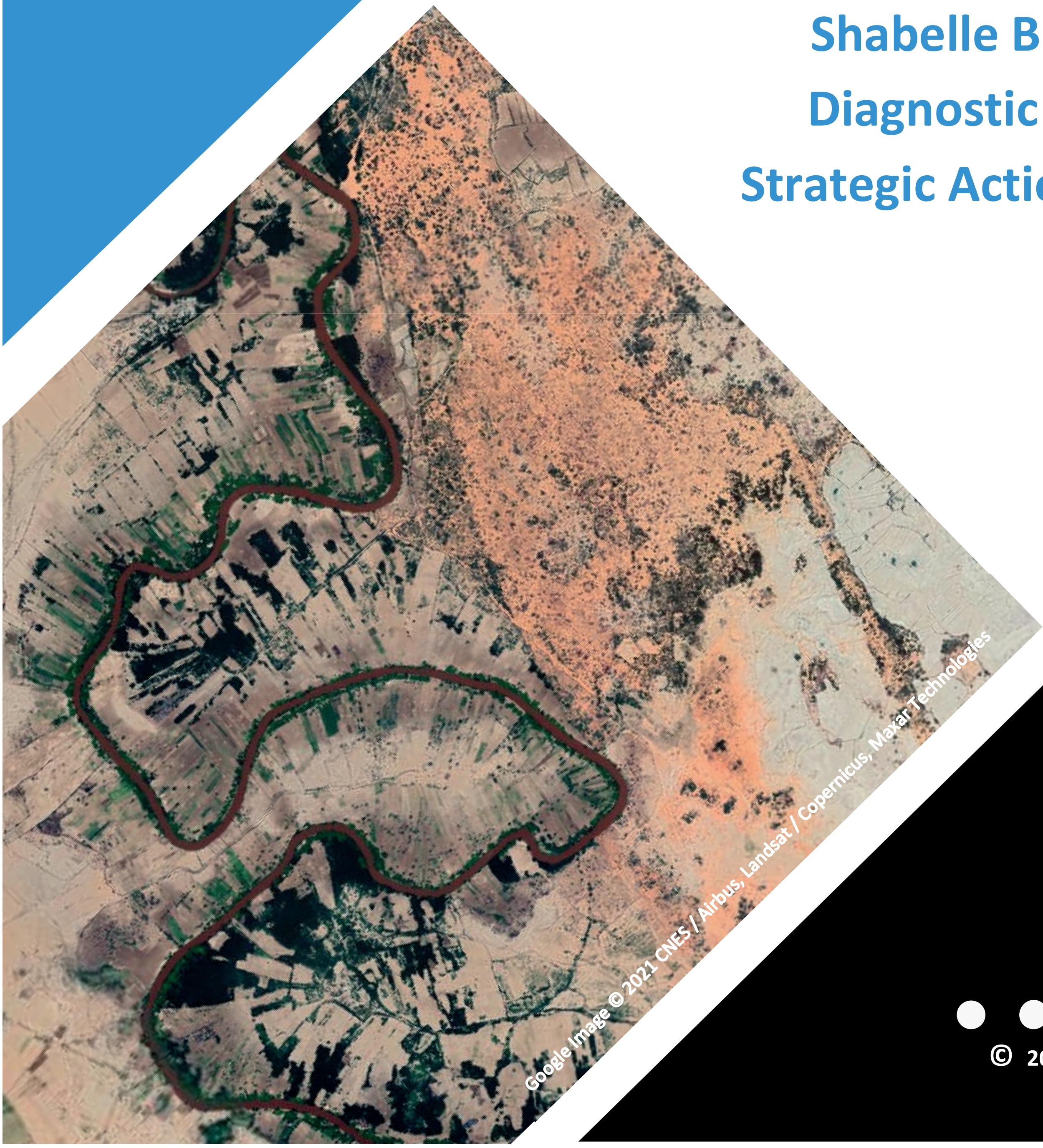
MINISTRY OF
Energy & Water Resources

Federal Government of Somalia

Shabelle Basin Diagnostic and Strategic Action Plan



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2021

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FOREWORD

Water resources are of critical economic and social importance for the Somali society. Sustainable development and management of these resources as well as preventing risks from floods and droughts, are a key steppingstone for socio-economic development as well as an entry point to wider peace building in the country. Against this background, the Federal Government of Somalia has initiated a process to strengthen water governance and developing sound institutions at federal and member state levels. A milestone in this process is the 2021 National Water Resource Strategy (NWRS) that has been developed through a participatory process with relevant stakeholders in Somalia. With the NWRS, we aspire to ensure water security with the ultimate aim to eliminate poverty and the impacts of poverty experienced by the people of Somalia.

The Shabelle river is one of the most important water resources in Somalia. It is the principal source of water for about 4 million people in Somalia, supporting livelihoods and the economy in the basin known as Somalia's breadbasket. Pressure on the scarce and finite Shabelle waters is growing rapidly. While fast-tracking counter measures is needed, the sustainable management of the basin's natural resources requires a better understanding of the nature and scope of the existing challenges.

With this Basin Diagnostic (part I) we provide a necessary knowledge base for sound decision-making in sustainably managing the Shabelle basin's water resources. The Strategic Action Plan (part II) defines strategic objectives and priority actions that need to be taken to address the water-related management issues in the basin.

The Basin Diagnostic and Strategic Action Plan together will allow federal government, sub-national level institutions, and other actors and development partners to prioritize and coordinate activities and investments to leverage the potential of the Shabelle's water resources. It shall help streamlining individual activities with a coherent overarching long-term approach that is aligned with the NWRS. With this, we hope to also provide the basis for engaging all relevant actors and stakeholders in addressing the water-related challenges that currently hinder good livelihoods and sustainable development in the basin.

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ACKNOWLEDGEMENTS

The Ministry of Energy and Water Resources (MoEWR) of the Federal Government of Somalia, supported by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), has developed the present Basin Diagnostic (BD) and Strategic Action Plan (SAP) for the Shabelle river basin. The report is the culmination of various contributions from a range of stakeholders representing government ministries, international cooperation partners and other Somali stakeholders, including private sector and civil society. These stakeholders are thanked for their contributions.

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List of Abbreviations

bcm	billion cubic meter
BD	Basin Diagnostic
DPSIR	Driver-Pressure-State-Impact-Response
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
MoA	Ministry of Agriculture
MoEWR	Ministry of Energy and Water Resources
MoPIED	Ministry of Planning, Investment and Economic Development
NWRS	National Water Resources Strategy
SAP	Strategic Action Plan
SWALIM	Somali Water and Land Information Management
IWRM	Integrated Water Resources Management

Part I: Basin Diagnostic

1. Introduction

The Ministry of Energy and Water Resources (MoEWR) of the Federal Government of Somalia has partnered with Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and its Sustainable Water Resources Management in Somalia Programme to lay the foundations for an Integrated Water Resources Management (IWRM) approach. This is in line with Somalia's National Water Resources Strategy (NWRS) which outlines the goal to "Operationalize Integrated Water Resources Management" (Goal 2).

To support reaching this overall goal, **the present Basin Diagnostic (BD) and Strategic Action Plan (SAP) for the Shabelle aim to provide the baseline for IWRM in the river basin**. The Shabelle river basin is one of the two major river basins in Somali, playing a key role for food and livelihood security and economic development of the country. Sustainable management of this critical resource requires an understanding of the nature and scope of challenges existing in the basin to enable stakeholders to address these and lay the foundations for an IWRM of the river basin.

The BD outlines the current state of IWRM in the Shabelle river along seven topical areas, including:

- The **natural and socio-economic context** of water resources development (Chapter 2)
- **Water resources** (Chapter 3)
- **Governance** of water resources (Chapter 4)
- **Floods** and flood mechanisms (Chapter 5)
- **Irrigation** (Chapter 6)
- **Livestock** management (Chapter 7)
- **Transboundary** aspects of the Juba-Shabelle Basin (Chapter 8)

Each chapter follows a similar structure, outlining the current state of IWRM (1), the main issues and challenges (2), root causes and causal relations (3) and preliminary policy implications/conclusions (4).

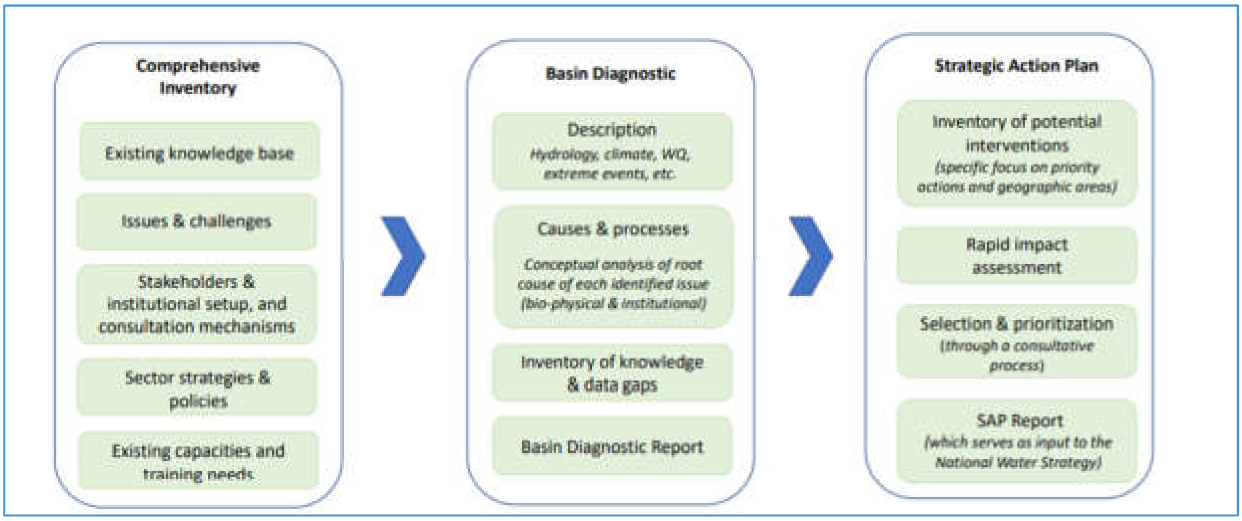
Based on this analysis, the SAP in the second part of this report defines strategic objectives and priority actions that need to be taken to address the water-related management issues in the basin. In doing so, the **SAP aims to provide an overarching framework for addressing priority issues in the Shabelle basin and facilitate better coordination of ongoing and planned development activities** by various actors. This way, the SAP will support streamlining individual activities with a coherent overarching approach that are aligned with the National Water Resources Strategy (NWRS). Finally, the SAP also aims to move activities away from the current ad-hoc response to water-related emergencies, to a more **systematic and long-term approach that addresses the water resources issues in the Shabelle basin in an integrated, durable, and sustainable manner.**

Both parts of the report, the BD and SAP, are predominantly concerned with the natural resource base and water governance. It is recognized that several external factors have a huge influence on the demand for water, and thus by extension on water resources management in the Shabelle basin. These factors include, amongst others, demographic trends, food prices, land tenure arrangements, rural development policies, agricultural trade rules and political stability. The MoEWR has no or only minimal control over most of these factors. Nevertheless, whenever appropriate, this report has identified these constraining factors. The reader is referred to the respective technical ministries for ongoing and planned programs and policies to address these factors (compare MoPIED 2020).

The BD and SAP for the Shabelle basin were developed in a phased approach with three main components that build on each other and were accompanied by a comprehensive consultative process (fig 1.1):

1) A data and information gathering phase, resulting in a comprehensive inventory of the existing knowledge base, issues, stakeholders and consultation mechanisms, policies and institutions, and capacities.
2) Development of the BD outlining the current state of IWRM and root causes of the current and anticipated issues/challenges encountered in the Shabelle basin (part I of this report).
3) Evaluation and selection of an integrated set of interventions to address the identified and prioritised issues, which were synthesised into a SAP (part II of this report).

Figure 1.1: Conceptual setup of the Basin Diagnostic and Strategic Action Plan



General Approach and Methodology

The Shabelle river, just like most river basin around the world, is a highly complex system. Developing a BD therefore requires employing a suitable methodology to account for this complexity. In the context of this study, the **Driver-Pressure-State-Impact-Response (DPSIR) methodology** in combination with **causal diagrams** was chosen to investigate the root cause of identified challenges and their various interactions. The DPSIR approach is commonly used in the EU Water Framework Directive (WFD) and also employed for other environmental analysis to highlight the impact of human activities on the environment. The DPSIR was complemented, where necessary, with causal diagrams. These have proved effective in conceptualising and visualising the cause-effect structure of a complex situation.

Another key element of the assessment was the **participatory approach in developing the BD and SAP with key stakeholders of the Shabelle basin**. This was determined critical to build consensus and buy-in from stakeholders and create ownership of the BD/SAP and the related process. The approach also aimed at enabling a co-created framework as a basis for IWRM in Somalia in the future.

The DPSIR approach was informed by two primary knowledge sources: **Existing primary and secondary data sources** on the Shabelle river basin as **well as semi-structured interviews** with key stakeholders. The first included scientific papers and data on a wide scope of topics such terrain, land use, hydrology, hydrogeology, geomorphology, agricultural irrigation, water use, flooding, demographics, socio-economics, climate, livestock, etc. Particularly the Somali Water and Land Information Management (SWALIM) of FAO served as an important source of data and information.[1] Additionally, Somali national strategies and policies were consulted. They provided further insight, particularly on socio-economic conditions and governance frameworks. Specifically, the **National Development Plan 2020-2024 as well as the National Water Resources Strategy (2021) provided major sources of input**.

Secondly, the assessment process engaged a broad range of stakeholders and experts at national and basin level through interviews and workshop discussions. A range group discussions and semi-structured interviews were held with stakeholders from the Somali Federal Government, Somali State Government, representatives of non-governmental organization, private businesses, representatives of international development partners active in Somalia as well as local and international experts/consultants (compare Annex A.5 List of Interviewees).

In addition, two review workshops took place in June and September 2021: The first workshop was held virtually in June over 2 days. During the workshop, the lead consultants presented the approach and methodology for the BD and SAP. Furthermore, preliminary findings on the state of the basin, including issues and challenges in key issue areas (flooding, irrigation, governance), were introduced and validated with workshop participants.

During the second workshop, held in September, the preliminary set of strategic actions to address the identified key challenges in the Shabelle basin were reviewed with workshop participants.

[1] https://faoswalim.org/

2. The Context of Water Resources Development in the Shabelle Basin

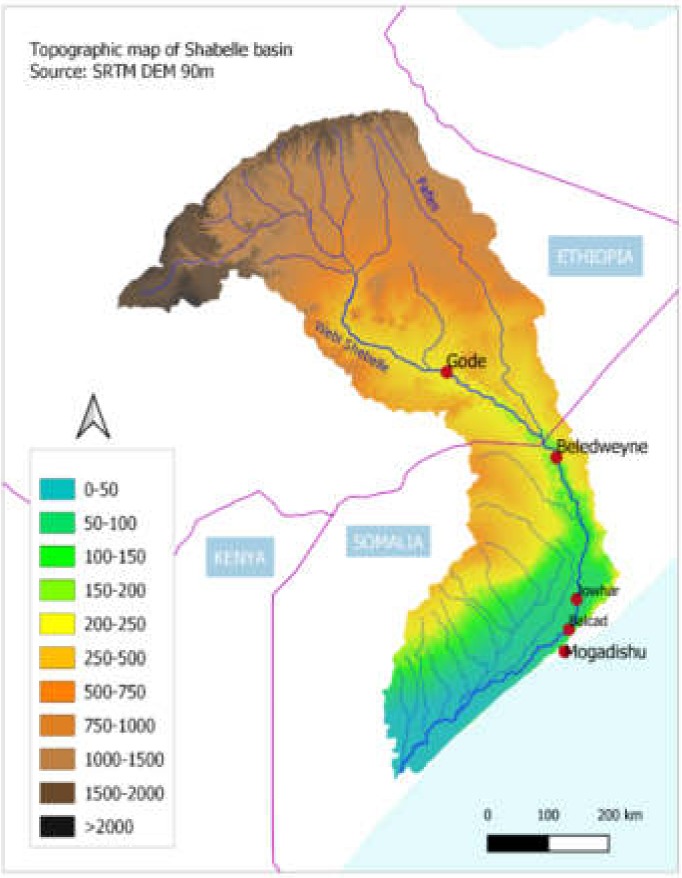
2.1 Topography and Drainage Network

The Shabelle is a perennial river that originates on the Bale Mountain in the Eastern Ethiopian Highlands (fig 2.1). The highest point in the basin is at 4,230 m while some 12% of the total basin area is above 1500m. The upper regions have steep slopes and incised channels. Because of the mountainous terrain, the drainage network in the upper catchment is dense. The main tributaries are the Fafen and Webi Shabelle. The latter is a perennial river while the former has intermittent flow.

After leaving the mountains, the Shabelle flows in south-east direction. Slopes in the middle region are gentle. Some 50 km upstream of Jowhar, the river enters a wide and flat alluvial valley that is characterized by inverse topography. At Balcad, near Mogadishu, the river turns southwest and continues roughly parallel to the coast, from which it is separated by a range of sand dunes.

The Shabelle catchment measures some 297,000 km2, of which approximately 64% lies in Ethiopia and the remainder in Somalia. The ephemeral tributaries in Somalia are dry for most of the year. The Shabelle is effectively a closed drainage basin since river flow normally does not reach the Indian Ocean. Rather, flow that reaches the low end of the river is mostly lost in the sands in southern Somalia, feeding an ecologically sensitive wetland area and recharging groundwater aquifers. Only in exceptional flood years does the Shabelle join the Juba river (Abdullahi Elmi Mohamed, 2013).

Figure 2.1: Topographic map of the Shabelle river basin



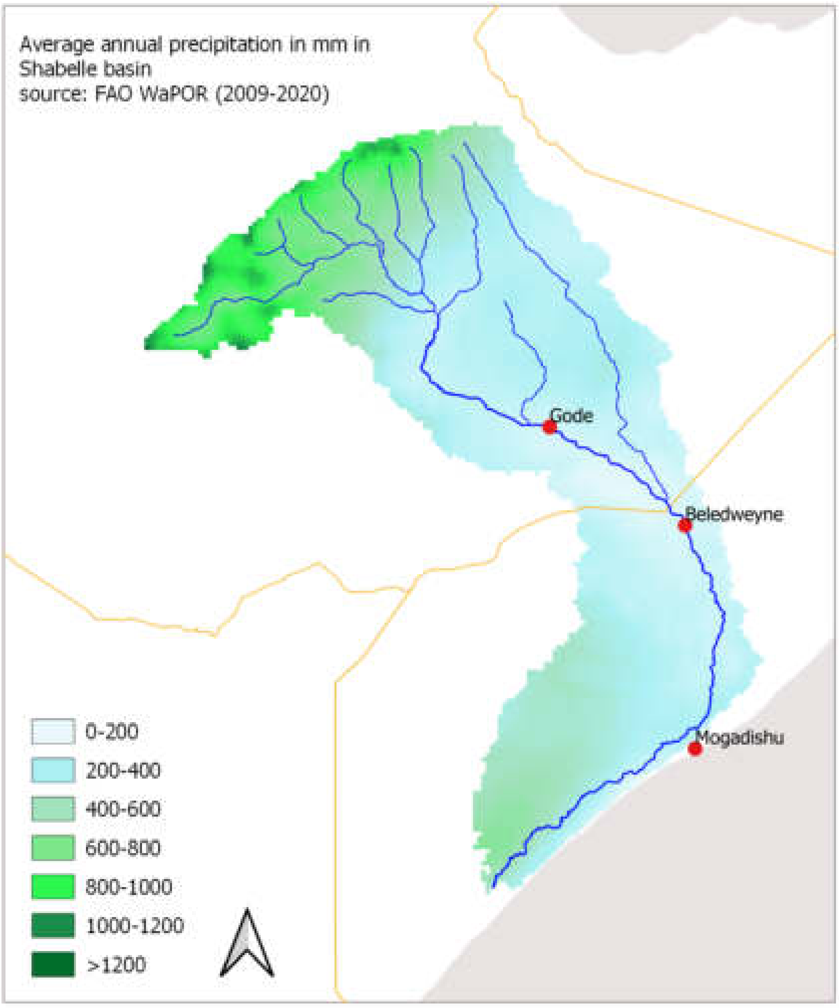
Most streamflow of the Shabelle (~90%) is generated in Ethiopia. The mean annual runoff at Gode in Ethiopia is 3.4 bcm but only 2.4 bcm reach Beledweyne in Somalia (Michalscheck et al 2016). Approximately 0.6 bcm of runoff is lost at Mustahil, which is an alluvial zone just north of the Ethiopia-Somalian border. The Shabelle flows are characterized by significant interannual variations. The river has a high sediment load. It also has a high saline content even during high flows. The Shabelle is the principal water source for Somalia's most productive agricultural zone in the Middle and Lower Shabelle regions.

