost information from all available sources and re-establish data collection networks. The purpose of this report is to prepare a comprehensive water resource assessment of Somalia based on data collected by SWALIM and partner agencies over the past years. The report is intended to assist decision makers, donors and investors.

The specific objectives of the report are:

- To assess the surface water and groundwater resources and the potential for meeting domestic, livestock and irrigation water supply demands in the whole of Somalia;
- To assess the water resources of the Juba and Shabelle river basins with special focus on water resources development constraints and potential;
- To identify major problems and priority areas within which more detailed investigations may be carried out.

As water and land resources of a river basin are inter-related and form a unit, a river basin is widely recognized as a natural unit for water resources planning and management. In this context, the water resources assessment of Somalia was carried out on the basis of a major river (drainage) basin. Although the surface water divide (catchment boundaries) may not follow strictly the groundwater aquifer boundaries, they are, however, seen to coincide generally with the major drainage basins. The general approach followed was to assess the water, land and related resources in each river basin. The assessment is based on the following major drainage basins:

1. Gulf of Aden basin
2. Darror basin
3. Tug Der/ Nugal basin
4. Ogaden basin
5. Shabelle basin
6. Juba basin
7. Lag Dera basin
8. Lag Badana basin
9. Central Coastal basin

Climate and Rainfall

Based on the agro-ecological zones of Somalia, the climate varies from desert in the north-eastern parts of the coastal areas of the Gulf of Aden basin and some areas in the Darror basin in the north-east; to arid and semi arid in much of the Gulf of Aden, Nugal and Ogaden basins in the central and northern regions; and to moist semi-arid in most of the Juba-Shabelle river basins in the south and in the mountainous areas of the Gulf of Aden in the north-west.

The long-term mean annual rainfall varies from 93 mm in the Darror basin to 549 mm in the Lag Badana basins. While the maximum annual rainfall in the Ethiopian and Kenyan parts of the Juba and Shabelle catchment reaches 1100 to 1350 mm, the maximum annual rainfall within Somalia is a high of about 700 mm in areas around Mareere in the lower parts of the Juba and Lag Badana basins. The minimum annual rainfall is around 20 mm in parts of the northern coastal locations in Gulf of Aden. In some parts of the Darror and Nugal basins it is as low as 66 and 80 mm, respectively.

Annual Potential Evapo-transpiration (PET) is between 1500 to 2000 mm in the southern river basins but exceeds 2000 mm in the northern basins (and is as high as 3000 mm in the northern coastal regions of the Gulf of Aden basin). In most locations, PET exceeds rainfall in all months of the year. In the southern basin areas, the monthly rainfall exceeds 0.5 PET in the *Gu* and *Deyr* seasons giving "growing periods" which allow some rainfed agriculture. However, in the case of the northern basins, except for few locations in the extreme north-west Somalia, even 0.5 PET exceeds rainfall in all months giving zero values for the longest growing period (LGP) in most of the areas. This is why most areas in the northern basins are not suitable for agriculture.

Hydrological Analysis of the Juba and Shabelle Rivers

The Juba and Shabelle are the only perennial rivers in Somalia. They are also the only rivers where long-term hydrological data are available. Based on streamflow data from 1963 to 1990, the long-term mean annual flow volumes in the Juba river at Luuq (catchment area-166,000 km^2) and at Jamama (268,800 km^2) are 5.9 billion cubic meter (bcm) and 5.4, respectively. The annual flows in the Shabelle river at Belet Weyne (207,000 km^2) and at Awdgegle (sp?) (280,000 km^2) are 2.4 bcm and 1.4 bcm respectively. The annual runoff-rainfall ratios (runoff-coefficient) are about 6.5% in Juba at Luuq and 2.1% in Shabelle at Belet Weyne. Annual flows decrease as the river flows downstream. This is mainly due to various factors such as: not much contribution to flows from the Somali catchment areas; frequent occurrence of bank full condition and spilling of flood into the flood plains and natural flood relief channels;river diversions for irrigation both during low and high flow periods; and losses due to evaporation and infiltration/recharge of the groundwater along the river. It is also evident that the flow in Juba is more than the flow in Shabelle although the catchment area of the latter is larger than the former.