2.2 Climate

Rainfall

Figure 2.2 shows the average annual precipitation over the Shabelle basin. There are three distinguishing features. The first is concerned with the fact that most of the basin receives only 400 mm of rain per year or less. Secondly, rainfall is high in the Ethiopia highlands at the upper reaches of the catchment. Most of the Shabelle flows are generated in this area. Finally, there is a pocket of quite substantial rainfall at the south-western tip of the basin, with average annual precipitation ranging between 400 and 700 mm, which should be enough to grow a crop.

Figure 2.2: Average annual precipitation in the Shabelle basin (mm/yr)



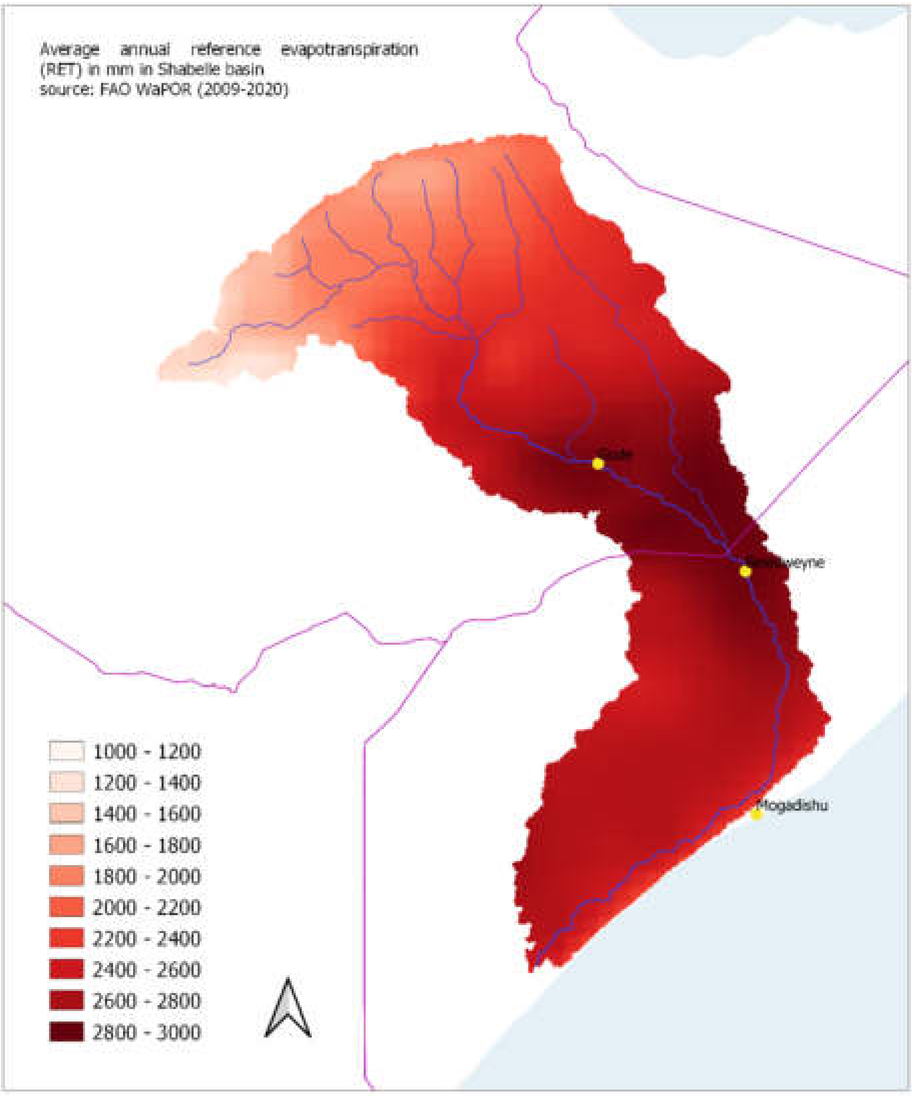
A measure of the temporal variability of rainfall over the Shabelle basin is presented in Annex 1—figure A1. It shows that the months from December to March are hot and dry. The weather in this period—called the Jilal season—is influenced by strong northeast monsoon winds. Rains start in early April and extend until mid-June. It is referred to as the Gu (first rain) season. In the Hagai season from July to September, rains intensify in the highlands but there are only occasional showers in the lower Shabelle basin. The second rainy season (Deyr) in Lower Shabelle is from October to early December.

From an agricultural perspective, it is noted that the Deyr rains are less reliable than rainfall in the Gu and Hagai seasons. Evidently, Gu and Hagai rains significantly influence the actual amount of water required for irrigation.

Potential Evapotranspiration

Reference evapotranspiration (RET) is defined as the evapotranspiration from a hypothetical well-watered grass surface. It represents the evapotranspiration that would occur if moisture availability were unlimited. RET is a function of climate parameters such as temperature, relative humidity, and solar radiation. It is a direct indicator of water demand by plants. The ration of rainfall over RET, therefore, is an effective measure of the aridity of a landscape.

Figure 2.3: Reference evapotranspiration in the Shabelle basin (mm/yr)



Reference evapotranspiration in the Shabelle (basin is high and ranges from 1000 to 3000 mm/year. (fig 2.3). Apart from a small wedge in the north-western corner of the basin, RET exceeds rainfall for the entire basin, typically by a very substantial margin. It means that water demand by plants is much higher than the available rainfall and explains the high sensitivity of the Shabelle basin to droughts. Drought conditions occur frequently in the basin because of the low and highly variable rainfall (fig 2.2 and Annex 1).

Actual transpiration and evaporation

Rainfall that does not reach the river or groundwater system system comprises of transpiration and evaporation. This water is not available for use outside its immediate vicinity. Transpiration is the portion of rainfall used to produce biomass; evaporation returns water to the water cycle without productive use.

Figure 2.4: Average annual evaporation in the Shabelle basin (mm/yr)

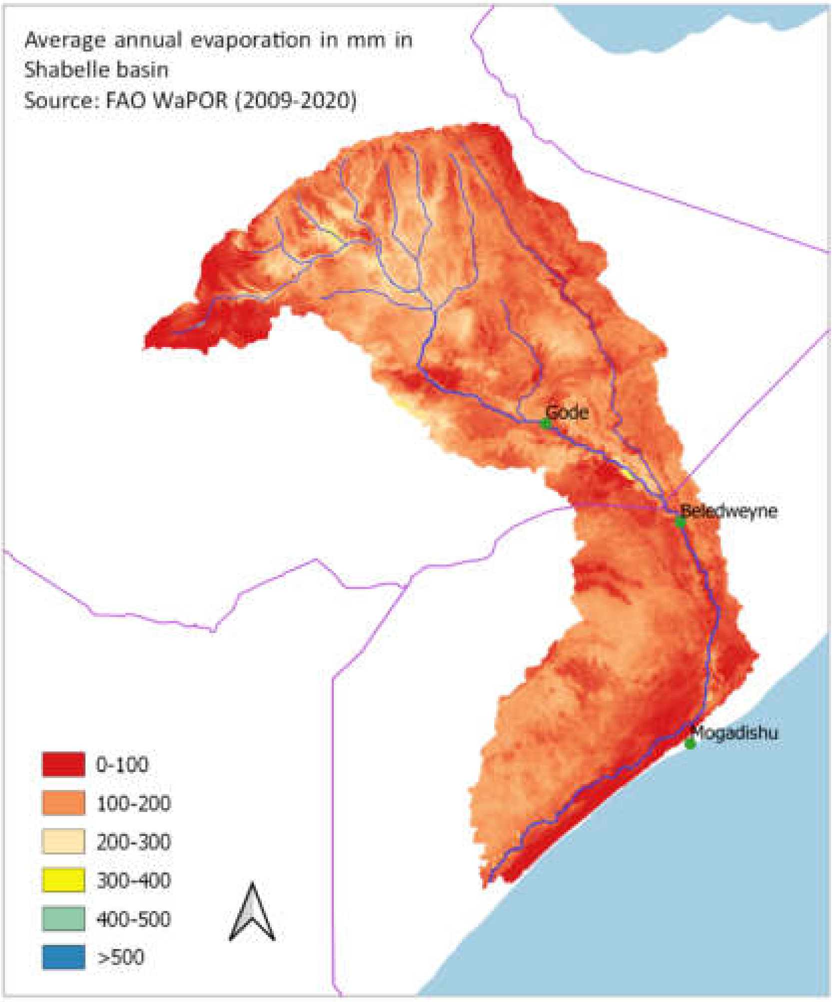
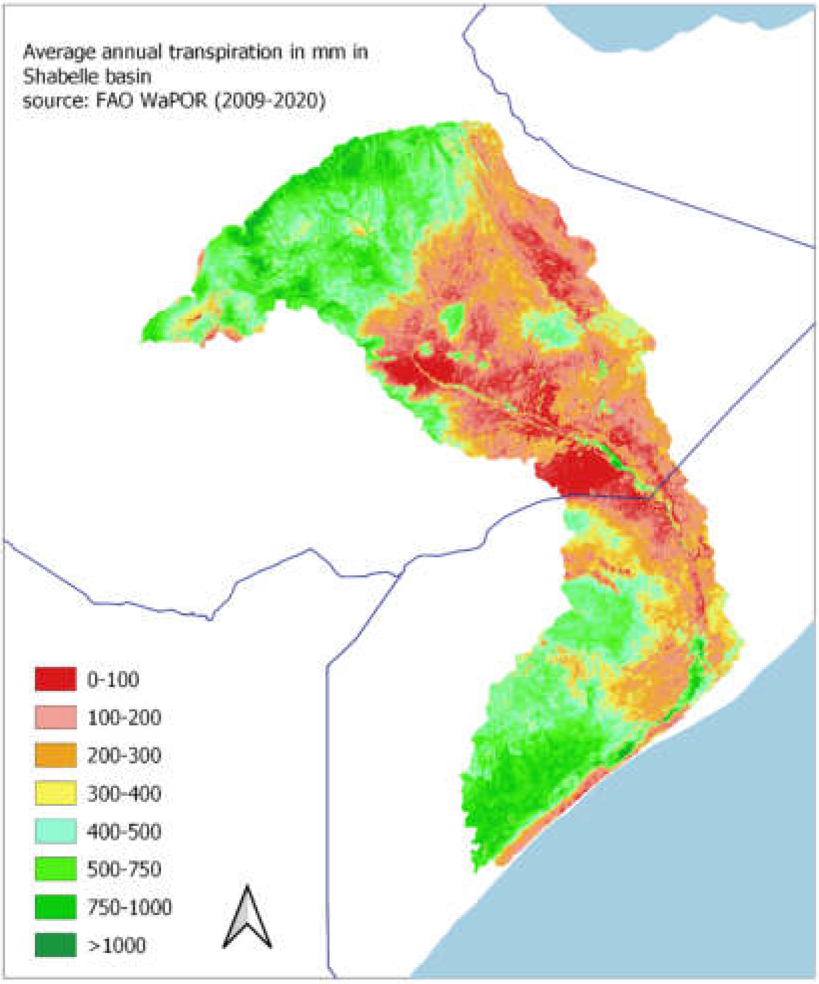


Figure 2.4 shows mean annual evaporation from soils in the Shabelle basin for the period 2009 to 2020. It only includes evaporation from the soil (not from canopy interception). The following observations are made:

- Evaporation is substantial in some river valleys in Ethiopia; in the middle reach of the river, there is a pocket around Mustahil—some 40 km north of the Ethiopia-Somalia border—with high evaporation losses.

- Evaporation in the alluvial valley in Somalia is generally low and below 100 mm/year, except for the irrigation schemes; this suggests wasteful irrigation practices.
- Evaporation in the hills north of the alluvial valley in Somalia—the Bakool and Bay regions—is quite substantial and ranges between 200-300 mm per year; it suggests a degraded landscape.

Figure 2.5: Average annual transpiration in the Shabelle basin (mm/yr)



The following observations are made:

- Transpiration—thus biomass production—in the Shabelle basin is concentrated in the Ethiopian highlands, the river valleys, the irrigation schemes, and in the south-western tip of the catchment.
- Transpiration values are low (< 200 mm/year) in the middle segment of the basin; it implies arid conditions.
- Transpiration values are substantial in the south-western region of the Shabelle, indicating potential for rainfed agriculture or 'wet' grazing areas.

Climate Change

In Somalia temperatures are expected to increase along with more erratic rainfall patterns and sea-level rise, leading to a higher frequency and intensity of natural hazards such as droughts and floods. Climate change is affecting social dynamics at the individual, community, and country level, undermining the population's ability to sustain their livelihoods. Climate projections for the years 2030, 2050 and 2070 indicate a rise in both minimum and maximum temperatures in Somalia (Ogallo et al. 2018). Increasing temperatures cause higher water evaporation, which is exacerbated by land degradation resulting from deforestation and over-grazing. Altogether, these dynamics challenge water and food security, causing droughts and famine enhancing the locals' vulnerability to existing tensions, which may lead to armed conflict.

In the last thirty years, Somalia has experienced more than 30 climate-related hazards, including droughts (12) and floods (19) – three times the number of climate-related hazards reported in the previous three decades. In the first half of 2021, more than 80 per cent of the country had already experienced drought conditions (OCHA 2021). The increased number of droughts is causing massive dying of cattle threatening the livelihood of (agro-)pastoralists, who become displaced or choose to migrate to large towns searching for better incomes (Goldbaum 2018). Prolonged dry spells have often been followed by disastrous floods, jeopardizing or even destroying the livelihoods of many already vulnerable rural Somalis. In 2019, in the amidst of the Deyr cropping season (October–December), following the poorest recorded harvest in southern Somalia during the previous Gu cropping season (April–June), flooding across the country had affected around 600 000 people and displaced more than the half of it (FAO 2019).

Recent analyses by the Potsdam Institute for Climate Impact Research (PIK) found that depending on the levels of future greenhouse gas emissions, different changes in rainfall patterns are likely to occur. According to the most optimistic low-emission scenario, there would be little variations in rainfalls, whereas with higher levels of GHGs emissions, precipitation will strongly increase between 2040 and 2060 in the northern region of Somalia. The amount of heavy precipitation days as well as very hot days is expected to increase by the year 2080, challenging crop production especially in the Hirshabelle and Galmudug regions. In a high-emission scenario an increase – in relation to the year 2000 - by up to 6 days/year of heavy rain and 93 very hot days in 2050 and 152 in 2080, is projected for Galmudug. (PIK 2021)

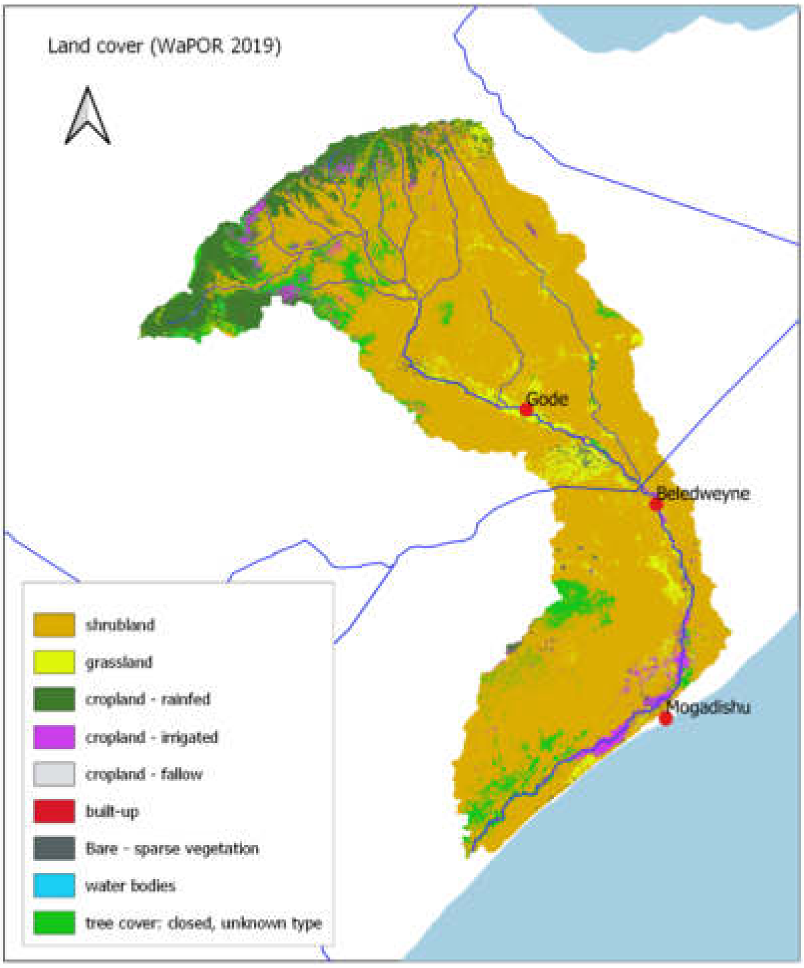
Hydrology projections indicate a stronger and more continuous rise of evapotranspiration, with regional variance. In the southern and northern Somali regions higher rates are expected. Here, evapotranspiration could increase by between 0.8 % and 3.9 % in 2030, and further to between 3.7 % and up to 7.5 % in 2080, compared to the year 2000 levels (PIK 2021).

A high exposure to these risks, coupled with the vulnerability resulting from the long history of unrest, underlines the need for implementing climate change adaptation and disaster risk reduction responses (PIK 2021).

2.3 Land cover

Land cover in the Shabelle basin (fig 2.6) is dominated by shrubland with some pockets of grassland. Rainfed agriculture is concentrated in the highlands in Ethiopia, while crop cultivation in Somalia centers around irrigation with Shabelle waters. The large irrigation schemes along the Shabelle are clearly visible (purple areas). There is substantial tree cover in the south-western region in the basin. Irrigation in the highlands mostly concerns small-scale supplementary irrigation.