There are considerable flow variations within a year as well as from one year to another. As the reliability of flow available is important for the design and planning of water resources, flow duration curves for the locations where long-term data are available have been prepared for all locations with long-term data. For example, the flows exceeding 50% and 90% of the time in Juba at Luuq are 152 m^3/s and 12 m^3/s, respectively. In the most downstream gauged location in Juba at Jamame, the 50% and 90% flows are 144 m^3/s and 10.3 m^3/s. In Shabelle river at Belet Weyne, the 50% and 90% flows are 61 m^3/s and 7.4 m^3/s, respectively. And in the most downstream gauged location in Shabelle at Awdhgle (sp?), the 50% and 90% flows are 45.7 m^3/s and only 0.26 m^3/s. This shows that the water in Shabelle river is diverted most extensively in the dry seasons.

High floods in the Juba and Shabelle are known to cause frequent problems. Flood frequency analyses of annual daily maximum streamflow values were carried out using different probability distribution functions. The 5-year, 10-year, 50-year, 100-year and 1000-year flood estimates based on the Gumbel distribution for Juba at Luuq are 1,117 m^3/s, 1,338 m^3/s, 1,825 m^3/s, 2,031 m^3/s and 2,710 m^3/s, respectively. These estimates for Shabelle at Belet Weyne are 337 m^3/s, 395 m^3/s, 522 m^3/s, 576 m^3/s and 754 m^3/s, respectively. Flood values in Juba are more than that in Shabelle although the catchment area of the latter is larger than the former. This is due to higher rainfall intensities as well as denser drainage networks in the upper catchments of Juba.

The flood volume is not very large compared to the catchment areas of the two rivers. However, various natural and man-made causes have aggravated the flood problems in the two river basins. These may be summarized as:

- River bed levels rising higher than adjacent land, due to sediment deposition;
- People breaching levees to irrigate land in dry seasons;
- Encroachment of natural flood plains;
- Unplanned closures of natural flood relief channels;
- Total break down of the existing irrigation infrastructure;
- A total lack of central or local governance managing the river basin.

The problem of drought is also a recurrent problem in the two river basin areas. The low flow analyses of streamflows were carried out to plan for the worst condition of flow availability. Annual one-day, seven-day, 10-day, 15-day and monthly low flows were calculated, using the daily flow data in the two rivers. The lowest flows in the two rivers reach very low values close to even zero in some years. And as the river flows downstream, the low flows are extensively diverted for irrigation and other uses and the minimum flows in the lower reaches dropped to zero in many years. Due to the very high variability and zero or near zero flow values in some years, low flow frequency analysis was reasonable in the two upstream locations of the two rivers only. Even in the two locations, the low flows beyond a 10-year return period were mostly zeros, using the standard probability distribution functions.

Water quality of the two rivers is a matter of concern since both the human and livestock populations use the river water for direct consumption. There was very little water quality data available for the two rivers. The only available long-term data was for Juba at Mareera where electrical conductivity (EC) values were available for the period, 1977 to 1990. It is observed that the salinity in the river rises during the *Jilaal* season and peaks during *Gu* flood season. There is also a slight rise during the *Deyr* flood season, but it never reaches the peaks of *Jilaal* and *Gu* seasons.

Very little sediment observation has been made in the two rivers. Based on 53 samples of suspended sediment observations data from November 1989 to November 1990 in Shabelle at Afgoi, the total suspended sediment load is calculated to be about 6.9 million tons per year during the one year period. This is a preliminary estimate and it should be used with caution as there are various other factors that affect soil erosion and sediment transport.

Surface Water in other Major Basins

Surface water is limited in all the other drainage basins. There is no river with perennial flows. In the case of the northern basins especially that of the Gulf of Aden, there are a number of small streams (*toggas*) which are mostly ephemeral that originate from the mountainous areas in the north-west (above 2000 m elevation) and flow to the coastal areas of the Gulf of Aden. Other *toggas* draining the Nugal, Bokh and Darrror Valleys and other minor valleys move towards the Indian Ocean. However, there is practically no surface water that reaches the ocean as the rainfall falling in these catchments is lost through evaporation and infiltration.

No long-term surface water monitoring is done in these streams. Some limited monitoring was done in the late fifties and in 1980 and 1981 in some catchments in the Gulf of Aden basin. The catchment areas of these *toggas* were in the range of 3000 km^2 to 4800 km^2. Perennial springs are located along these *toggas* where the groundwater tables are intersected by the rocky outcrops. These *toggas* carry very high flood flows and debris after intense rainfall. Such surface runoff lasts for a few hours to a few days. Flash floods as high as 2500 m^3/s have been observed in *toggas* with a catchment area of 3,660 km^2. There were 12 flood events observed in one year in the same *togga*, out of which four were between 900 m^3/s and 2200 m^3/s. In such *toggas,* the annual runoff-rainfall ratio (runoff coefficient) are estimated to be between 3% and 6%.

Surface Water Storage

Wars (also called *bailey*, water pan, ponds or dams) and *berkads* are commonly used to collect surface (storm) water from small catchments of 2 to 3 km^2. *Wars* are more common than *berkads* in southern drainage basins mainly because of the favourable soil type (clayey) for the construction of *wars*. From the distribution of water points in the old 1:100,000 topograhical maps, we can see that percentage of rainwater ponds/reservoirs (87% in Shabelle, 91% in Juba, 79% in Lag Dera and 98% in Lag Badana) is larger compared to groundwater sources in the southern river basins than in the central and northern drainage basins (25% in Gulf of Aden, 28% in Darror, 39% in Nugal, 77% in Ogaden and 39% in central coastal basins).

Rainfall and climate regime is important for designing the *wars* and *berkads* and in estimating the amount of rainfall that can be harvested. Some studies in the past (***Kammer and Win, 1989***) show that in catchments of 2.5 to 4 km^2, storms of less than 15 mm rainfall did not produce runoff unless the antecedent moisture content was high. This would mean a threshold daily rainfall value of 20 to 30 mm, and there were only 9 to 16% of the rainfall days which exceeded this threshold values. Daily rainfall data have been analysed as part of this study in some locations to calculate the number of days and amount of rainfall with daily rainfall exceeding different threshold values. The results show that there are few days with rainfall exceeding threshold values of 20 mm and that 24-hour maximum rainfall is sometimes close or even higher than the long-term annual rainfall.

Groundwater Resources

Southern Somalia, which is traversed by the two perennial rivers, has the best hydro-geological conditions for finding groundwater such as along the major *toggas* in the alluvial deposits and weathered basement. In the areas covered by the Gulf of Aden, the Darror and the Nugal Drainage basins, groundwater movements start in the mountainous areas and move in two directions. The first is from the south to the north from the mountainous regions to the coastal areas of the Gulf of Aden. The second is from the north to the south towards the Haud and Sool plateaus. The hydro-geological divide also mostly coincides with the surface drainage divide.

The areas of good groundwater potential are as follows:

- Baydhaba Plateau, Buur, Waajid, Damassa areas in the Juba and Shabelle basins;
- Alluvial plains along the Juba, Shabelle and Lag Dera rivers;
- Shallow aquifers in the sand dunes in the central coastal belt and the northern coastal regions (freshwater lenses), in the Galkayo and Dhuusamarreb Ancestral drainage systems in the Mudug-Galgaduud Plateau, along the *toggas* in the mountainous areas and sloping plains of Northern Somalia;
- Deep aquifers in the Mudug-Galgaduud Plateau with wells of 100m to 250 m depths;
- Shallow aquifers in the Galcayo and Dhuusaarreb ancestral drainage and Coastal belt along the Gulf of Aden;
- Upper catchment area of the mountainous zone in the Gulf of Aden and Darror basins where many springs and underground/surface dams and infiltration galleries could be constructed;
- Plateaus and valleys in northern Somalia (Sanaag region, Haud Plateau and Darror Valley).