Figure 2.6: Landcover in the Shabelle basin



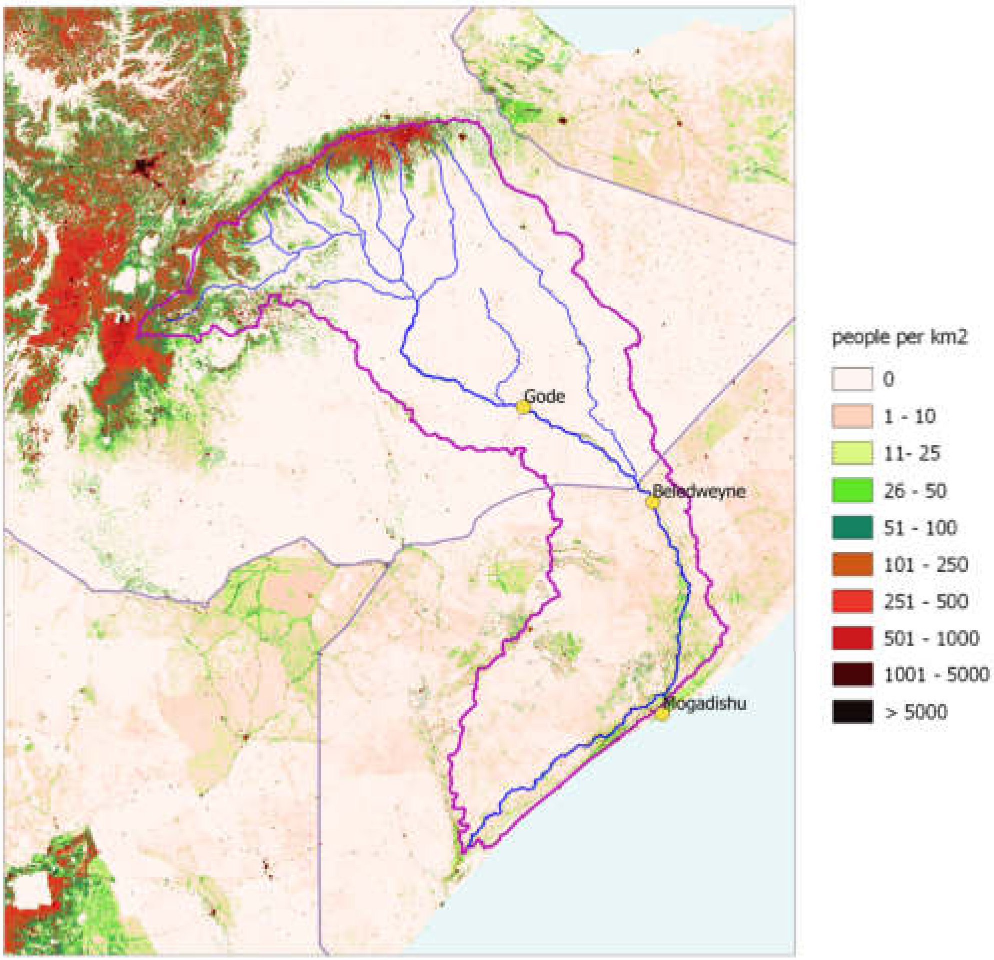
2.4 Socio-economic Features

2.4.1 Population

Population in the Shabelle basin is concentrated in the Ethiopian highlands (fig 2.7) and along the Shabelle river. According to LandScan 2019, the respective Somalian and Ethiopian population in the Shabelle basin are:

- Somalia: 2,152,033
- Ethiopia: 10,200,074
- Mogadishu (officially outside Shabelle basin but very much integratedinto it): 1.785.193

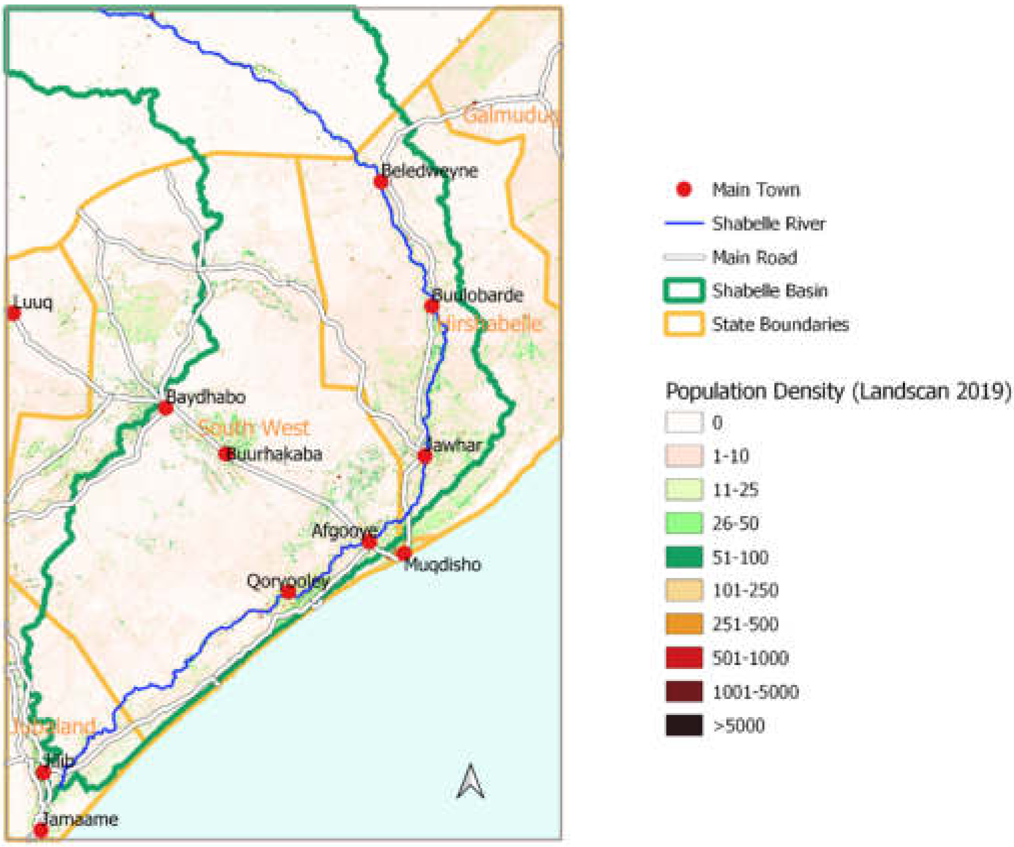
Figure 2.7: Population distribution in the Shabelle basin



Source: LandScan Global 2019; Oak Ridge National Laboratory

The large arid and semi-arid regions are mostly used by nomadic herders and have a much lower population density. Nevertheless, the Somali part of the Shabelle basin is home to some 2 million people. Population concentrations can be observed in the southern region (fig 2.7). While primarily rural, there are also some larger towns including Beledweyne, Jowhar, Balcad, and Afgooye. There is also a sizeable population around Baidao and Buur Hakaba, and along the main highways.

Figure 2.8: Administrative boundaries in the Shabelle Basin



Source: UNOCHA

2.4.2 Socio-economic Profile

The Shabelle basin is highly important for Somalia's food production. Virtually all of the country's crop production takes place in the Shabelle and Juba basins. Although crop production only contributes roughly 5% to the country's GDP, it is very important for Somalia's food security as well as employment (MoPIED 2020). Livestock production in the Shabelle, which is often practiced in combination with crop-production, has a much higher economic relevance. Overall, the Somali livestock sector contributes over 40% to the national GDP and provides 75% of total export by value. Livestock is also significant with regard to generating foreign exchange. It is no surprise, that also at the individual and household level, livestock has for centuries been the traditional repository for wealth and social prestige. In addition, livestock is critical to food security. Average per capita consumption of milk is 330 liters per year in Somalia. It is 22 kg for meat (MoEWR 2021b).

While the agricultural sector holds significant potential for socio-economic development, many challenges impede advancement.

<u>Poor road infrastructure</u>

The road infrastructure in the Shabelle basin is poor. There are about 4,000 km of primary roads, of which 2,800km are paved and 1,2000 km are unpaved. About 90% are in poor condition. Equally, the 7,000 km of secondary roads are mostly gravel or earthen and in mostly bad condition (OCHA 2021). Most roads are earth roads which are often impassable during rainy seasons. Major paved roads, like the one from Jowhar to Mogadishu, are in poor state needing repair and are likewise often impassable after heavy rains or floods. The poor road infrastructure is a main constrain for farmers seeking to market their agricultural products. Transportation over the very rough roads and resulting, damaged products and higher prices, to the extent that the production of some crops (such as tomatoes and lettuce) is no longer a viable for local farmers (MoPIED 2020). The poor road infrastructure hence has a detrimental impact on the livelihood situation in the Shabelle basin.

<u>Inadequate education and health facilities</u>

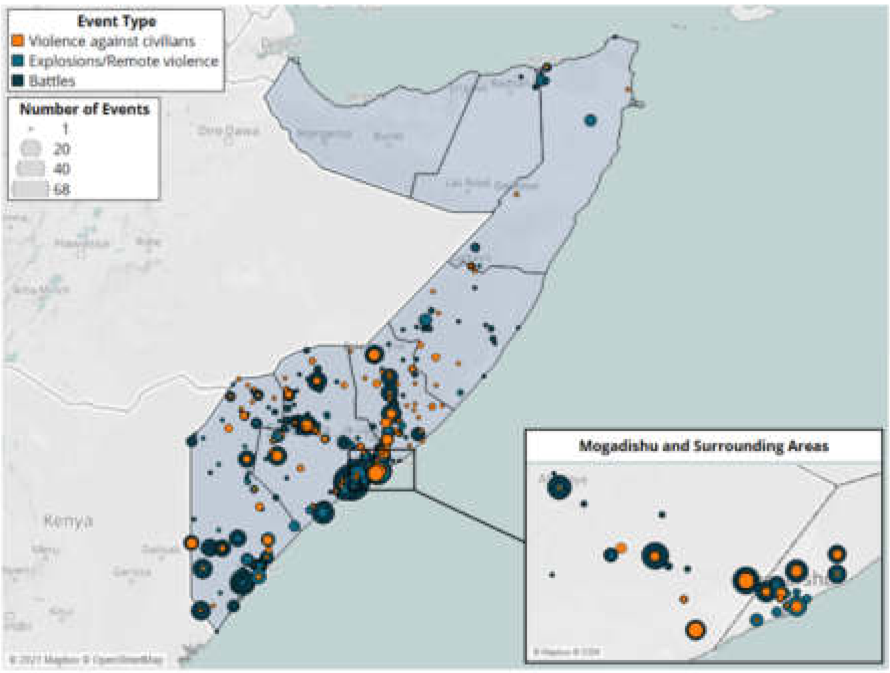
Access to educations and health facilities is very limited. Surveys in the lower Shabelle showed that there are mostly just one or two schools in each town and village, some have none at all (FSNAO 2013). The number of children enrolled in schools is low. The same accounts for health facilities. Health services are mostly run by NGOs and focus on maternal and child health programs. Public health posts are uncommon. Some villages also have private clinics and traditional healers. Accessing these services greatly depends on financial means.

<u>Insecurity</u>

Insecurity in the Shabelle, in particular the lower Shabelle region, is very high. Clashes between clan militias and with state forces are common (and have increased again over the last year). In addition, al-Shabab is controlling most rural areas of the middle and lower Shabelle river basin.

Insecurity and violent clashes have direct and indirect impacts on the economic activities and interventions related to food security. Amongst others, they increase the risks and costs for accessing local markets and hence deriving an income for local farmers.

Figure 2.9: Events of organized political violence involving al Shabbab (01/2020 – 03/2021)



Source: ACLED, April 7, 2021

2.4.3 Dominant Livelihood Systems

Somalia's livelihoods systems fall into four broad categories: Pastoralists, agro-pastoralists, fishing and coastal communities, and urban populations (a fifth category is considered to be internally displaced persons).

In the Shabelle basin, the predominantly rural population comprises pastoralists, crop-farmers and agro-pastoralist, the latter combining crop production with raising livestock such sheep, goats, cattle and camels.

The basin hosts a large population of cattle, sheep, goats, and camels. Most livestock are grazed on semi-arid pastures further away from the river. However, during dry seasons herders move closer to the river zone in search of fodder and water for animals. Generally, pastoralism is the most-widespread livelihood system in Somalia and also dominant in the Shabelle river. However, pastoralists/nomads are naturally very mobile, moving between different pastures and across large areas (also crossing into neighboring countries) – they are hence not confined to the Shabelle basin. The exact numbers of livestock present in the Shabelle is therefore unknown, but estimates provided by the national Government indicate relatively high numbers (see table 2.1).

Population living close to the river engage in irrigation agriculture, whereas the people living further away use rainfed agriculture (see chapter 3, water resources). Irrigation agriculture relies on water provided by the Shabelle, particularly during dryer seasons. While demand for water can (so far) be met, the agricultural output (for irrigated as well as rainfed) is very low.

Table 2.1: Somalia livestock population estimates 2018

Region	Camel	Cattle	Goats	Sheep	Total
Hiraan	912,500	420,900	2,719,800	940,000	4,993,200
Middle Shabelle	210,500	395,900	2,325,500	1,037,900	3,969,800
Lower Shabelle	511,100	1,088,300	2,409,500	945,400	4,954,800

Source: MoPIED 2020

Table 2.2: Individual water footprint in Somalia in 2020

Category	Virtual water consumption (l/cap/day)
Irrigated food: vegetables, fruits, sugar, rice, some maize	172
Rainfed food: cereals (maize, sorghum, vegetables, fruits)	153
Imported food	817
Milk	752
Meat	338
WASH water	25
TOTAL	2256

Source: MoPIED (2020) Overview and Outcome of Five Water Resources Management Options

2.4.4 Water and Sanitation

Access to water and sanitation services in Somalia has improved over the last years. While there are no exact numbers available for water and sanitation situation within the Shabelle basin[2], most recent country statistics indicate that 61% of all Somalis have access to improved primary water source and 42% to improved sanitation facilities (REACH & UNICEF 2021). These number are however slightly skewed as the situation in urban areas as well as IDP camps are generally better than in rural and especially pastoralist communities. It can therefore be expected that the water and sanitation situation in rural areas of the Shabelle is much more dire.

Water supply is mainly provided by groundwater which is accessed through shallow wells and boreholes. To a lesser degree, water supply is ensured by springs, open reservoirs (berkads) and dams. Major barriers for accessing water sources include, amongst others, difficulties in reaching water points, long distances, insecurities in accessing and high water prices (REACH & UNICEF 2021). Water quality is also likely to be a significant problem due to the poor sanitation issue (in addition to often high salinity levels of groundwater).

Most local communities, including in the Shabelle basin, have no proper sanitation and often rely on open defecation (AfDB 2015). This has effects on hygiene and health, regularly causing outbreaks of acute water diarrhoea, typhoid and cholera. Furthermore, women in particular suffer from poor sanitation situation as they are often forced to relief themselves after the fall of darkness, leaving them vulnerable to harassment and abuses.

In the absence of public water services, water supply and sanitation in urban areas, including the Shabelle basin, is often provided by the private sector. In some instances, private companies also organize sewage removal which they collect from individual households and deposit it in landfills or wadis.

Box 2.1: Water supply by private companies

The capital of Middle Shabelle, Jowhar, is served through a management company named "Farjanno". The company operates under a concession from the Federal Government of Middle Shabelle and includes representatives of key clans. The Farjanno company has successfully provided water services to the urban community throughout much of the civil war. Other newer PPPs have tried to reproduce similar arrangements with limited success so far.

(Source: AfDB 2015)

The international donor community and multiple NGOs also play a significant role in providing water and sanitation services, particularly in rural communities. They provide of funding, technical assistance and capacity building. Most sector related services including operation and maintenance are however delivered and managed directly by the private sector and beneficiary communities, with little or no government support. In rural areas, water supply services mainly focus on quantity with little consideration for quality.

There is a great need for state actors to play a stronger and more active role in providing framework conditions and actual implementation of water supply and sanitation in the Shabelle basin to improve the situation for urban and rural communities. This will support state legitimacy and contribute to stability and peace in the basin.

[2] There are no separate assessments available for the Shabelle basin. Additionally, many survey on WASH do not include data from the middle Shabelle because of lack of access due to the more difficult security situation).

2.4.5 The Impacts from the Covid-19 Epidemic

During the first half of 2020, Somalia faced severe challenges simultaneously. During a national emergency caused by the worst locusts' outbreak in 25 years, a series of floods affected nearly a million people between April and June 2020 displacing almost half of them. This has caused serious impacts at multiple levels, from the propagation of water-borne diseases among the displaced to alarming consequences in the agricultural sector, as farmlands were submerged and entire crops were destructed (OCHA 2020). In this scenario, the Covid-19 pandemic reached Somalia, exposing the country to a further challenge (WHO 2020). The fact that many Somalis were displaced and live in densely populated camps combined with a very weak health system aggravated the COvid-19 situation. While the Somali government banned international and national flights, academic institutions were closed, and large gatherings were prohibited. Nevertheless, compliance with health measures by the Somali population was found to be low. (Mohammed et al 2020)

However, while in Somalia's private sector Covid 19 has inflicted contracting sales and employment by about 30% and leaving most firms with liquidity challenges (World Bank Blogs 2021), it seems that households involved in the agricultural sector may have been slightly less exposed to Covid-19-related income losses (FAO 2021). According to the FAO, the Covid-19 pandemic did not impact the price of locally produced food staples. A brief increase in imported rice prices between April and May 2020 was observed, likely related to Covid-19 disruptions to global rice markets, panic buying and increased demand during the month of Ramadan (FAO 2021).

In the Horn of Africa region, Covid-19 was predicted to largely impact livestock trade as governments planned to control the spread of Covid-19. By closing non-essential businesses and workspaces, they eliminated the demand for livestock products by restaurants, bars and street vendors. Furthermore, movement restrictions, border closures, and, in some countries like Somalia, the closure of livestock marketplaces in fact stopped or increased the cost of supplying livestock to domestic and international markets (Mercy Corps 2020a). In the first months of the pandemic Mercy Corps monitored the livestock system in different east-African countries, among which Somalia, and found that the limited livestock trade was jeopardising food security and was expected to worsen. Namely the Kingdom of Saudi Arabia – the main Somali livestock importer – had closed the entrance for international travellers, reducing the usual high livestock demand caused by the traditional Islamic pilgrimage to Mecca, Hajj (Mercy Corps 2020b), (Asala 2020).

Analyses of Covid-19 impacts differ: A report on food systems conducted by the FAO at the beginning of 2021 showed that Covid-19-related impacts on livestock exports to the Middle East region from Somalia were not as severe as previously anticipated. Instead, livestock export volumes remained relatively stable during 2020 and livestock prices remained well above average. As such, these high livestock prices likely offset the impacts on food access that the rise in imported rice prices could otherwise have had in pastoral areas (FAO 2021). However, a more comprehensive Report published later on by the Somalia's Ministry of Planning, Investment and Economic Development (MoPIED) together with UNDP, found an overall drop of GDP of 1.5 per cent in Somalia since the beginning of the pandemic. In this time, livestock exports have dropped by 50 % and had devastating impacts for rural and nomadic communities whose livelihood is based on pastoralism (UNDP 2021).

3. Water Resources in the Shabelle Basin in Somalia

3.1 Introduction

The Shabelle river basin is shared between Ethiopia and Somalia. Virtually all runoff originates in the Ethiopian highlands. While the Shabelle basin is the largest of Ethiopia's 12 major basins, it has the least runoff in terms of volume per unit of area, because large parts of the Shabelle catchment—both in Ethiopia and Somalia—are situated in arid or semi-arid climate zones.

Figure 2.1 presents the topographic map of the Shabelle basin while figure 2.2 shows the average annual precipitation. It is noted that the pocket of rather substantial rainfall at the south-western tip of the basin, with average annual precipitation ranging between 400 and 700 mm, hardly contributes to the Shabelle flows.

The Shabelle is effectively a closed basin as the river does not enter into the Indian Ocean but ends in a depression area, feeding ecologically sensitive wetlands and recharging groundwater aquifers. Only in years with exceptionally high rainfall does the river flow actually reach the Juba River, just before reaching the Indian Ocean. Virtually all Shabelle flows are currently used for irrigation and other productive purposes, percolate to the groundwater, or are lost through evaporation in the main river or in occasionally flooded areas.

This chapter starts by listing the main water security challenges in the Shabelle basin in Somalia. It then defines the main elements of the Shabelle system and continues with a discussion on water availability and water demand. This is followed by a discussion on the risks arising from water related hazards. The chapter ends with a summary of the findings.

Challenges to water security in the Shabelle basin

The Shabelle is the principal source of water for about 4 million people in Somalia (compare chapter 2.4.1). Most of these people are fully dependent on the Shabelle and have no access to other water sources. Pressure on the scarce and finite Shabelle waters is growing rapidly because of population growth, economic development, and ongoing irrigation development that is uncoordinated and uncontrolled (see chapter 6, Irrigation). While family planning and addressing demographic developments is outside the scope of this assignment, it is recognized that ongoing population growth is putting unprecedented pressure on land and water resources, and could result in halving the available amount of water per capita.