Groundwater Use

While surface water sources are limited to the riverine areas in the Juba and Shabelle basins and in *toggas* in the northern basins, groundwater sources such as dug wells, boreholes, springs, sub-surface dams and infiltration galleries are predominantly used to meet the human and livestock needs.

Dug wells are extensively used along the *toggas*, sloping plains and the coastal areas (freshwater lenses) with depth ranging from 2 or 3 m to 10 m. Water quality is a problem in these wells due to poor construction and since they provide common outlets for both livestock and humans. Boreholes are a permanent source of water for most of the people. In the southern river basins, average depth varied from 90m to 220 m in Bakool region, 60 to 70 m in Bay region, 60 to 25 (? check figure - Ed) m in the Hiraan region and 50 to 100 m in Gedo region. The average yield was around 10 to12 m^3/hr. Borehole depths ranged from 90 to 220 m (with static water levels from 80 to 130 m) in the north-western regions of Somalia (Somaliland). The estimated yield was from 3 to 30 m^3/hr. Water levels in Bari, Nugal, Eastern Sanaag and Mudug regions in central and north-eastern Somalia were estimated to be around 30 m, 160 m, 120 m and 230 m, respectively. Many boreholes have been abandoned due to the unsustainable draw down of static water levels.

Many natural springs exist in the Juba, Shabelle and Lag Dera basins (about 1 to 3% of the identified water points in the topographical maps) and in the mountainous areas of the Gulf of Aden basin, Darror basin and Nugal (about 10% of the water points). Perennial spring sources are found across the mountainous areas and a number of thermal springs are found along the coast in the Gulf of Aden basin.

Water for Human and Livestock

Sufficient quantity and quality of water for human needs is considered a basic human right. Access to safe water is said to be limited to only about 20.5% of the population, of which 53.1% live in urban areas and 4.1% in rural areas (*World Bank*, 2006, cited by IUCN, 2006). The present per capita consumption is said to be lower than the basic need standard of 20 lpcd.

Data on water used across regions and socio-economic profile is not available. However, given the scarcity of water, 20 lpcd and 50 lpcd are considered the average water consumption (basic requirement) in most regions Based on these figures and the current population estimate of 7.5 million, the total basic water requirement for the whole country is estimated to be 240,000 m^3/d.

Water for livestock is crucial as the livelihood of the majority of the population depends on livestock. Considering the 25-litre (is it ‘2.5’-not ‘25’? check – Ed), 1.6-litre and litre per head per day (lphd) requirements of cattle, sheep/goats and camels, respectively, water demand for livestock in the country is about 230,000 m^3/day (based on the livestock population of 4.7 million in 1988).

Recent population estimates show that there is a general trend towards urbanization in the country as the internally displaced population returns to the towns. Urban water supply will therefore be an important issue. Most such towns are rehabilitating the old piped water system. Various management models based on public-private-participation (PPP) are now in place in these towns. Boreholes are the predominant source of water for such systems.

Water for Agriculture

The crisis of food security linked to flood and drought is a striking feature of life in Somalia. Crop production is largely limited to the alluvial plains of the Juba and Shabelle rivers and inter-riverine area of Bay region where 90% of production is undertaken. In northern regions, where pastoralism is predominant, crop cultivation is mostly confined to the alluvial plains and slopes along the *toggas* in the northern basins and in natural oases where groundwater is available. Production is mostly smallholder and subsistence based.

Given the climatic regime of the country with its erratic and irregular rainfall pattern and the high potential evaporation losses, the water requirements of the crops are generally high. The cropping patterns for the irrigated agriculture in the Juba and Shabelle river basins consist of fruit trees, maize and groundnuts in the *Gu* and *Deyr* periods and tomatoes, sesame, cow peas and vegetables in the *Deyr* and *Jilaal* seasons. Based on a standard cropping pattern covering the above crops and representative cropping areas, irrigation water requirements were estimated, using climatic conditions of Jilib (in Juba basin) and Jowhar (in Shabelle basin). The irrigation water requirements (considering 65% field application efficiency only) for the representative copping patterns were an average of 0.36 l/s/ha or 11,400 m^3/ha and 0.37 l/s/ha or 11,800 m^3/ha, respectively.