Climate change is increasing the variability of rainfall and water availability and will probably aggravate both flood and drought events. Flooding in the high-flow season is widespread and can last for weeks or even months (see chapter 5, Floods). Urbanization and dumping of garbage into the river and canal system are having an adverse impact on water quality, and effectively reduce the basin's water budget since water that does not meet quality standards cannot be used. In addition, uncoordinated upstream water developments may further reduce the already inadequate Shabelle flows. Ethiopia has planned large water developments, including hydropower dams and irrigation areas, in the upstream Shabelle basin (see chapter 8, Transboundary). While no large-scale water projects are currently being implemented in this area, there are signs of lower dry season flows. The exact cause for this has not yet been established. Nevertheless, at present, there is no requirement for 'prior notification'. There is also no cooperation with Ethiopia on equitable use of the river. Further, there are no consultation mechanisms or procedures for joined flood and drought management. This absence of coordination and communication introduces a high level of uncertainty about future availability of Shabelle flows and could potentially lead to water conflict within Somalia as well as with neighbouring countries.

Managing the scarce Shabelle waters in Somalia is further complicated due to a general lack of managerial capacity at all levels, and by the absence of accurate water data and climate information. There are also no data on water demand or on the extent of the irrigated areas. Information on groundwater aquifers and sustainable yields is also missing.

Because of decades of civil war and an almost 30-year investment gap, physical infrastructure for flood and irrigation management has dilapidated. Many infrastructure elements such as water regulation structures and canals are no longer fully operational. Specifically, the system of 9 barrages (see table 6.2) on the Shabelle river that served to maintain adequate head for gravity irrigation is dysfunctional, with almost all barrages requiring maintenance and repairs large scale water storage facilities are either absent or dysfunctional.

To further complicate matters, some parts of the Shabelle basin in Somalia are subject to security concerns and are currently inaccessible to the federal state-level governments. This hugely complicates coordinated management of the scarce Shabelle waters and efforts to achieve water security and associated socio-economic development for the people living in the basin (see chapter 4, Governance).

One Basin - Three Systems

The Shabelle basin in Somalia comprises three principal components (fig 3.1): the riparian zone, the surrounding drylands mostly covered with shrubs and grasses, and Mogadishu. The fast-growing city of Mogadishu is not part of the Shabelle basin but greatly affected by it as water supply for the city is provided by aquifers that are recharged by Shabelle waters.

The water resources of the riparian zone and the surrounding drylands are in fact unconnected. Runoff from the dryland areas barely contributes to the Shabelle flows, while both zones have different livelihood systems (fig 2.6). The riparian zone is dominated by irrigated agriculture while the drylands are mostly used for livestock rearing with some subsistence agriculture. All three zones will be discussed independently in the remainder of this chapter.

Figure 3.1: Principal components of the Shabelle system in Somalia

3.2 Water Availability

The Riparian Zone

Accurate information on recent Shabelle flows and the hydrologic regime of the river is not available. The published discharge record for the hydro-station upstream of Beledweyne—near the border with Ethiopia—ends in 1989. More recent water level recordings are available for this station, but these levels cannot be transferred to discharge because of the absence of a credible rating curve—which is the relation between river level and river flow at the control section. Hence the exact volume of transboundary inflows from Ethiopia has not been known for the last three decades.

Nevertheless, the below section provides an estimate of water availability in the Shabelle according to information in various literature and based on historic data.

1. Average annual rainfall over the entire Shabelle basin measures approximately 425 mm (FAO WaPOR), of which only a small fraction (less than 4%) actually flows into the river.
2. When leaving the mountains and entering the foothills in Ethiopia, the average annual discharge of the Shabelle is approximately 3.8 billion cubic meters (Abdullahi Elmi 2013).
3. Some 250 km further downstream at the town of Gode, the average annual flow of the Shabelle has declined to about 3.1 billion cubic meters (FAO SWALIM 2012).

Box 3.1: Irrigation at Gode in Ethiopia

The above image shows the Gode irrigation scheme. The weir/intake is at Lat = 6.021, Lon = 43.115. The intake and canal have a capacity of 46 m3/s; the canal has a length of 17 km from the intake to the scheme.

The command area of the Gode scheme is 17,000 ha but an estimate on Google Earth approximates the area under actual irrigation at 4,000 ha (2020). Using annual evaporation, transpiration, and rainfall data from FAO WaPOR in combination with standard values for irrigation efficiencies, the annual water use of this scheme is estimated between 50-80 million cubic meters (mcm).

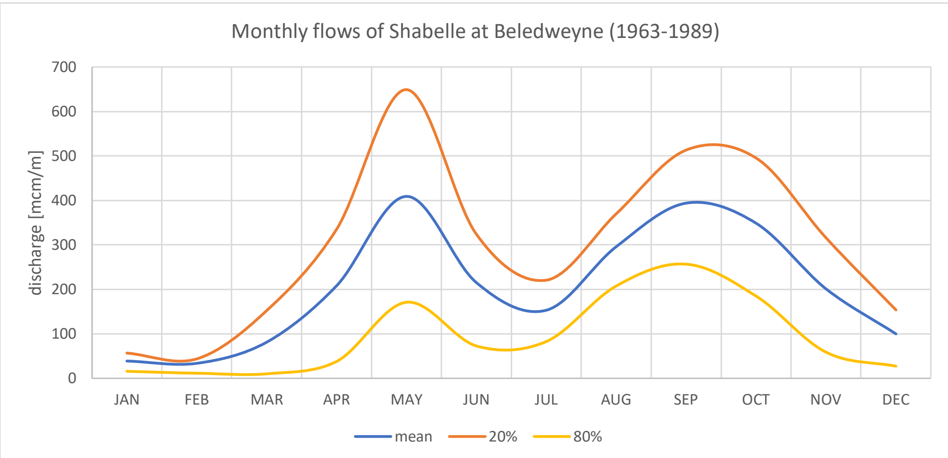
4. Historic transboundary flows crossing into Somalia are estimated at 2.47 billion cubic meters (table 3.1). This figure is derived from the 1963-1989 data set. More recent data are subject to large uncertainties because the rating curve at the border hydro-station has not been verified for many years.
5. Apart from Gode irrigation scheme (Box 3.1), part of the water losses between Gode and the border occur in the floodplain between Kelafo and Mustahil (Fig 5.1 – Flood Chapter). The confined river channel at Mustahil has created a large upstream alluvial area that inundates during floods. Average annual water losses in this area are estimated at 560 million cubic meters (based on evaporation, transpiration, and rainfall data from FAO WaPOR).
6. The flow of the Shabelle river is further reduced in Ethiopia and Somalia through progressive infiltration and evaporation in the channel, and because of the absence of tributary inflow (Abdullahi Elmi 2013).
7. The interannual variability of the Shabelle is high and provides a key challenge for productive use of Shabelle waters, as well as for flood management. The annual discharge at Beledweyne with 20% probability of exceedance amounts to 4.33 billion cubic meters (bcm), while it is just 0.45 bcm for 80% exceedance probability (table 3.1). Although these data represent the timeframe 1963-1989, it illustrates the highly variable nature of water resources availability in the riparian zone.

Table 3.1: Historic annual discharge at Beledweyne

Annual discharge at Beledweyne (1963-1989 data set)	Annual discharge [bcm]
Mean	2.47
Exceedance probability: 20%	4.33
Exceedance probability: 80%	0.45

Source FAO SWALIM W-11

Figure 3.2: Historic monthly discharge at Beledweyne



Source FAO SWALIM W-11

8. Likewise, the seasonal variability of water availability in the riparian zone is high (fig 3.2). Note that low flows in the months from December to March approach zero at Beledweyne in the historic data set
9. In January and February in the years 2016 to 2019, the Shabelle dried up completely from Beledweyne to the Juba confluence, which had not happened before. No conclusive explanation has been provided for this phenomenon, but it is tentatively attributed to increased upstream water use in combination with climate change. Perennial flow resumed in 2020 but stopped again in 2021.
10. Runoff contributions to the Shabelle from catchments in Somalia are small to negligible. Several ephemeral streams briefly discharge into the Shabelle after heavy rains but are mostly dry for the rest of the year.
11. Average annual Shabelle flow of 2.47 bcm at Beledweyne (for the period 1963-1989) translates into 78 m3/s. This implies that the Shabelle is, in fact, a relatively small river in terms of volume of discharge. By comparison, the annual runoff in the neighboring Juba River is almost three times higher.

Box 3.2: Melka Wakana Reservoir

The above image shows Melka Wakana reservoir in the upstream reach of the Shabelle in Ethiopia. The hydropower facility (Lat = 7.172, Lon = 39.436) was commissioned in 1988 and has an installed capacity of 153 MW. The maximum release capacity is 60 m3/s.

The reservoir has a life storage of 763 million cubic meters (mcm). Coordinated operation of Melka Wakana could have a substantial impact on the hydrologic regime of the Shabelle given the average flow at Beledweyne of 78 m3/s. The total annual discharge of the Shabelle in a drought year is 450 mcm (with exceedance probability of 80%), which is smaller than the life storage of the reservoir. Therefore, Melka Wakana could provide over-year storage in drought years.

Suggestions that periodic flushing of sediment from Melka Wakana reservoir is responsible for occasional spikes in the sediment load of the Shabelle could not be confirmed.

12. There is anecdotal evidence that climate change is changing the hydrologic regime of the Shabelle and has resulted in unprecedented floods (in 2020) and more droughts. However, this observation cannot be substantiated with flow records because of the absence of reliable flow data for the river.

13. Melka Wakana (Box 3.2) is currently the only large reservoir in the Shabelle system. With a life-storage of 763 mcm the reservoir has the capacity to regulate the hydrologic regime of the river. For instance, it is larger than the annual dry season flows at Beledweyne, which is estimated at 450 mcm (Table 3.1). The reservoir could also capture about 15% of the flood wave. However, there are currently no mechanisms for coordinated transboundary water resources management of the Shabelle.
14. Because of the alluvial nature of the riparian zone in Somalia, it is probable that the Shabelle interacts with connected groundwater systems, specifically in the very flat area around Jowhar and further downstream.
15. While a detailed study of groundwater availability in the Shabelle basin in Somalia does not exist, there are probably two aquifers in the study area: a shallow perched aquifer and a deep semi-confined aquifer. Recharge of the deep aquifer is probably derived from higher rainfall areas in Ethiopia.
16. The perched aquifer is situated in the alluvial deposits in the riparian zone and reportedly has groundwater levels between 6 and 10 meters deep. It is recharged by Shabelle waters. The impermeable base of the aquifer is probably not deeper than 30 m but likely shallower. Given the areal extent of the riparian zone, the groundwater resources could be significant.
17. Shallow groundwater can be accessed through shallow wells with motor pumps and is widely used for watering livestock, small-scale irrigation, and water supply for people. However, sanitary conditions of many shallow wells are poor.
18. The recharge mechanisms of the shallow aquifer—and the rate of replenishment—have not been established in detail but will include infiltration in the current and former riverbeds. To what extent infiltration in the periodically inundated areas contribute to groundwater recharge has not been established.
19. The movement of water within the aquifers follows gravity and will flow towards the coast.
20. Since it is unlikely that water supply in the riparian zone will rely on groundwater from the semi-confined deep aquifer, this aquifer will not be discussed in this section. Rather, it is included in paragraph 3.3.2.2.

Outside the Riparian Zone

21. There are no perennial rivers outside the riparian zone. The many streams in this region (fig 2.1) are ephemeral and flashy—thus responding quickly to a rain event—and dry outside the rainy season.
22. Rainfall is the principal source of water. While highly variable—both within the season and between years—average annual rainfall in this zone is 439 mm (source: FAO WaPOR, for the period 2009 to 2020); this represents a considerable resource.
23. Some 183 mm of this average annual rainfall (439 mm) is lost to evaporation (source: FAO WaPOR, for the period 2009 to 2020). Evaporation represents rainfall that returns to the water cycle without productive use. By contrast, transpiration is the portion of rainfall used for biomass production (such as fodder), which is considered a productive use in the region dominated by livestock rearing and subsistence agriculture (fig 2.4 and 2.5).
24. This implies that over 40% of the renewable water resources (i.e. rainfall) in the dryland area in the Shabelle basin in Somalia are lost without productive use. This represents a huge waste of resources.
25. Increasing the productive use of rainfall—which implies capturing rainfall and encouraging it to grow biomass—would enhance the resource base for livestock rearing in this region. This is feasible but difficult in practice because of the scale of dryland areas and the communal nature of range land management.

26. Deep groundwater represents another source of water in the dryland zone. Information about the extent and sustainable yield of this water source is scarce. Deep groundwater is recharged by direct infiltration in fractures and fissures and has a (very) high residence time. It is probable that deep groundwater contains a substantial fossil component. This implies that the sustainable yield of these aquifers is not determined by recent infiltration, or—by implication—by recent climate conditions.

Mogadishu

27. Water supply of Mogadishu—with a population of just below 2 million but growing rapidly—is provided by 3 groundwater well-fields.
28. Most of the wells are located within 2 km from the ocean and are subject to saltwater intrusion. Water abstractions from the aquifers must hence be carefully controlled.
29. Recharge of the aquifers probably occurs by underground seepage from the Shabelle river. Recharge values are not known but are expected to vary greatly from year to year as a function of the annual flow of the river.
30. Pollution and wastewater management are major challenges in Mogadishu Water treatment facilities are inadequate.

3.3 Water Quality

There is currently no detailed assessment of water quality, pollution sources and loads in the Shabelle basin. Nevertheless, deteriorating water quality is of increasing concern, for surface water resources and particularly for groundwater resources which are already today is often of poor potable quality. Pollution of water resources in the Shabelle basin is a rapidly growing problem, specifically near urban areas, that must be addressed. Pollution sources include uncontrolled dumping of waste into rivers, agricultural run-off and and lack of sanitation and wastewater management. Inadequate sanitation facilities in urban areas and the riparian zone intensify the spread of waterborne diseases. Overflowing of sanitary latrines during flood events poses a serious health risk to communities and ecosystems in flood-prone areas.

In general, poor water quality has severe impact human health in Somalia, especially in rural areas, where access to clean water is limited. Water treatment facilities are also required to provide potable water of good quality to the urban population. The lack of clean water also contributes to the malnourishment of children, especially when water used for drinking is not pre-treated in any manner. The lack of clean water and sanitation facilities have led to the rise in water-borne disease rates in Somalia, resulting in approximately 20% of deaths of children under five (National Water Resource Strategy 2021).

For agricultural water use, the main water quality concerns relate to high sediment loads in the Shabelle, as these lead to siltation of irrigation infrastructure. Moreover, the Gu floods (April-May) are often of high salinity and therefore not suitable for irrigation in the first 10-14 days of this flood period. It further reduces water availability for irrigation. By contrast, high salinity of the Shabelle waters does not occur during the Deyr rainy season.

Box 3.3: Water-related ecosystems and water quality in the Shabelle basin

Healthy floodplains and associated wetlands ecosystems can play an important role in supporting water security and enhancing water quality. They can act as a sponge and thus regulate water volume, by attenuating floods and releasing water during low-flow conditions. Floodplains can also trap sediments and filter water, which improves water quality and supports nutrient cycling. These processes are also important for recharging aquifers and ensuring groundwater quality.

There is limited information on water-related ecosystems in the Shabelle basin. The 2019 National Biodiversity Strategic Action Plan states that "the sub-coastal valley of River Shebelle is characterised by swamps and floodplains. Here along the three channels of the river, a swamp of 25 km wide and 150 km long covering around 3,000 km2 area exists with high potential significance for biodiversity." The swamp/wetland also is important for the recharge of the underlying groundwater aquifers which supply water to the coastal towns and settlements in the south.

The functioning of these important wetland ecosystems could be adversely affected by water abstractions upstream, quality of inflowing water as well as conversion and fragmentation of the wetlands for agricultural purposes. Further assessments would be necessary to fully understand the role of water-related ecosystems in the Shabelle basin in providing access to clean water, supporting livelihoods and flood mitigation in local communities. This refers especially to assessment and improved environmental management of the swamp area in the sub-coastal valley of the Shabelle, for its reported importance for water security and quality of water supply of coastal towns and communities.

3.4 Water Demand in the basin

Water Demand in the Riparian Zone

Water demand in the riparian zone is dominated by irrigated agriculture. Figure 3.3 presents a schematic of water allocations for the pre-war system consisting of 9 barrages and the Jowhar Offstream Storage Reservoir (JOSR). The command areas for this system are reported in table 6.1.

The system as depicted in Fig 3.3 does not exist anymore. Large parts of the former irrigated areas have been abandoned—mostly at the tail-end—because of persistent failure of water delivery after canals and water control structures silted, and after the barrages were unable to create adequate head. This subject is discussed in detail in Chapter 6: Irrigation.

Current irrigation in the riparian zone in the Shabelle consists of a patchwork of improvised irrigation in the former command areas, in combination with gradually expanding irrigation schemes outside these areas that take water directly from the river. Irrigation water is delivered by canals, pumps, or by deliberate breaches of river embankments. Irrigation development is unregulated, uncoordinated, and unconstrained. Water delivery among the many independent schemes is provided on a 'first-come, first serve' basis, which is risky for downstream water users but also frequently leads to inefficient use (waste) of water resources.

Because of topography, soils, and the proximity of Mogadishu, most irrigated agriculture in Somalia occurs in the Shabelle basin. The sector is of key economic importance because a large number of people depend on irrigated agriculture for their livelihood and food security. Nevertheless, it is estimated that less than 10% of the Somali population depends on irrigated agriculture for its food security.

Given the size of the riparian zone, there is no shortage of good agricultural land in the Shabelle basin. Rather, water availability is the constraining factor: there is simply not enough water to sustain irrigation on all land in the Shabelle basin that would in theory be suitable for irrigated agriculture.

Unconstrained and uncoordinated irrigation development—as has occurred in recent years—in combination with low water productivity will inevitably reach the limit of the Shabelle system and compromise secure water supply. This situation is exacerbated by the absence of storage capacity and the high-interannual variability of the Shabelle, which supplies abundant water in wet years but quickly causes deficits in drought years. In fact, dry-year flows of 0.45 bcm (with exceedance probability of 80%) can irrigate not more than 30,000 ha (based on 1 m water requirement and 50% irrigation efficiency), which is much lower than the current irrigated area. Furthermore, this figure does not consider other productive water uses, environmental flow requirements, or water supply for Mogadishu.

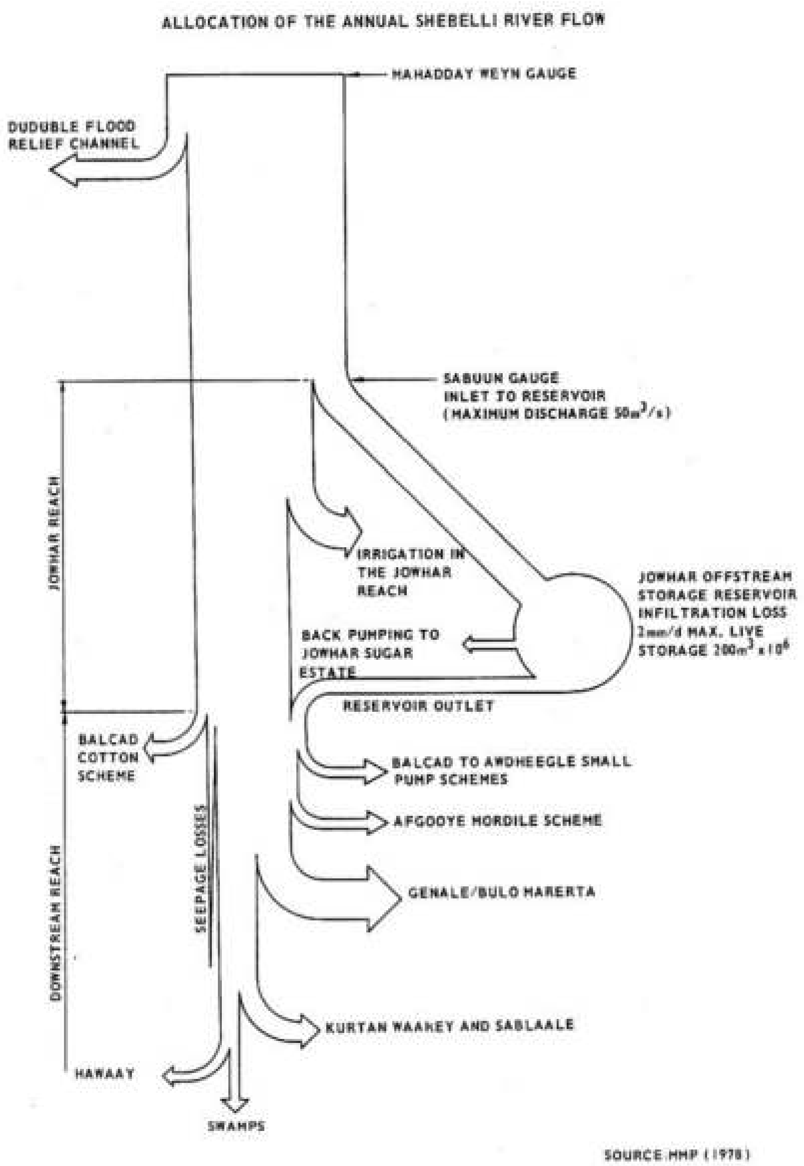
In 2012, FAO SWALIM estimated the annual irrigation water demand in the Shabelle basin at 550 mcm. This figure has since increased because of rehabilitation of existing irrigation schemes and development of new ones.