Considering the 80% dependable flow (flows exceeding 80% of the time) available in Juba at Bardheera and in Shabelle at Mahadey Weyne, it is estimated that 50,000 ha of land could be irrigated year-round in Juba basin, while seasonal irrigation for a second crop of maize and sesame could be provided in much more land (up to 170,000 ha). In the case of Shabelle river, irrigation could be provided for up to 25,000 ha in the *Gu* season and it can be increased to 80,000 ha for the *Deyr* crops. These figures are preliminary estimates and are based on unregulated flow in the two rivers.

In the case of the mountainous regions in north-west Somalia, small pockets of land which are less than 1 to 2 ha are irrigated and cultivated along the *toggas*. Due to the high PET values and low rainfall, water required to meet the net irrigation requirement (effective rainfall minus crop requirement) for one crop of maize and sorghum during about four months growing period each is in the range of about 6000 m^3 and 5500 m^3 per ha (for the agro-climatic condition of Hargeisa). If 65% irrigation efficiency is considered, about 9230 m^3 and 8460 m^3 of water would be required per ha.

Recommendations for Future Activities

The following are some of the recommendations for future activities that would help improve water resources management in Somalia.

Meteorological Network

- The rainfall stations in the Juba, Shabelle, Gulf of Aden and Nugal Drainage Basins in Somalia are within the recommended network density of World Meteorological Organization (WMO). However, the network densities in other basins are sparse. It is recommended that network density be installed in the following basins: an additional three in Lag Dera, two in Lag Badana, one in Darror, five in Ogaden and five in the Central Coastal basins. This would bring the total rainfall stations in the country to 86 from the currently operational 70 stations.
- None of the above rainfall stations is the automatic recording type nor does any one of them measure other agro-climatological parameters. It is recommended that the 'tipping bucket' type automatic rain gauges be installed in 15 stations, covering at least one in each major basin, and some additional ones installed in the northern mountainous regions and in the central coastal basin areas.
- Pan evaporation, wind, relative humidity, water and air temperature and sunshine hours are other agro-climatological parameters that are required for water and agricultural development and management. WMO recommends one evaporation station in 50,000 km^2 in hilly and coastal areas and one in 100,000 km^2 in arid regions. It is recommended that 19 evaporation stations be installed covering all the major drainage basins.
- Apart from the meteorological stations within Somalia, it is important that rainfall data are available from the upper catchment areas of the Ethiopian and Kenyan highlands and

other areas in the catchment both for flood forecasting as well as runoff estimation using rainfall-runoff models.

Hydrometric Network

- Daily staff gauge readings are observed in each of three hydrometric stations in the Juba (Luuq, Bardhere and Bualle) and Shabelle rivers (Belet Weyne, Bulo Burti and Jowhar). There are eight other stations, four in each riverine area, mostly in the downstream stretch of the two rivers that were operational before 1990 but have not been re-established yet. The currently operational stations in the upper stretches of the rivers are appropriate for the estimation of the flows available in the river. The stations in the lower reaches should be rehabilitated in the future, especially after the irrigation infrastructure in the downstream areas are rehabilitated and start functioning again.
- The other small streams in the northern basins do not have perennial flows but are known to generate flash floods during the rainy season. It is recommended that discharge measurement and river gauging be carried out in at least five such *toggas* in the north. These may be T. Durdur (north-eastern Gulf of Aden), T. Hodomo (north-central Gulf of Aden), T. Dhut (Darror basin), T. Nugal (Nugal basin) and the *togga* contributing flows to the Xingalool internal drainage basin. These can be useful for designing early flood warning systems.
- The presently operational hydrometric stations observe daily gauge readings. Since no discharge measurements have been made after their rehabilitation, rating curves have not been developed. It is recommended that direct discharge measurements be started as soon as possible so that the rating curves can be developed.
- SWALIM is installing automatic water level recorders in four locations, Luuq and Bualle in Juba river and Belet Weyne and Jowhar in Shabelle river. Although the water level variations within a day are not expected to be much, these water level recorders would help derive the flood hydrographs and they would also be useful to observe any variations in the irrigation and other diversions within a day.

Surface water quality and sediment measurements

- The Juba and Shabelle rivers are extensively used by the people and livestock to meet their water needs in the riverine areas. While water salinity is a major concern, other parameters related to human and aquatic health (microbiological analysis, dissolved oxygen (DO) and minerals) are also important. It is recommended that water quality observations be carried out in at least two locations each in the two rivers, Luuq and Bualle in Juba and Belet Weyne and Jowhar in Shabelle. As urbanization and agricultural development increase along the river course, the water quality observations should be carried out in key locations in the downstream areas of the river, especially after the gauging stations in the lower reaches are rehabilitated.
- It is recommended that sediment sampling be undertaken in at least two locations in each river, Luuq and Bualle in Juba and Belet Weyne and Jowhar in Shabelle. As the soil erosion is found to be high during the first rainfall period sediment sampling should be done as frequently as once every week during March to June and once in two weeks during other months.
- The other rivers and *toggas* are also central in meeting the water needs of the people and livestock of the areas. Water quality monitoring in such rivers should also be carried out, taking into consideration agricultural and human interventions in these *toggas*.

Groundwater monitoring

- It is recommended that hydro-geological investigations be carried out in the future to update past studies and to estimate the renewable groundwater available including the potential recharge areas. This will require a detailed assessment of the topography, geology and hydrology of the areas, including some sub-surface investigations. While this activity needs to be carried out in the long term, it is recommended that the groundwater monitoring of some key bore holes be done in the short term.
- Based on the data collected in SWIMS by SWALIM, a selected number of bore holes covering different river basins and aquifer systems should be monitored. The monitoring should include: yield tests, observations of seasonal variations of the water level, water quality tests (especially the salinity and its seasonal variation but including other physical (temperature, colour, turbidity, odour and taste), chemical and bacteriological analyses (coliform etc).
- The shallow wells (dug wells) and springs should also be monitored to test its suitability for human and livestock consumption.

Runoff characteristics of small catchments

- Selected catchments like those of *toggas* in the north and small catchments that are used to collect storm water in the *wars* and *berkads* spread across the country should be monitored for one to two years. A meteorological station should be installed as required, equipped with automatic rain gauges and taking observations of other parameters like pan evaporation, wind, air temperature, relative humidity, sunshine hours and automatic surface water recording facility (gauges in a river or a *war*, *berkad* or pond) . A simple water balance -- taking into consideration rainfall, evaporation¸ infiltration and other losses, soil moisture content and runoff -- can then be used to develop the rainfall-runoff relationships in different catchment and physiographic conditions.

Survey of water demand for humans and livestock

- There is little data available on the water consumption pattern of households and livestock. Factors such as the socio-economic profile, quantity and quality of water sources available, cost of water, climatic conditions are essential for designing interventions to improve access to safe water. Hence, it is recommended that users' surveys of water sources covering different regions/basins, rural and urban, be carried out to better understand the water consumption characteristics and the water needs of different regions. This should also include nomadic communities who move with their livestock from one place to another. Such a survey should be done on a water source basis (consumers using one source) and community basis (community and livestock using different sources).

Optimising Water Input to agriculture

- Water use for agriculture consumes the maximum amount of water. The crop yield of the major crops grown such as maize and sorghum are seen to be low and, as expected, the yield is higher in irrigated areas than in rain-fed areas. While crop yield depends on many types of inputs such as climatic conditions, soil, seeds, and fertilizers, it is also a matter of interest to optimise the water input to agriculture. Better water management through the forecast of climatic conditions (forecast of on-set and expected amount of rainfall) and water availability may assist the farmers to improve the agricultural productivity. A study linking water availability, rainfall forecasting and selection of cropping patterns and types may be carried out. This will require an integrated water, land and agricultural resources approach.