In fact, no accurate information exists on 1) the current extent of irrigated agriculture, 2) total irrigation water demand, 3) water productivity in irrigated agriculture, and 4) total water availability. Nevertheless, it is probable that the capacity of the Shabelle to provide secure water supply for all existing schemes has already been reached or exceeded. It implies that water shortages in drought years are inevitable. This situation is exacerbated by continuing irrigation development, possible upstream water development in Ethiopia, climate change, and growing abstractions for other productive purposes, notably domestic and industrial water supply.

Additional observations:

- There is no assessment of environmental flow requirements for the Shabelle.
- There are no mechanisms for maintaining the required environmental flows in the river.
- There is no estimate of water requirements for the wetland area in the Shabelle depression close to the Juba confluence and no water has been reserved to preserve these wetlands.
- Water demand for domestic and industrial purposes is growing rapidly because of population growth and economic development. Water for towns in the riparian zone such as Beledweyne, Jowhar, and Afgoye is supplied by the Shabelle. Nevertheless, this demand is a fraction of irrigation water demand and can be met in principle.
- Actual water demand of individual irrigation schemes is a function of the planting date, cropping patterns, and irrigation practices and differs per scheme.
- Before the civil war in Somalia, plans had been developed to further expand irrigated agriculture in the Shabelle basin by 88,282 ha, requiring some 1.2 bcm/yr. These plans seem unrealistic given the status of the water resources in the Shabelle, the potential upstream developments, and the water shortages already experienced.

Figure 3.3: Allocation of the Annual Shabelle Flow before the Civil War



Water Demand Outside the Riparian Zone

There is no irrigation outside the riparian zone. Hence water demand in this zone is mostly concerned with domestic water supply and livestock watering. Both are distributed and a function of local conditions and are supplied by local water sources, including deep groundwater.

Water requirements for fodder and subsistence agriculture in the dryland zone are met by rainfall.

The farming systems in this zone—and the associated water requirements and water security issues—are discussed more in detail in Chapter 7: Livestock. Water use in the riparian zone will not affect water demand and security in the dryland areas further away from the river as these two hydrological systems are effectively disconnected.

Water Demand for Mogadishu

Mogadishu is a fast-growing city with a population approaching 2 million people that currently depends for its water supply on aquifers that are indirectly recharged by the Shabelle.

Total annual water demand approximates 80 mcm (based on 100 l/capita/day) and is probably less. This represents less than 4% of the average annual Shabelle flows. In addition, water conservation measures such as roof water harvesting could supplement water supply for domestic purposes, while desalination is practiced in many coastal cities.

One can therefore conclude that water demand for Mogadishu can generally be met. Water security for the city will depend on timely and adequate investments in water infrastructure, including water treatment facilities, efficient water delivery systems, and waste management. A large role for the private sector is foreseen. Demand management and incentives to wisely use and converse water resources should also be introduced and encouraged.

3.5 Conclusions

This chapter has reviewed the status of the water resources in the Shabelle basin. Among the main conclusions is that the current extent of irrigation agriculture in the basin already exceeds the available water resources in the Shabelle in drought years. At the same time, pressure on water resources is increasing to unprecedented levels because of population growth, socio-economic development, and uncontrolled expansion of irrigation areas. Climate change and water development in Ethiopia can exacerbate an already precarious situation.

Hence water shortages in drought years seem inevitable. This affects the irrigation sector—where some areas cannot be cultivated and water conflicts within schemes, among schemes, and with pastoralist communities may arise—but also the integrity of the riverine environment. With progressively expanding irrigation areas in combination with more upstream water use—and possibly climate change—the total acreage that will be affected by drought will continue to grow unless measures are taken to increase secure water supply or reduce water demand.

Nevertheless, there are still several realistic options to improve water security. Options to address drought conditions exist and include expanding reservoir and other storage capacity or conjunctive use of groundwater and surface water. Improved irrigation practices can reduce water use in irrigated agriculture although high sediment content in the Shabelle waters prevents the introduction of sprinklers or drip irrigation. Cultivation of crops that require less water can also be considered.

However, all these measures are ineffective if unconstrained and uncoordinated expansion of irrigated areas in the basin continues. Some agreed-upon mechanism must be devised to check irrigation development, regulate water abstraction, and allocate scarce waters during drought years. Before this is successfully achieved, drought hazards in irrigated agriculture—with spill-over effects to other sectors—will not be addressed in a fundamental manner and will continue to have adverse impacts on socio-economic and environmental systems in the riparian zone.

Lastly, while this study considers the Shabelle basin only it is recognized that the Juba has almost three times as much water as the Shabelle and that an integrated Shabelle-Juba perspective is recommended when evaluating potential water resources development options and strategies in Somalia.

4. Governing Water Resources of the Shabelle

4.1 Introduction

Since the start of the civil war, state and federal government actors have effectively been absent in Shabelle basin and not (yet) been able to rebuild institutional structures beyond some urban areas. Fragmented local communities, non-state humanitarian as well as private sector actors have since dominated water resources governance in the basin.

Somalia is currently in the process of re-establishing a sound water governance framework to provide an effective structure for restoring water services to the Somali population. At the national level, the **Ministry of Energy and Water Resources (MoEWR) has been established which is the primary actor, responsible for water and water related issues**, including overall formulation, direction and coordination of national water resources. However, there is uncoordinated management of water resources between the Federal Line Ministries and Federal Member States.

To move towards the establishment of functioning water governance framework the Government of Somalia, under guidance of the MoEWR, has recently developed **the National Water Resources Strategy (NWRS)** to develop impetus for holistic water sector reform as well as priority activities to address key water challenges. The NWRS outlines 3 overarching key goals, 20 sub-strategies and specific subordinate strategic objectives and actions. Water governance is mirrored in goal 1 "Establishing a Functional Water Governance Framework" which is further substantiated by several specific objectives and sub-strategies. Guiding principles have been defined to frame strategic objectives and actions for developing future policies, legislation and strategies for improved water sector governance (table. 4.1).

Table 4.1: Guiding water governance principles of the NWRS (2021)

Guiding Principles 1: Develop Policies, legislation, and strategies for improved water sector governance
• National water policy will provide the framework for sustainable water resource management and development at national level and reflect the water sector needs at FMS levels
• National water policy requires various supporting operational tools and guidelines to support implementation
• Water is a socio-economic and environmental good and requires integrated and inter-sectoral approaches to ensure sustainable management
• A cooperative government will seek to harmonize policy approaches and collectively support policy implementation
• Ensuring alignment of policy and legislation at national and FMS level is required to ensure effective water sector governance at various scales
• Enabling legislation provides for phased and progressive realization of the national water policy
• Use of regulations enables more adaptive responses to ensuring effective water resource management and development

In the time being, **rules and procedures for regulating access and distribution of water are formulated at a very fragmented, localized level**. There is only limited knowledge available about how exactly water resources are dealt with at this level between different user groups and within as well as across different locations along the Shabelle. Intervention by government and other actors should nonetheless be aware that multiple local and informal arrangements have developed over the last decades and consequently involve local stakeholders in order to jointly assess and design water interventions and forthcoming changes in water governance structures.

4.2 Formal Water Sector Regulation

Before the collapse of the central Somali Government in 1991, the Ministry of Water and Mineral Resources was responsible for setting the overall policy framework and for managing water resources. The Water Development Agency within the same ministry was responsible for planning, development and quality monitoring of domestic water supply systems (AfDB 2015).

The Irrigation Department at the Ministry of Agriculture was responsible for all irrigation schemes, larger infrastructure operation and maintenance along the Shabelle river. Licencing of land rights was also managed by the Ministry of Agriculture (the Department of Water and Land Management). In 1975 the Somali Government passed a land legislation which officially transferred control of land tenure rights from traditional authorities to the government. The law allowed landholders to register up to 30 ha of irrigated land and up to 60 ha of non-irrigated land as a state leasehold, with a 50-year lease (WB & FAO 2018). The aim was to improve agricultural production and to establish large-scale farming corporations. However, many farmers did not register their land because of the high costs of land registration and the complicated land registration procedures (WB & FAO 2018). By 1986, only about 5.3% of the total land in the lower Shabelle was registered (FSNAU 2013).

During the civil war many of the farms in the lower Shabelle region were taken over by armed militias from pastoralist groups that fought against the Siad Barre regime (coming from other areas within Somalia). Land tenure has since become very complex issue that is connected with many disputes (FSNAU 2013, WB & FAO 2018). Additionally, it is reported that several of these new farmers have little or no knowledge about irrigation farming as they had not traditionally engaged in farming activities.

Since 2012 and the launch of the Provisional Constitution formalized national and federal institutions are gradually being re-established. There are three levels of government, including the Federal Government System (FGS) five Federal Member States (FMS) and 73 districts. Somalia's national government structure is based on a strong federal system. Alongside the FGS there are five FMS, including Jubaland, South West, Hirshabelle, Galmudug and Puntland (Somaliland has a special status but is considered part of Somalia).

The Provisional Constitution does not assign specific functions to each of these government levels and does not outline a framework for cooperation between them, including issues related to water resources management. This remains work in progress (compare MoP 2020). However, according to the **Wadajiir Framework for Local Governance** (adopted in 2015) each government function should be performed by the lowest level of government that is able to implement an activity effectively. This focus on decentralized governance structures aims to increase the trust between citizens and the various level of state structures and pay tribute to the manifold local governance arrangements that have evolved over the last decades.

Hirshabelle is the youngest of all FMS and is still in the beginning of establishing main governance structures. The highest priority is the management of the Shabelle river due to its economic relevance as well as recurring floods which affect a large part of the population (MoP 2020).

Struggle over power and resources between the FGS and FMS is key challenge slowing many development processes and hindering the establishment of functioning state institutions in most parts of the county.

The lack of formal governance structures (and its impacts in terms lack of security and public services) is filled by informal structures, including arrangements by local communities, private actors and Al Shabaab (compare chapters 4.3 and 4.4).

4.3 Non-governmental Water Sector Governance

Community institutions today play a key role in regulating and managing access to water resources within the Shabelle river, especially in rural areas. For example, local water management committees (so-called *maddas*) have been established amongst the agro-pastroalist groups in the lower Shabelle (Gomes 2006, Hassan 2015). These maddas inform gatekeepers (*yassin*) about their water requirements. Based on this information on water requirements, gatekeepers then organize seasonal schedules for water allocation and also organize repairs and maintenance which they assign to different madda members. Twice a year farmers have to desilt a section of the main irrigation canal as well as a section of their distributary or otherwise pay a fine. Disputes between community members and/or gatekeepers are mediated by traditional Baxaar or village council of elders (masarweyn). Village committees manage land issues and aspects related to water intakes for pastoralists (Gomes 2006). It is reported, that to some degree village committees also report and coordinate water abstraction as well as flood warning across villages.

While this system at the community level seems to work relatively well, regulation of privately-owned large-scale farms has been reported to be more difficult. These farms have the ability to build and operate canals without any regulation.

Private actors in general play an important role in Somalia, often providing services that are traditionally managed by state entities, including in the water, health and energy sectors. Water supply in urban areas for instance is predominantly provided by different individual private actors and companies (e.g. Mumin Global Service and Trading Agency, Farjanno or Ijaabo Water). It is reported that in some urban centers PPS-arrangements have been set up with donor support. Private actors here provide services under some degree of public sector regulation (AfDB 2015). The private sector is also relevant in providing skilled laborers for various water activities such as civil works construction, repairs and maintenance of water related infrastructure (such as repairing pumps).

However, marginalized communities (e.g. those belonging to weaker clans or less financial means) have limited or no access to private sector services. For example, during times of drought pastoralists often rely on water provided by very costly and often unaffordable privately owned water tankers. In these situations, water for livestock can only be accessed by more well-off herders and those with stronger clan structures.

Finally, also **donor agencies and NGOs** play an important role in providing and rehabilitating water and sanitation as well as irrigation and flood mitigation infrastructure. While donors and NGOs often provide the financial resources and capacity building activities, operation, regulation and maintenance are usually managed directly by communities or private actors. Often projects establish new structures (such as farmer associations, water or irrigation committees) or build on already existing ones.

4.4 Insecurity and Local Disputes

With only 411 m³ of freshwater per capita/person Somalia is a country of high water stress (WB 2020). The continuous decline in freshwater availability has resulted in fierce competition and recurring local conflicts over water resources. Control over water resources between different clans and regional government authorities has been a sensitive issue which often results in conflicts, particularly between different user groups from livestock and agricultural communities (MoEWR 2021). Conflicts over water often erupt when wells dry up and local water supplies diminish, particularly during dry seasons when groups of pastoralists settle closer to the riverine areas of the Shabelle. While traditionally, these types of disputes have been mediated by clan elders and other community members, the increasing amount of escalating conflicts seem to indicate that the coping capacities of these institutions become overstretched.

While local disputes have traditionally been dealt with by clan and village elders the Ministry of Agriculture has lately tried to intervene in conflicts related to water allocations. In 2016/17 farmers from the middle and lower Shabelle were brought together in order to solve issues around water allocation. While some form of dispute settlement (based on specific allocation of water based on days) was found and agreed upon, enforcement proved difficult.

The lack of formal governance structures (and its impacts in terms lack of security and public services) is also filled by the islamist group al-Shabaab. Resulting insecurity is a major problem in many parts of the country, including the Shabelle basin (particularly the lower basin). Al-Shabaab controls large areas of land, particularly in the middle and lower basin, and often launches attacks on government-controlled checkpoints and buildings (WB & FAO 2018). Al Shabaab has established a parallel governance system in many rural areas. For example, in the Hirshabelle FMS larger cities are run by government while rural areas remain under control of Al Shabaab (MoP 2020).

Al-Shabaab as well as the national army and clan-based militia groups all operate checkpoints, increasing the costs for farmers to access markets. This also makes rehabilitation of flood and agricultural infrastructure relatively difficult as any government and/or foreign supported interventions is a potential target for al-Shabbab.

4.5 Preliminary Policy Implications

The (human) capacity to regulate water management in Shabelle does exists; while not highly advanced, this 'on the ground' capacity is adequate given the current practices of water and agricultural management in Shabelle; this local capacity should not be underestimated or disregarded.

At this stage, emphasis should be on strengthening local governance structures that are currently running the irrigation systems; while probably sub-optimal, the system does work, and investments are being made in irrigated agriculture in Shabelle basin.

However, water allocation across communities and different Somali states require coordination (compare chapter 6). Some form of central water allocation/licencing system will have to be established at the basin level (either coordinated by the FGS or some inter-state platform established between FMS) to avoid over allocation and upstream-downstream disputes (or ideally avoid the latter).

Aspects related to flooding also cannot be (entirely) managed by local governance structures and require a higher-level authority to improve and develop adequate infrastructure and planning responses, including upstream-downstream coordination. The FGS is here currently making first important steps – the MoEWR together with other ministries established the Floods and Drought Task Force will focus on flood forecasting, early warning and flood interventions. It will also coordinate interventions of different actors.

Similarly, water delivery and sanitation services, currently managed by private or donor/NGO actors require more government involvement to provide standards, expand access and ensure that also marginalized groups can access them. FMS or lower government authorities together with NGOs and private sector seem the adequate level to address interventions here.

5. Floods and Flood Mechanisms in the Shabelle Basin

5.1 Introduction

Floods are a major issue in the Shabelle basin in Somalia. Recurrent floods inundate large tracts of land along the river together with adjacent low lying areas, and cause significant damage to infrastructure, crops, livestock, and property. In addition, floods are accompanied by an elevated risk of malnutrition and water-borne diseases, and displace a large number of people.

This chapter presents an inventory of the main flood-affected areas. It subsequently discusses the hydrologic and hydraulic mechanisms that cause flooding. The chapter concludes with a discussion on whether flood control can be based on a comprehensive understanding of the flood regime of river Shabelle, or if another approach is required that is better suited to the specific Somali circumstances.

Figure 5.1: Maximum historic flood events

Source: EU Global Surface Water – Dataset 1984-2019

5.2 Flooding in Shabelle Basin

Recurrent floods in the Shabelle basin cause damage to homes and the road network, displacement of people in rural and urban areas, loss of crops or delayed planting, and the spread of water-borne diseases. The maximum extent of historic flood events in the Shabelle basin in Somalia is presented in figures 5.1.

The following three main flood regions can be distinguished:

- The Shabelle valley in Hiran region (region A); flooding occurs close to the Shabelle channel.
- The large alluvial valley in the Middle Shabelle region (region B); flooding is widespread.
- The area immediately upstream of the Shabelle-Juba confluence (region C).

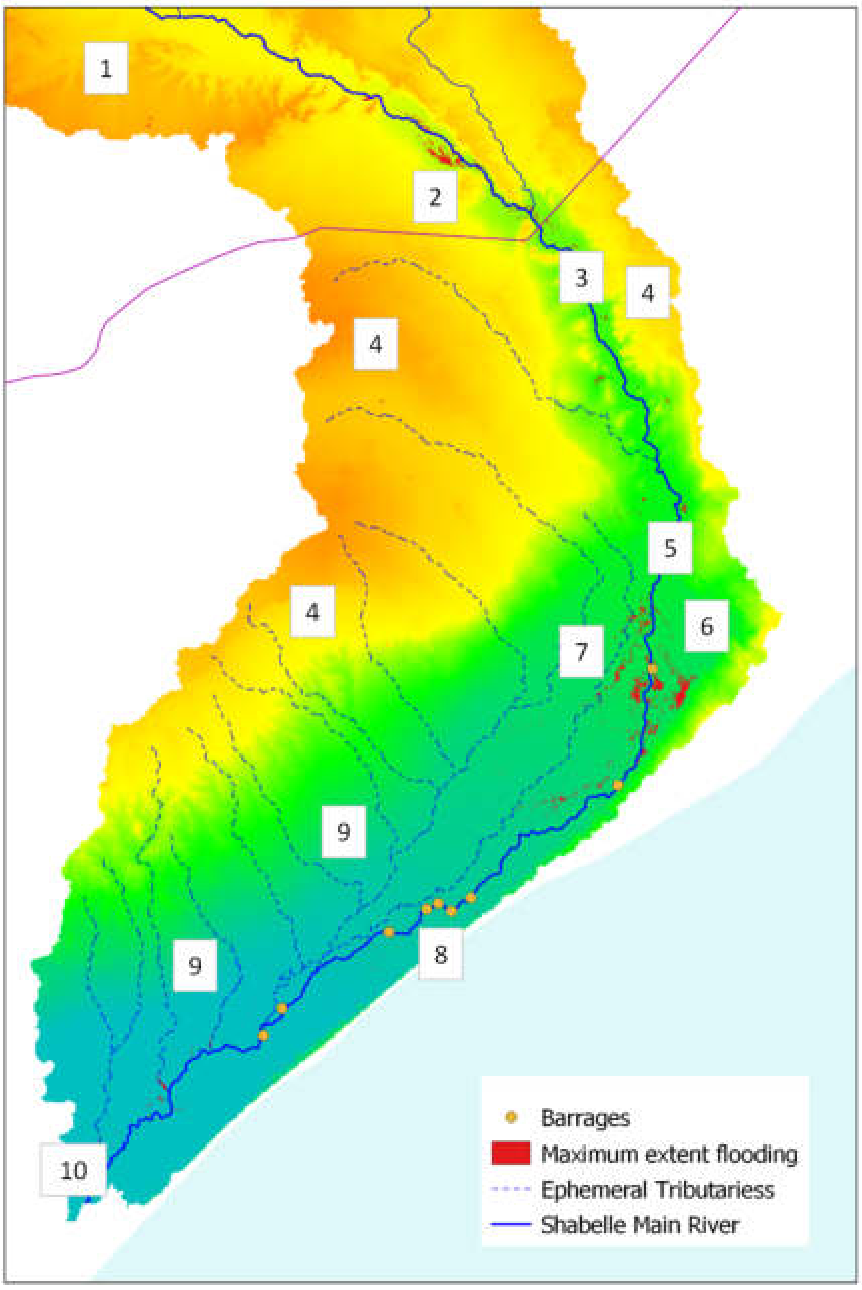
From upstream to downstream, the following principal flood events have been identified:

a) When Shabelle levels are high, flash floods from local tributaries cannot drain into the main river, causing back-water effect and inundations near the confluence (with the Shabelle). Flooded areas are quite small and mainly concern agricultural land within the narrow alluvial valley. This occurs mainly along the Shabelle in the Hiran region. While flooding occurs every year, including in dry and normal years, the damage caused by this type of flooding is only significant in wet years because of the prolonged duration of the flood, which delays planting or affects crop growth.
b) Parts of the Shabelle valley in the Hiran region are flooded because of bank overtopping or because embankments are breached. Flood waters cannot return to the main river and gradually seep downstream in the alluvial zone adjacent to the river. Water is trapped in low lying areas, where it causes prolonged inundations and only slowly recedes.
c) Flooding of Beledweyne city—with a population of over 250,000—has become a regular event. Some 80% of the city was affected in 2019, with inundations lasting for several weeks and causing widespread disruption and damage. Anecdotal evidence suggests an increase in the frequency and extent of flooding of Beledweyne, although community-led interventions in 2020 have prevented flooding in the first half of 2021.
d) Widespread flooding in Middle Shabelle in the area around Jowhar. Bank overtopping in the alluvial valley causes flows in the Shabelle channel to decrease from 160 to 100 m3/s and inundates adjacent areas. Periodic flooding leads to extensive damage to agriculture and closing of critical infrastructure such as the Beledweyne-Jowhar-Mogadishu highway and Jowhar airport. Inundations can last for several weeks and disrupt the local road system and transport network. Flooding in this region happens every year—including in drought and normal years—but the inundated area is larger in wet years, causing widespread displacement of the local population. During this period, farmers cannot access markets or procure agricultural inputs, and schools and public infrastructure are closed. Flooding of pit-latrines causes the spread of water-borne diseases and contamination of water sources, while standing water increases the occurrence of malaria. Increased flood damage is partly attributed to uncontrolled settlements in the floodplain.
e) Flooding of agricultural lands in the respective irrigation schemes. Implications are similar to d).
f) Incidental flooding near the Juba-Shabelle confluence. This only occurs during years with exceptional high flows.

5.3 Principal Flood Mechanisms in Shabelle

The above-mentioned flood events in the Shabelle basin are caused by a combination of factors. Figure 5.2 presents an inventory of potential flood mechanisms. While most factors amplify peak flow, others decrease the intensity of flood events. Each factor will be discussed in the below text.

Figure 5.2: Inventory of flood mechanisms in the Shabelle basin in Somalia



1) More intense rainfall because of climate change

2) Local geological conditions at Mustahil in Ethiopia reduce the capacity of the high flow channel, which attenuates flood flows in downstream Shabelle

3) Riverbed aggradation because of siltation and dumping of solid waste

4) Land degradation amplifies the runoff response to a rain event, causing incised channels and higher peak flow in local streams

5) Embankment breakage (unintentional and deliberate)

6) No storage capacity to capture flood peak; Jowhar off-stream storage not operational

7) Dysfunctional flood release canal

8) Uncoordinated operation of the barrage system

9) Many parallel ephemeral streams reach peak flow at the same time

10) Back-water effect at Shabelle-Juba confluence

Source: (source for historic maximum flood extent: EU Global Surface Water – Dataset 1984-2019)

Mechanism 1: More intense rainfall because of climate change

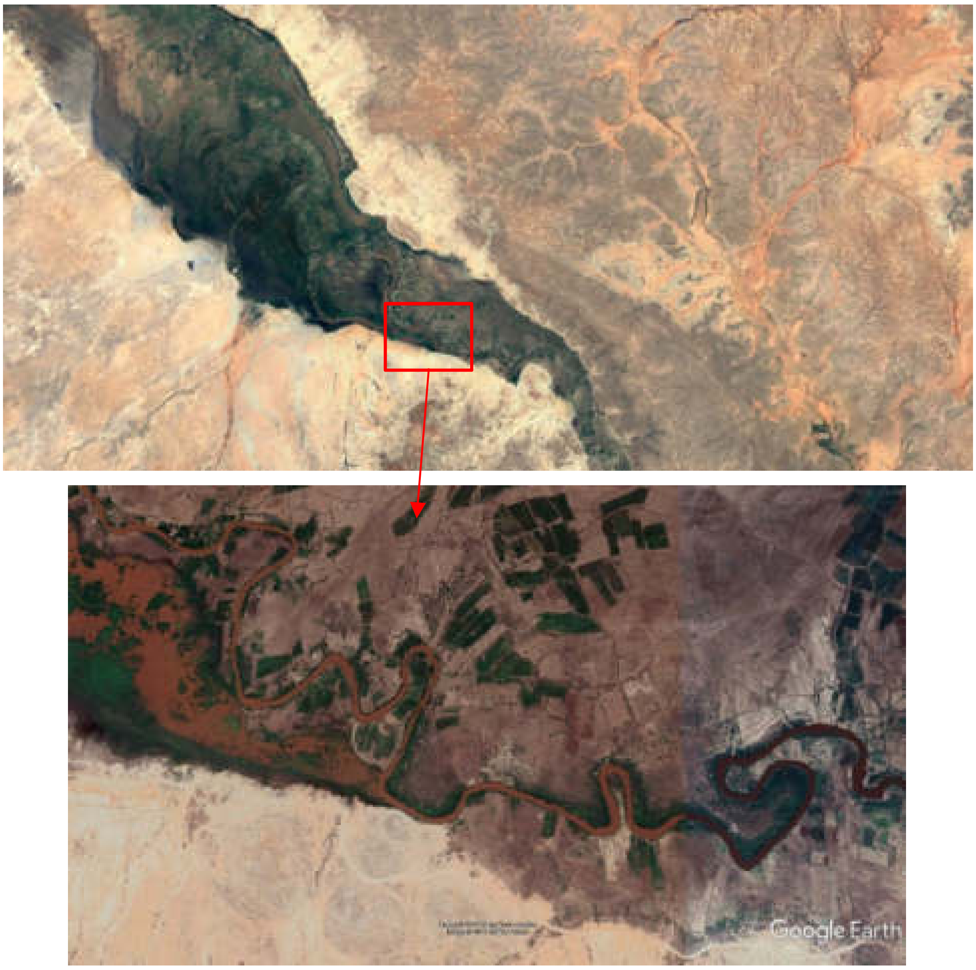
Recent climate projections (IPCC, 2018) predict that the Horn of Africa is subject to a warming and more variable climate. The main climate impacts are manifested in 1) increased aridity, 2) higher temperatures, 3) more frequent and more severe flooding, 4) more frequent and more intense droughts, and 5) higher variability of rainfall and associated streamflow.

Given the uncertainties associated with the climate models - specifically at more local scales - it is not meaningful for a basin diagnostic to attempt to quantify the range of future flooding events caused by climate change. For now, we conclude that the extent of future climate change in the Horn of Africa is yet unclear but that future flood events will probably intensify.

Mechanism 2: Local geological conditions at Mustahil in Ethiopia reduce the capacity of the high-flow channel

Figure 5.3 shows a confined channel at Mustahil some 40 km of the Ethiopian-Somalian border.

Figure 5.3: Confined channel at Mustahil



Source: Google Earth image of Mustahil (Lat = 5.239, Lon = 44.683)

Local geological conditions at Mustahil have confined the Shabelle river to a single narrow channel without a floodplain. The hydraulic capacity of the river for high flows is therefore reduced and causes the water surface to back-up towards the upstream during floods. This has created an upstream alluvial area some 50 km in length and 10 km in width in Ethiopia. This backwater zone inundates during floods and captures the flood wave, attenuating the downstream hydrological regime of river Shabelle.

<u>Mechanism 3</u>: Riverbed aggradation

The Shabelle in Somalia is subject to gradual riverbed aggradation caused by erosion in the upstream catchments that lead to a high sediment load in the river. Sediment loads are probably increasing because of land-use changes and more intense rain events caused by climate change.

A rising riverbed decreases the hydraulic capacity of the channel and leads to more frequent bank spill. In urban areas, this situation is exacerbated by massive dumping of solid waste in the channel, which further reduces the bank-full capacity of the river. In the low-lying areas around Jowhar, bed aggradation has caused inverse topography where the channel is now above the surrounding land.

Bed aggradation is also reducing the free board of bridges and hydraulic structures, increasing the risk of blockages through debris, which further reduces channel capacity. For instance, Jowhar bridge is now occasionally submerged

The rising riverbed in the main river also result in flooding at the confluence with tributaries. Higher water levels in the main river will cause back-water effect in the tributary—which will extent some way upstream from the confluence—that typically result in inundation of the adjacent low-lying areas. Thus, bed aggradation in Shabelle amplifies flooding along tributaries.

Box 5.1: Case study of Beledweyne

Regular flooding of Beledweyne is caused by a combination of factors:

1. Embankments in and upstream of Beledweyne have not been properly maintained and are (very) low.
2. Floodwaters that spill over the embankment (in combination with man-made breaches) upstream of Beledweyne—on occasion many kilometers upstream of the town—cannot return to the river and are trapped in low-lying (urban) areas; note that the Hiran Development Program in collaboration with community-led initiatives has constructed flood protection works in 2020 (fig 5.4 & 5.5), which so far have prevented flooding in 2021.
3. Bed aggradation caused by siltation has reduced the hydraulic capacity of the channel. This is further aggravated by dumping of solid waste into the riverbed. The maximum holding capacity of the Shabelle channel in Beledweyne is now regularly exceeded.
4. Long-term deterioration of the flood release canal and intake structure that would channel part of the floodwaters to a point downstream of Beledweyne (fig 5.6 & 5.7). It is noted that part of the canal was rehabilitated in 2020 through community-led initiatives.

Uncontrolled urban development and encroachment in flood prone riparian areas increases the risk of the population living in these areas. Moreover, encroachment on riparian areas does not leave sufficient space to build flood protection works.

Figure 5.4: Dike (in combination with a road) constructed perpendicular to the Shabelle upstream of Beledweyne

The dike is blocking lateral flow of floodwaters that are outside the main channel; water would otherwise have been trapped in low-lying urban areas in Beledweyne (the dike as been constructed by the Hiran Development Program in collaboration with community-led initiatives).

Figure 5.5: Flood retention walls upstream of Beledweyne (constructed by Hiran Development Program in collaboration with community-led initiatives)

Figure 5.6: Silted flood release canal in Beledweyne & associated flooding of agricultural land

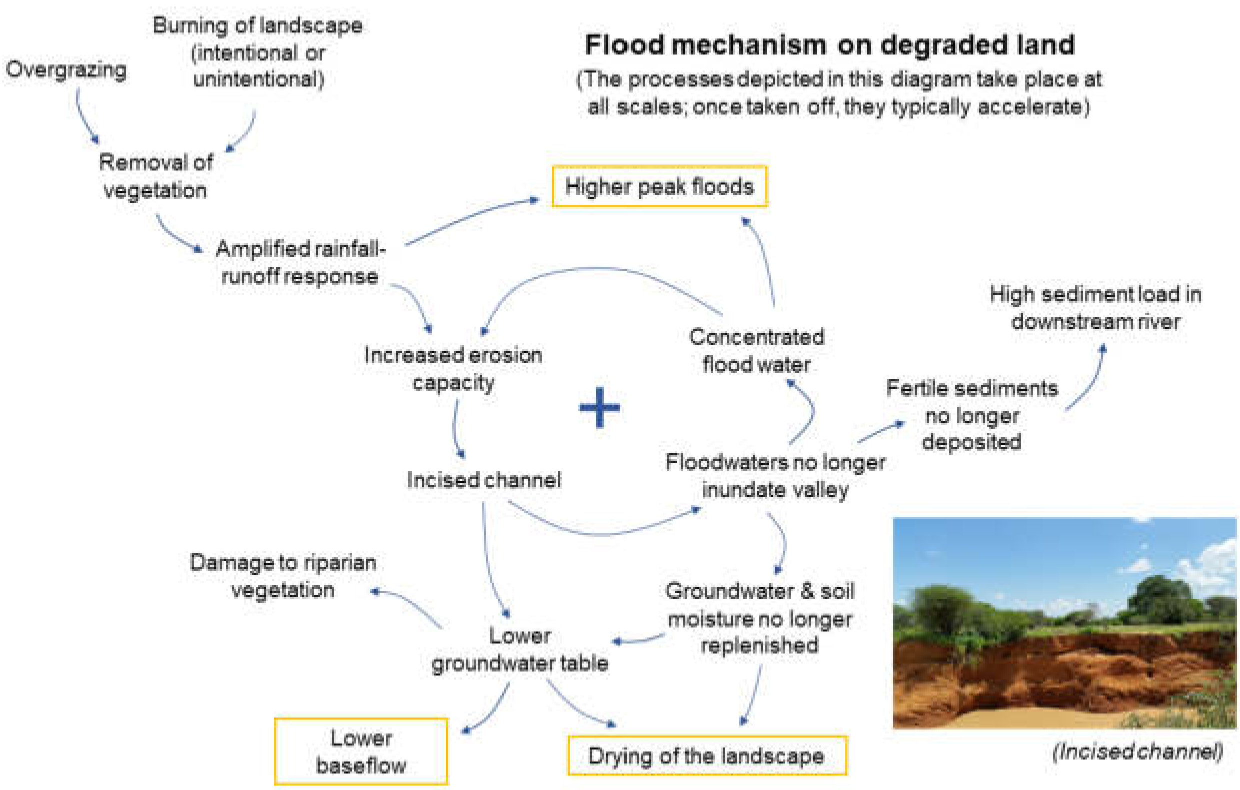
Figure 5.7: Intake structure for the flood by-pass in Beledweyne requiring maintenance, before the partial rehabilitation in 2020

Mechanism 4: Higher flood peak on degraded land

Large parts of the Shabelle basin are subject to land degradation because of overgrazing, bush fires, inappropriate agricultural practices, or desertification. Removal of vegetation amplifies the runoff response to a rain event, and therefore increases the sediment transport of the stream. For tributaries with adequate slope, i.e., those in the middle and upper reaches of the Shabelle basin, increased runoff velocity will cause the tributary's channel to erode. Consequently, floodwaters will concentrate in the incised channel and stop inundating the adjacent lands. As a result, groundwater and soil moisture are no longer replenished, and fertile sediments no longer deposited. In addition, incised channels lower the groundwater table and progressively dry-out the productive alluvial valleys. Since rain falling on dry soils will percolate much slower, run-off from the riparian area into the river will be accelerated and thus flood peaks from heavy rain events will increase. The processes described above are presented in fig 5.8 and take place at all scales. Once taken off, they typically accelerate.

Mechanism 5: Embankment breakage

Figure 5.8: Flood mechanism caused by land degradation



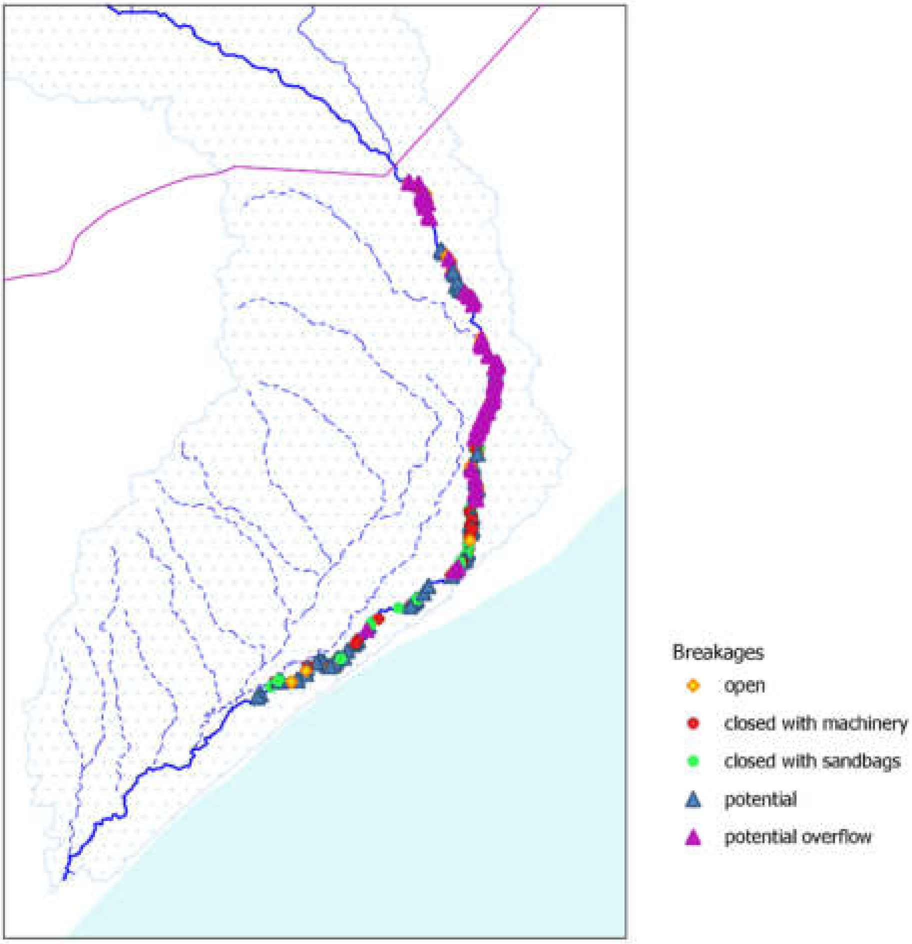
Flood control embankments have been constructed to protect low-lying areas along the Shabelle. Most embankments are low (0.5 to 1.5m). However, maintenance and repairs of these embankments are minimal to non-existent.

Frequent breakage of embankments occurs along the Shabelle (fig 5.9 and 5.10). This is caused by bank spill or because levees are not properly maintained and in bad state. In addition, embankments are often deliberately breached in the low-flow season for farmers to access scarce water for irrigation needs (fig 5.11), predominantly for sesame fields. Since many breaches are not repaired and remain open, they cause uncontrolled flooding in the subsequent high flow season(s). The extent and duration of this uncontrolled flooding of agricultural land depends on the Shabelle flood regime, which varies from year to year. In wet years, inundations can last for weeks or even months. Note that most irrigated farms benefit from the moisture left in the soil provided the inundation does not last too long and does not prevent planting.

Embankments that are repaired are commonly cut again to access irrigation water for adjacent fields. Constructing gates would remedy this situation (fig 5.12), specifically when combined with higher embankments.

An excerpt from the main report of the Genale-Bulo Marerta Project (1978) states that "in parts of the study area the river is on a levee and there is a risk of flooding. However, the damage caused by flooding is reduced because the riverbanks are very stable and do not erode easily under low flows. Over the years flood banks have slowly been built up so that when the river overtops its banks in one area it is near to bank top along the whole length from Jowhar to Falkeerow. Thus, a further slight increase in level leads to overtopping elsewhere with the result that the river levels are self-regulating, and it appears that the river rarely overtops its banks by more than 0.1 m. In consequence, erosion of the banks is rare and flooding in the study area can often be avoided by an additional low bund where bank levels are low". Hence, flood damage will be severely reduced if embankment breakage is prevented.