Water resources development

- Water resources development potential exists especially in the Juba and Shabelle basins and in some of the watersheds in the mountainous areas of the northern basins. Such development should assist in better management of the water resources in the basins to address the problems of "too much", "too little" and "too dirty" water. The planned water resources development in the Juba and Shabelle rivers includes rehabilitation of the old irrigation infrastructure such as barrages and canals. Some inter-basin diversion, off-stream storage and reservoir projects (e.g. Berdheere in Juba) were planned in the past. These should be reassessed, based on the data collected and the assessment and studies carried out on the water and land resources by SWALIM, including this one.
- In the case of the flooding problem in the Juba and Shabelle rivers, it is seen that integrated flood management would help alleviate many of the problems presently attributed to floods in the areas. Even a small flood event that occurs once in every five years is known to create major problems. Various strategies of integrated flood management can be undertaken, such as reduction of flooding, reduction of susceptibility to damage, mitigating the impacts and preserving the natural resources of flood plains (WMO and GWP, 2004). It is recommended that an integrated flood management plan be developed for the two river basins, based on a river basin approach.

Data Gaps

- There were major data gaps in some regions (southern regions in Lad Dera and Lag Badana basins) due to security concerns and data gaps in some sectors such as water for other uses like industry, environment and wetlands (swamps).
- It is recommended that efforts are made to collect data on the above so that water resources management can be carried out in a holistic manner.

Glossary of Somali Terms

Balli	Small surface water harvesting ponds
Berkad	Underground reservoir, lined or un-lined, excavated to store surface runoff
Deyr	October to November, minor wet season
Elmi Jama	Sorghum variety grown in Northern Somalia
Gu	April to June, major wet season
Hagaa	July to September dry and cool season
Jilaal	Dry season from December to March
Mugciid	Underground reservoir storage well with an average depth of 15 meters
Togga	A non-perennial (seasonal) stream which is deep and narrow
Wadi	A non-perennial (seasonal) stream which is wide and shallow
War	Unlined dug-out (dam), usually 2 to3 m deep

List of Abbreviations

AEZ	Agro-ecological zones
AMC	Antecedent moisture content
CV	Coefficient of variation
DD	Drainage density
DEM	Digital Elevation Model
EC	Electrical Conductivity
EC	European Commission
EV1	Extreme value type 1 distribution
FAO	Food and Agriculture Organisation of United Nations
FSAU	Food Security Analysis Unit
FSAU	Food Security Analysis Unit- Somalia
GEV	General Extreme value distribution
GWP	Global Water Partnership
Ha	Hectare
IDPs/IDP	Internally Displaced People /Internally Displaced Person
IDWA	Inverse Distance Weighted Average
ITCZ	Inter tropical Convergence Zone
IWRM	Integrated Water Resources Management
KS	Kolmogorav-Smirnoff goodness-of-fits tests
l/s/ha	Litre per second per ha
LGP	Length of Growing Period
LN2	Log-normal distribution
LN3	3-parameter Log-normal distribution
LP3	Log-pearson type 3 distribution
Lpcd	Litre per capita per day
Lphd	Litre per head per day (livestock)
LUT	Land utilization type
MDGs	Millennium Development Goals
PET	Potential Evapotranspiration
PPP	Public-private participation
PSAWEN	Puntland State Agency for Water, Energy and Natural Resources
RC	Runoff coefficient
RFE	Rainfall Estimates
RH	Relative Humidity
SWALIM	Somalia Water and Land Information Management
SWIMS	Somalia Water Source Information Management System
UNCEF	United Nations Children’s Fund
UNDP	United Nations Development Programme
UNESCO	United Nations Education, Science and Cultural Organization
WHO	World Health Organization
WMO	World Meteorological Organization

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