Figure 5.9: Breakages of Shabelle levees – Aug 2019



Source: FAO SWALIM (https://spatial.faoswalim.org/layers)

Figure 5.10: Embankment breach in May 2021

Figure 5.11: Deliberate embankment breach for irrigation purposes

Figure 5.12: Small irrigation channel equipped with a gate

<u>Mechanism 6</u>: No storage capacity to capture the flood-peak

Apart from the Melka Wakana storage reservoir (Lat= 7.172, Lon = 39.436) in the upstream reach of river Wabe Shebelle in Ethiopia, there is no active storage capacity in the Shabelle system that can capture the flood wave. Melka Wakana has a reported life storage capacity of 763 mcm and is predominantly used for hydropower production. Current reservoir functions do not include flood control and management of the reservoir is not coordinated with Somalia.

In the Somali part of the basin, the Jowhar Off-stream Storage Reservoir (JOSR) was constructed in the 1980s with a capacity of 200 mcm (fig 5.13). JOSR is currently not operational because 1) Sabuun barrage, which serves as intake structure, is damaged, 2) the intake canal is silted, and 3) the reservoir is silted. Some limited rehabilitation works have been implemented in recent years (with Turkish funding). Nevertheless, JOSR is still not operational. The reservoir is located in an economically important area.

The proposed Duduble Off-stream Storage Reservoir—with an intended capacity of 130 mcm—was never completed, only the Duduble flood relief canal, that was intended to divert water into the storage reservoirs has been constructed (see below).

<u>Mechanism 7</u>: Silted flood release canal

The Duduble flood relief canal upstream of Sabuun barrage was constructed in order to redirect Shabelle floodwaters to abandoned downstream river channels (5.13). As construction was funded by the Chinese Government,the canal is therefore often referred to as “the Chinese Canal”.

Flood waters would be released into Duduble only after JOSR had filled completely while water levels at Beledweyne were still high. Sabuun barrage served to create adequate head to direct flow into the canal. The barrage is no longer operational because the steel gates have been removed (fig 5.14). Head created by wooden debris—as pictured in fig 5.14—is inadequate and inflexible.

In addition, Duduble canal is silted. While Al Mizan (see page 61) has undertaken some desiltation works in 2020, the canal bottom has not yet reached its original design level and Duduble is unable to perform its flood release function. Figure 5.13 shows that little water reaches the outlet of the canal. Moreover, extensive irrigated areas have been developed on both sides of the canal and Duduble currently doubles as an irrigation canal, which conflicts with its flood release function.

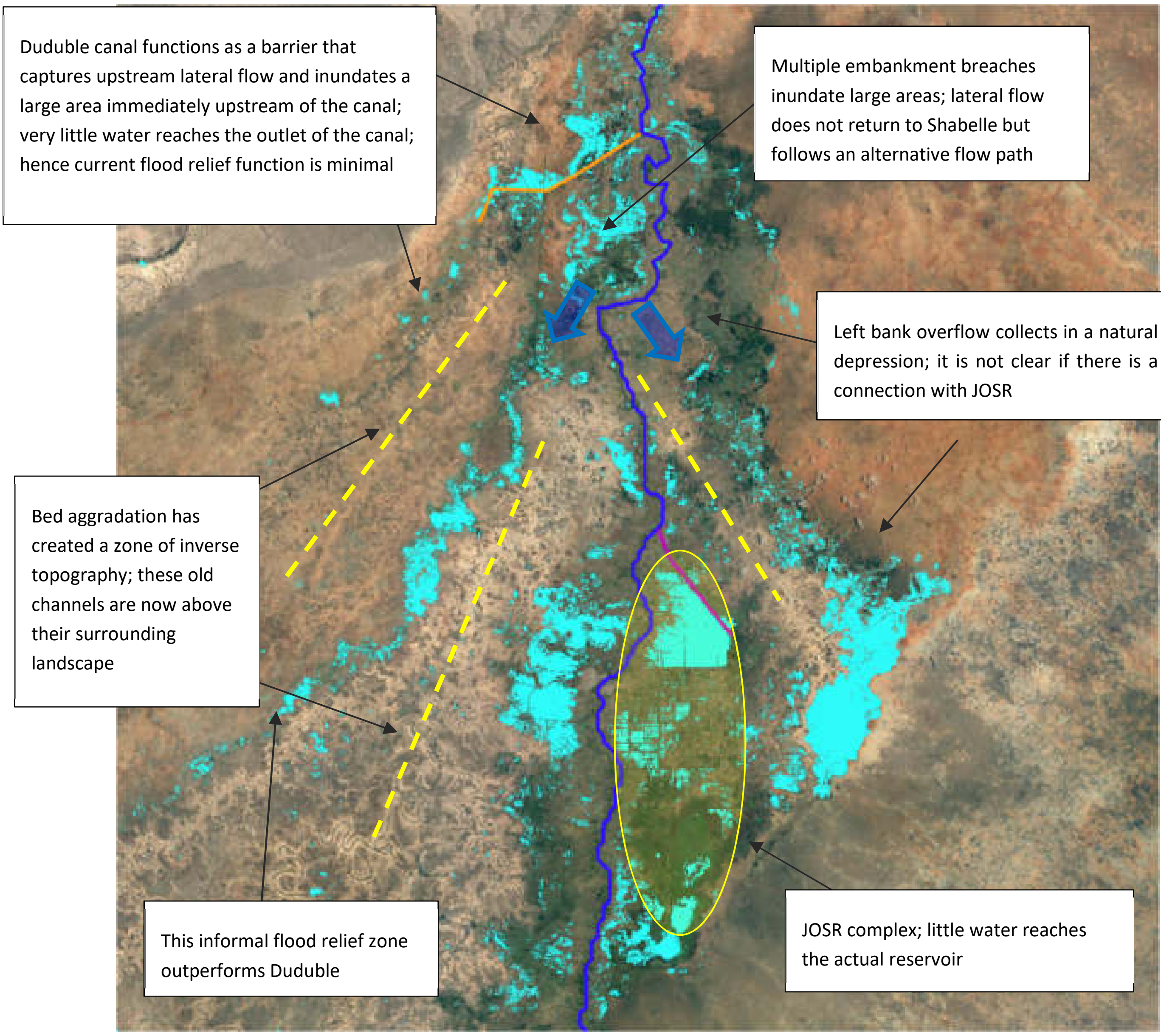
Duduble was also intended to supply water to agro-pastoralists and farming communities between Jowhar and Wanla Weyne. It is noted that the oxbow lakes in the downstream abandoned river channels could serve to store released flood waters, which would gradually infiltrate and could be used for agricultural activities. It is probable that these former riverbeds consist of highly pervious formations allowing for fast infiltration.

The area around Jowhar is very flat. Bed aggradation has created inverse topography in which the river channel is above the surrounding area. Water spilled over the embankment, therefore, cannot return to the main river and is trapped, prolonging the duration of the flood. Figure 5.13 shows that Duduble canal effectively doubles as a barrier that traps lateral flow of water that has spilled over the riverbanks in the upstream Shabelle reach. Duduble canal therefore prolongs inundation of the land upstream of the canal.

In addition to Duduble canal, Dhamme Yaassin and Primo Secondario canals were also used for flood relief purposes in the past when the Shabelle waters were high. Flood waters would pass into the abandoned river channels at the tail of the irrigation schemes. Hence rehabilitation of Dhamme Yaassin and Primo Secondario will reduce flooding in the downstream areas.

The effectiveness of the original flood relief system—which consisted of JOSR, Duduble canal, and the large primary irrigation canals—is illustrated by the fact that flooding before 1991 was much less severe than it is right now, in terms of inundated area and duration.

Figure 5.13: Flood mechanisms in Middle Shabelle



Box 5.2: Two-dimensional Hydraulic Model of the Jowhar area

The Shabelle River Initiative developed a two-dimensional hydraulic model (HEC RAS) for the Shabelle river reach from Beledweyne to Jowhar. Because of the inverse topography in this region—where the channel is above the surrounding land—flood waters that have escaped the channel cannot return and flow parallel to the river in north-south direction. They inundate large areas including urban centers such as Jowhar. The model, therefore, not only covers the Shabelle channel but also the wide alluvial zone.

Screenshot of the model for an area just upstream of Jowhar

A complete spatial dataset of the study area could only be prepared by combining various data sources. The level of detail in the model, therefore, varies per location as a function of the available elevation data. Input from residents and farmers was used to refine the model and add detail at key locations, specifically near irrigation canals and major infrastructure elements.

The model highlights flooded areas and shows how inundations progress after a breakout occurs. The objective of the model is to work with residents and farmers and provide them with the necessary tools to identify hazards and protect their families and livelihood.

Subset model near Sabuun Barrage to review the flow distribution around the structure

The model was developed by Guled Ahmed (gahmed60@gmail.com) and Hussein Amiin (hhamiin65@gmail.com), who jointly founded the Shabelle River Initiative.

Figure 5.14: Sabuun barrage; without steel gates, water levels are controlled by wooden debris

Mechanism 8: Uncoordinated operation of the barrage system

Nine barrages in the Middle and Lower Shabelle regulate river flow and upstream water levels (table 6.1 and figure 3.3). Most require maintenance and repairs. Sluice gates that are stuck cause upstream flooding and sedimentation. Operating rules—if any—focus on securing water supply for individual irrigation schemes without considering flood mitigation in the upstream reaches. There is presently no mechanism or institution for coordinated operation of the barrage system.

Untimely closure of sluice gates—i.e. during peak flows—further aggravate upstream bank overtopping and inundation. It is noted, however, that flooding in the lower reach of Shabelle is quite limited (5.1).

Mechanism 9: Many parallel ephemeral streams in Bakool and Bay regions

The drainage system in Bakool and Bay regions is characterized by many parallel ephemeral streams of approximately similar length and slope that join a parallel tributary of the main river (fig 5.2). In the event of rainfall over the entire region, all streams reach peak flow at roughly the same time. This could lead to flooding along the main tributary and at the point where this tributary joins the main river. Flow in the ephemeral streams is very flashy, however, no serious inundation events have been reported in Bakool and Bay (fig 5.1).

Mechanism 10: Backwater effect at the Juba-Shabelle confluence

The Shabelle contributes to the Juba River only in exceptional flood years. In this case, high Juba levels hold back Shabelle flows and cause back water effect and inundation in the area immediate upstream of the Juba-Shabelle confluence (fig 5.2). However, this happens only on rare occasions.

Box 5.3: Inundations in urban areas

Flash floods have been reported in built-up areas in the riparian zone that are caused by local rainfall and runoff from small streams that collects in local depressions. The extent of this flooding in the low-lying urban areas in Jowhar, Beledweyne, Afgoye and other towns in this zone is limited but it causes damage to homes and infrastructure and could lead to health risks.

Flood protection measures for this type of flooding are local and need to be reviewed on a case-by-case basis. It could include improved drainage or land regulations that prevent permanent settlements in areas prone to inundation.

5.4 Flood Analysis

Flood analysis of natural rivers—and the Shabelle in particular—is difficult for several reasons:

- Flood analysis is based on the statistics of extreme events. But extreme floods are rare, and it requires at least 50 years of good quality streamflow data to fit a probability distribution. A complete 50-year data record for the Shabelle at Beledweyne is not available.
- Moreover, measurement of the actual flood is difficult and almost always inaccurate. Because of bed aggradation and bank-spill, the rating curve for the Shabelle at Beledweyne is probably incorrect. Thus, the historical extremes in the flow record are most probably incorrect—and possibly by a wide margin.
- The rainfall-runoff mechanism in the upstream basin that has produced the historic flood has probably changed due to land-use changes. Since these changes continue historic distribution of extreme events does not represent the future distribution of extreme events.
- Climate change will change the intensity of extreme rain events—and probably also land-cover and rainfall-runoff mechanism. With more extreme rain, the likelihood of extreme flood events increases. It reinforces the observation that the historic distribution of flood events does not represent the future. It is likely that future flood events will be more frequent and severe.

In the Shabelle basin, quantitative flood hydrology is further complicated by numerous embankment breakages and bank over-toppings, inverse topography, and the uncoordinated operation of the nine barrages and the flood release canal.

Therefore, it is unlikely that flood control in Shabelle basin can be based on a comprehensive understanding of the hydrological and hydraulic processes. Since it is improbable that flooding can be fully prevented, a more practical approach is to focus on preventing expensive flood damage.

5.5 Preliminary policy implications

Floods are a recurrent event and a waste of scarce water resources. However, there are several measures that can be taken to address flood risks.

Flooding of urban areas can be addressed in principle by a combination of civil works, by-pass canals, management of solid waste that is otherwise dumped in the river channel, and regulations to prevent building in the floodplain. Flood prevention of urban areas, therefore, depends on investments and land management and can be addressed. The main challenge is fund mobilization for the required investments.

Addressing the recurrent inundation of the low-lying area around Jowhar is more difficult. Floods in this zone have a negative impact on crop yields and agricultural production, damage critical infrastructure and buildings, temporarily cut the road network, and lead to health hazards. Furthermore, it results in a waste of water that cannot be used for other productive purposes or during the dry season. However, no loss of life has been reported.

Practical measures to prevent recurrent floods in this region include rehabilitating JOSR, rehabilitating Duduble flood relief canal and channelling the floodwaters to the downstream abandoned river channels, repairing and strengthening river embankments, and equipping these levees with off-take structures for irrigation. This would eliminate the need for farmers to cut embankments in the dry season to irrigate their fields. What is critical is that excess floodwaters are either stored or channelled to groundwater recharge areas. Just letting floodwaters evaporate is a waste of scarce resources that the Shabelle system cannot afford.

It is noted that flood control in Somalia could possibly benefit from additional reservoirs in Ethiopia that would be able to capture part of the flood-wave, provided these reservoirs are used for non-consumptive water use only, such as hydropower production, and are filled by following a filling regime that takes account of downstream water needs. In this regard, it is noted that flooding has also been recognized as a water related hazard along the Shabelle in Ethiopia.

Flash floods outside the riparian zone are a recurrent phenomenon that can be addressed by diverse soil and water conservation measures in combination with check and sand-dams. The above measures have the additional benefit of storing floodwaters for use at a later point in time. This topic is discussed in detail in Chapter 7.

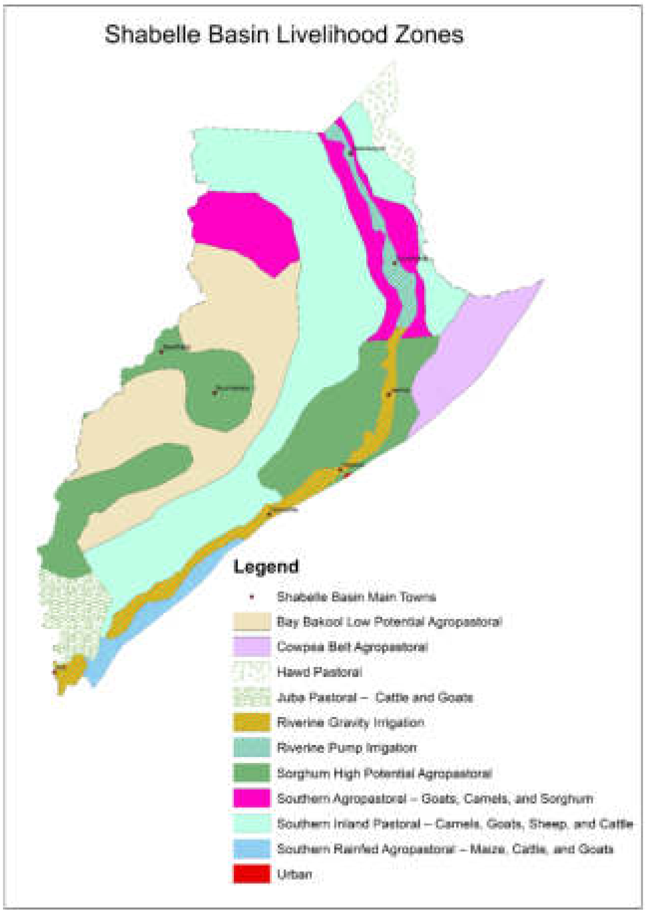
6. Irrigation in the Shabelle basin

6.1 Introduction

The Shabelle Basin in Somalia is characterized by irrigated and rainfed agriculture along the Shabelle River riparian area, whereas agropastoralist livelihoods dominate in the immediate neighborhood of the riparian area, and pastoralism further away from the riparian area.

Irrigated agriculture in the Shabelle basin in Somalia is concentrated in the alluvial zone on both sides of the river (fig 6.1). Average annual precipitation in the alluvial zone is below 400 mm (fig 2.2) while potential evapotranspiration exceeds 2000 mm per year (see section 2.3). There is no rainfall in the period from January to March. Under these conditions, irrigation is a precondition for high-yield agriculture. Main crops include maize, sesame, sugar cane, and vegetables.

Figure 6.1: Livelihood zones in the Shabelle basin



Source, FSNAU – FEWS NET

In spite of using most of the Shabelle waters, yields in irrigated agriculture in the basin are stubbornly low. The very high yield-gap is even more obvious when comparing yields in the Shabelle with yields in gravity irrigation systems with similar soil and climate conditions, such as the Nile delta and Nile valley. This chapter examines the reasons for the underperformance of irrigated agriculture in the basin.

The chapter starts with a brief description of irrigation in the Shabelle basin before the civil war. It follows with a detailed analysis of current irrigation. A causal diagram identifies constraining factors and could be used to identify potential interventions. The chapter continues with a discussion of an effective public-private-partnership (PPP) arrangement in the Shabelle basin that aims to improve the performance of irrigated agriculture. It concludes with a discussion of a set of preliminary p policy measures and their implications.

6.2 Pre-War Status of Irrigation in the Shabelle Basin

Since the 1920s irrigation schemes have been developed on the Shabelle in Somalia. There were two major types of water delivery: 1) flood recession (deshek) cultivation caused by riverbank overtopping, and 2) irrigated agricultural systems (pump or gravity supplied) based on a limited number of gravity-fed river intakes (FAO SWALIM 2007). A total of 9 barrages (fig. 6.2 and table 6.1) controlled water intake into a system of primary canals. In addition, some small (private) canal systems originated directly from the river. The primary canals were designed to have enough head to reach fields through a complex system of secondary, tertiary, and quaternary canals.

Figure 6.2: Location of barrages in the Shabelle basin

Table 6.1: Barrages in the Shabelle basin

ID	Name	Command Area [ha]	Latitude	Longitude	Year of Establishment
1	Saabuun	50942	2.8871	45.5435	1970
2	Balcad	10000	2.3428	45.3807	1967
3	Janaale	67440	1.8079	44.6886	1927
4	Mashallaay	27000	1.7446	44.5981	1986
5	Qoryooley	26800	1.7818	44.5355	1955
6	Falkeerow	4120	1.7554	44.4806	1955
7	Kuntunwaarey	5000	1.6512	44.3036	1986
8	Sablale	940	1.2907	43.8049	1970
9	Haaway	3000	1.1633	43.7172	1970

FAO SWALIM (2007) reported that nearly 90% of the schemes were operational before the civil war broke out in 1991, although the area under actual irrigation was smaller than the command area. Exact figures of the total area under controlled and flood irrigation before the civil war are not available. A total of 140 large farms dominated irrigated agriculture with only a limited area allocated to smallholders. The main crops grown included sesame, maize, sugarcane, and vegetables.

Irrigation scheduling and management of the barrage system were under the overall supervision of the Land and Water Department in the Ministry of Agriculture. Commercial concessions for bananas and sugarcane growing and processing were considered private investments and were therefore managed and administered privately (FAO SWALIM 2007).

6.3 An Analysis of Underperforming Irrigation in the Shabelle Basin in Somalia

Current Status of Irrigated Agriculture in the Shabelle Basin in Somalia

After many years of civil insecurity and unrest, large parts of the original irrigation schemes in the Shabelle basin in Somalia collapsed. A report by FAO SWALIM (2007) observes:

- None of the 9 barrages used for regulating water for irrigation is currently fully operational. All require major rehabilitation work because gates are stuck, embedded in mud, or have disappeared, while lifting gears are broken.
- Because of poor maintenance and siltation, the capacity of most canals to supply water to the irrigation fields has substantially decreased. Some canals are completely silted or overgrown with vegetation. Where water delivery has failed, fields have been abandoned, mostly at the tail-end of the former irrigation schemes.
- Thus, the former irrigation schemes are either only partially operational or not operational at all
  Less than 50% of what existed before the break-out of war is currently operational.
- However, many new canals have been developed outside the former irrigation schemes.

- Because of the breakdown in water delivery, farmers have deliberately cut embankments along the Shabelle to irrigate their fields, which has led to widespread flooding and is among the principal causes of low yields.

Since the SWALIM study in 2007, some canals and water distribution structures have been rehabilitated. However, the quality of the repair works is generally insufficient and the canal system continues to be only partly operational.

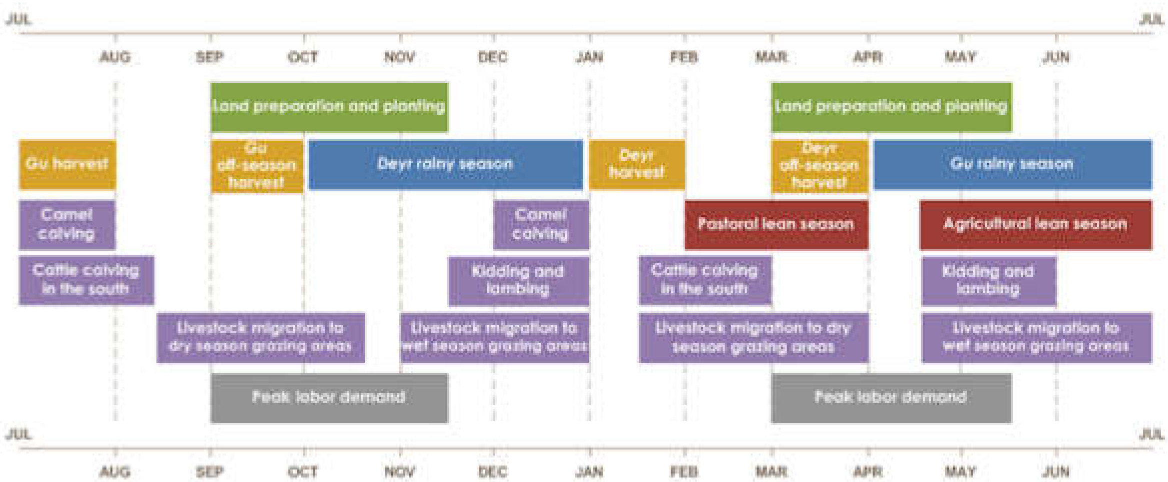
The irrigation in the Shabelle alluvial zone is comprised of commercial irrigated farming and subsistence small scale irrigated farming, which often also rear a limited number of livestock units, mainly cattle, sheep, and goats. Irrigation in the Hiran Region riparian area is mainly pump fed with limited gravity fed irrigation, while irrigation in Middle and Lower Shabelle is mainly gravity fed with few areas of pump fed irrigation. Main crops grown differ with region, district, and locality, mainly being driven by resources available to the farmer, size of farm and proximity to the market Main crops include maize, sesame, sugar cane, and vegetables. Perennial crops such as bananas and papaya, as well as tree crops (citrus, mango, among others)—which are exported and potentially profitable—are irrigated with groundwater. It is noted that few farmers maintain banana fields in the dry season. The major crops grown in the different regions in the Shabelle basin are given in the Annex

The irrigated areas are now fragmented into a patchwork of small systems in the former command areas and new schemes developed elsewhere in the riparian zone. Water delivery is on a 'first come, first serve' basis and is hardly coordinated among schemes, which is risky for downstream water users. Small-holders have continued cultivating the most resilient parts of the former large estates. They have organized local mechanisms to clear and maintain canals, and regulate water delivery within the schemes. It has to be noted that these farmers have no official land rights and that land tenure of the former estates is unclear. Nevertheless, a farmers-class with attachment to the land is gradually emerging.

The absence of reliable information on the current extent of irrigated agriculture in the basin is a complicating factor in managing the Shabelle waters. Similarly, there are no accurate data on total water use and water demand.

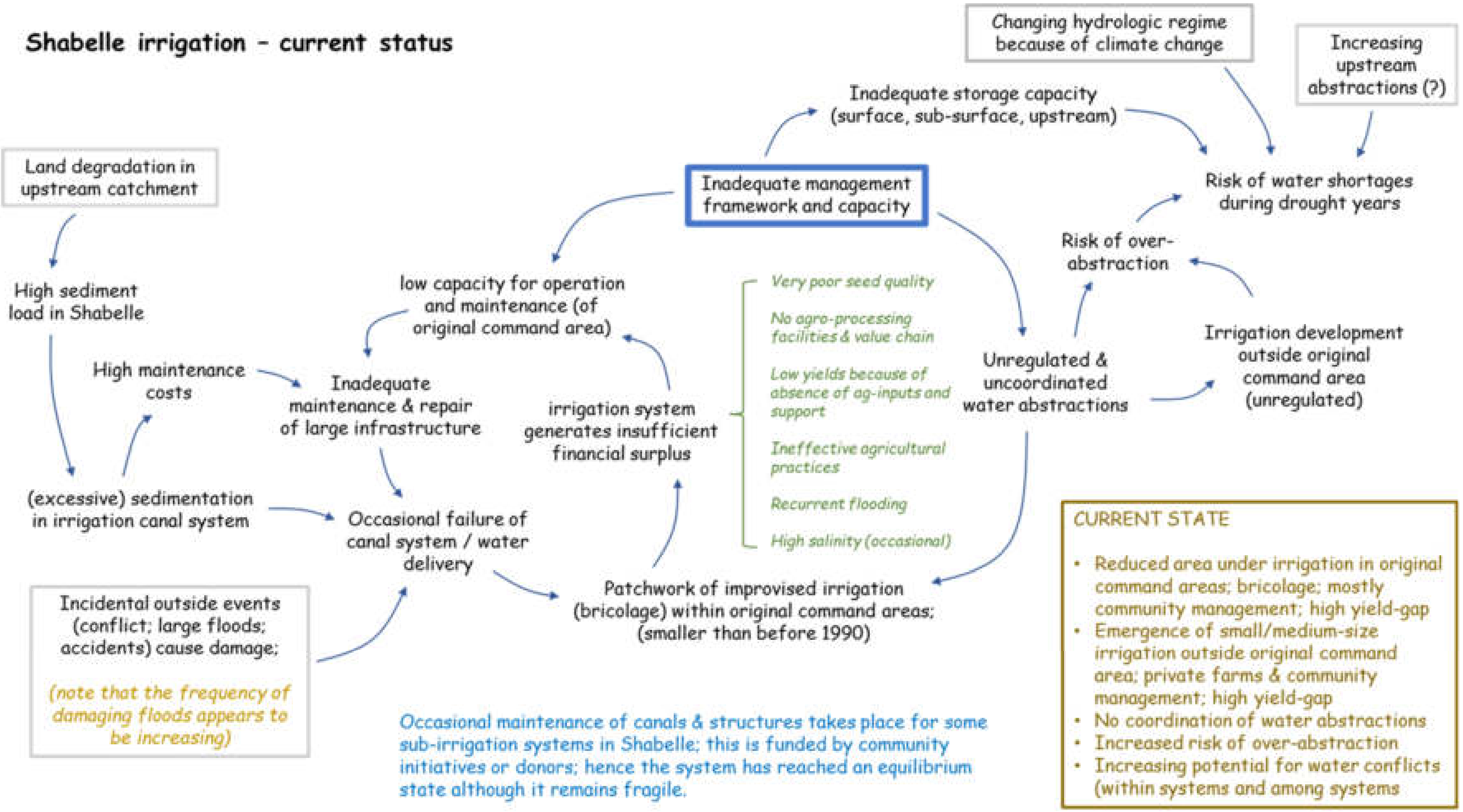
Figure 6.3 shows the general cropping and agricultural calendar for Shabelle in Somalia while Annex 6A presents the principal farming systems in the riparian zone.

Figure 6.3: General seasonal cropping calendar for Shabelle in Somalia



Source: FEWS NET SOMALIA (https://fews.net/east-africa/somalia)

Figure 6.4: Causal diagram describing current irrigation in Shabelle in Somalia



Analysis of issues and causal relationships in irrigated agriculture

Irrigated agriculture in the riparian zone in the Shabelle basin in Somalia involves many variables (including, for example, water availability, siltation issues, governance, or seed quality) and is complex. Increasing the understanding of this highly complex system requires a systematic approach. To this end, fig 6.4 presents a causal diagram that conceptualizes and visualizes the cause-effect structure of the irrigation system in the Shabelle in Somalia. The diagrams aims to serve as a basis for identifying analyzing intervention options, but also makes it easier to communicate the system dynamics in a structured manner. Figure 6.4 is further explained in the below text.

Land Degradation in Upstream Catchments

1. Land degradation in upstream catchments causes erosion and leads to high sediment load in the Shabelle.
2. The high suspended sediment load causes siltation in the irrigation canal system and blocks water control structures. Periodic removal of silt is required.
3. Removal of silt from primary and secondary canals (and sometimes large tertiary canals) requires mechanical equipment such as an excavator. The removal of silt from tertiary, quaternary, and quinary canals is organized by farmer communities and can be achieved with manual labor.
4. Mechanical removal of silt is expensive. In the pre-civil war era, it used up a substantial share of the annual budget for the irrigation scheme. Data from similar irrigation schemes—such as the Gazira scheme in Sudan—suggests that this can reach up to 50% of the annual budget for operation and maintenance.

Weak Local Government

5. The federal government is not involved in managing irrigation schemes, while state level and local governments have limited capacity for operation and maintenance of the large irrigation schemes. Many large irrigation infrastructure elements—such as main and secondary canals, as well as off-take and diversion structures—silt regularly and gradually deteriorate. Some have completely silted.
6. None of the nine barrages on the Shabelle river have been properly maintained. The barrage system, therefore, is no longer able to perform its primary function of raising river levels—in a synchronized manner—to create adequate head for gravity irrigation. Furthermore, a centralized irrigation authority to manage the barrage system no longer exists.

Occasional Failure of Water Delivery

7. Consequently, the centralized gravity irrigation schemes—which were developed around the 9 barrages and involved a dendritic network of primary, secondary, tertiary, and quaternary canals—has become subject to cascading failure of water delivery. The centralized system is fragile by design since the failure of one infrastructure element leads to insecure water delivery for the entire downstream section.

Community Arrangements

8. However, community arrangements—organized by direct stakeholders—have emerged in many places for maintenance, operation, and repair of individual elements of the irrigation system.
9. Further, some large canals have been cleaned—with funding from international donors, or through private or community initiatives. Where gravity flow is not possible, pumps have been installed. However, neither central nor local government actors are involved in these efforts.
10. This has resulted in a patchwork of improvised irrigation schemes using elements of the former irrigation system combined with new offtake canals. These schemes are managed by

communities. A few large farms still exist. Although this setup is sometimes referred to as 'bricolage', it exhibits inherent resilience.

New Investments

11. In recent years, new investments—often with money from the diaspora—are gradually expanding the irrigated area inside and outside the former command areas.
12. Nevertheless, the total area under irrigation (in the original command area) today is smaller than before 1990.

An Emerging Smallholder Farmers Class

13. With most of the former large farms taken over by local communities, a smallholder farmer class with attachment to the land is emerging in the Middle and Lower Shabelle.
14. However, land tenure in these community irrigation schemes is complicated and undefined. Most smallholder farmers have no formal land title. Many farmers fear that the establishment of formal governance institutions and could compromise their current (implicit) land claims.

Very Low Yields

15. With some exceptions, crop yields are generally low—despite secure water supply in most years apart from severe drought years. This is caused by the absence of extension services and the unavailability of agricultural inputs such as fertilizer and pesticides. In addition, mechanized land preparation is rare.
16. In addition, poor quality seeds are among the principal causes of low yields. High quality seeds are generally not available and there is limited awareness of farmers of the importance of maintaining seed quality.
17. High salinity of the Shabelle in the first two weeks of the Gu season adversely affects crop growth.
18. Consequently, the yield gap is very high; for instance, anecdotal evidence suggests that a good yield of maize in the Shabelle basin is ususally below 2 ton/ha (compared to a potential yield of 5 ton/ha or more as obtained in irrigation schemes with similar conditions, such as the Nile Delta).

Flooding

19. Inundation of cultivated areas because of floods—which can last for weeks or even months—can also lead to crop failure or low yields because of delayed planting or crop damage.

No Value Chain

20. Agro-processing facilities are inadequate or have been destroyed—such as the sugar mill at Jowhar. Consequently, value addition of agricultural produce is low. Similarly, returns on export commodities such as sesame, bananas, and lemons are negatively affected by non-tariff trade barriers such as phytosanitary requirements. Food aid lowers farm-gate prices and compromises the economic viability of agricultural production.
21. Periodic flooding damages the road network within the irrigation areas and disrupts the transport system. It cuts off market access for farmers, herewith reducing the price for their produce. Further, it increases the costs for inputs such as diesel or fertilizer. Lower returns lead to less funds for maintenance of irrigation infrastructure or investments in agro inputs.

Insufficient Financial Surplus to Maintain Irrigation Infrastructure

22. As a result, many irrigation schemes do not generate adequate financial surplus to provide for proper maintenance of main canals and large water control and diversion structures. This perpetuates the 'bricolage' nature of most of the current irrigation schemes.

Unregulated Water Abstractions and development of irrigation

23. A major implication of the absence of governmental institutions is that water abstractions from the Shabelle are unregulated and uncoordinated. The current water abstraction regime could be categorized as 'first come, first serve'.
24. Numerous (small and mid-size) private irrigation schemes have been developed outside the original command areas. For instance, a large irrigation area (>7,500 ha) has emerged along Duduble flood relief canal. In other instances, irrigation water is pumped directly from the Shabelle river. These abstractions are not regulated.
25. Thus, currently, the total area equipped for irrigation probably exceeds the capacity of the Shabelle river, specifically in a drought year. It is noted that the exact size of the irrigated area is unknown.
26. In the absence of regulation or management of water abstractions, the risk of over-abstraction is high.

Inadequate Water Storage Capacity

27. This situation is exacerbated by the absence of adequate water storage capacity in the Shabelle system in Somalia. The Jowhar Off-Stream Storage Reservoir—with a capacity of 200 mcm—is not operational while a planned Duduble off-stream reservoir—with a proposed capacity of 130 mcm—was never developed.
28. Thus, for now, the storage capacity in the Shabelle basin in Somalia is inadequate to provide for secure water supply for the entire irrigated area for all years. It increases vulnerability to periodic drought years. (Sub-surface and groundwater storage potential is not included in this assessment. Potential upstream storage in Ethiopia is also not considered).

Changing Hydrologic Regime of the Shabelle

29. In addition, there is anecdotal evidence—in the absence of reliable long-term flow records—that the hydrologic regime of Shabelle is changing, with more extreme events (droughts and floods).
30. Increasing abstractions in the upstream catchment in Ethiopia may further reduce river flows, specifically in drought years.
31. For instance, the Shabelle has dried up completely from Beledweyne to the Indian ocean in the dry season (Jan-Feb) in the years 2015 to 2019, which had never happened before.

Increased Risk of Water Conflicts

32. Consequently, there is increasing risk of systemic water shortages during drought years. Hence the potential for water conflicts—within irrigation schemes and among irrigation schemes—is rising.
33. For instance, incidents have been reported during drought periods of farmers damming irrigation canals to prevent downstream water flow. For now, these reported water conflicts are within irrigation schemes, not (yet) among schemes.

Limits to increasing water-use efficiency

34. Farmer knowledge of irrigation scheduling and crop water demand is generally high because of multi-generational experience. However, gravity irrigation through open earth-lined canals is inherently subject to low water-use efficiencies.
35. Efficient irrigation technologies—such as drip irrigation, or sprinklers—are not used because of the high concentration of sediment in irrigation water originating from the Shabelle. It is noted that groundwater contains much less sediments.
36. Soils in the Lower Shabelle area are sandier—because of the proximity of the coastal dunes. Nevertheless, most irrigation takes place on alluvial riverine soils. Sandier soils imply higher irrigation water requirements but excess water percolates to the groundwater. It also implies that night reservoirs are difficult to maintain in these areas.

Box 6.1: Improving the Performance of Irrigated Agriculture: the Al Mizan Case Study

Al Mizan provides an interesting example of an effective PPP arrangement that aims to improve the performance of irrigated agriculture in the Shabelle basin.

Al-Mizan International Trading Company is a Somali company that is active in the sesame value chain as a producer, promoter, processor, and exporter. Al-Mizan started in 1997 and has since entrenched its role in the sesame export business. The company started as an exporter of non-processed sesame but currently exports mostly colour-sorted sesame as well as hulled sesame. It has built this capacity through own investments in processing equipment, and with support by agencies including CEFA and FAO Somalia as part of a PPP arrangement to promote sesame production and export in Somalia. The improved capacity in exporting quality-processed sesame has resulted in assured market access for sesame farmers who are mostly small-scale growers with average farms ranging from 1 to 2.5 ha and yields ranging from 0.2 to 0.3 tons per hectare.

With sesame export being a low-margin high-volume business, Al-Mizan aims to increase total production by increasing yields as well as acreage by its collaborating farmers. To this effect, Al-Mizan supports farmers in improving their irrigation system, through an arrangement where Al-Mizan pays for rehabilitation and maintenance of the canal system. Costs are deducted from the price farmers receive upon selling their sesame produce to Al-Mizan. The company also support farmers through training on irrigation system management and operation, and on sesame production, including, land preparation, irrigation, planting, weed management, harvesting, drying, and threshing.

About 80% of the crop production takes place in the Lower and Middle Shabelle and Middle Juba. With current security concerns in Lower Shabelle and high cost of transport for sesame grown in Middle Juba, Al-Mizan's current focus is to promote greater sesame production in the Middle Shabelle. Al-Mizan currently collaborates with 6000 farmers who grow sesame on approximately 11000 ha of irrigated land. Of this 8000 ha of land is situated in Mahaday district, 2800 ha in Jowhar district, and 200 ha in Balad district. Al-Mizan also has its own 500-ha sized farm in Mahaday.

All collaborating sesame farmers, including Al-Mizan, are members of the Sesame Seed Improvement and Multiplication Association (SESIMA). Farmers sharing irrigation infrastructure also belong to a water user association which regulates water distribution for irrigation within the system and ensures proper operation and management of the system. Al-Mizan supports collaborating farmers with tractor services including ploughing, harrowing and canal repair, with equipment owned and available from its farm in Mahaday. Such tractor services are provided at a cost below market rate and are payable after farmers have sold their produce. Currently, contributing farmers pay approximately 23.5 US$ per hectare for all Al Mizan services.

Due to decreased sales and Al-Mizan's commitment to ensure that farmers break even, the gross margins have progressively decreased with a decrease in volumes exported. Al-Mizan is trying to address this by supporting more farmers to grow sesame through the rehabilitation of the Duduble canal so as to open a further 12,000 ha to sesame production.

6.4 Preliminary Policy Implications

Yields in irrigated agriculture in Shabelle basin in Somalia remain persistently low despite goods soils, access to water to supplement inadequate rainfall, and several effective PPP organizations. It implies that individual farmers – or even communities – are simply unable to tackle four principal constraining factors in irrigated agriculture in this zone: insecurity, recurrent large floods, insecure water delivery because of water shortages in drought years, and economically unviable farm-gate prices.

These four factors cannot be addressed by individuals, companies, or NGOs and must therefore be solved at local, state, and federal government levels.

By contrast, it is probable that other constraining factors such as the unavailability of fertilizers or pesticides, the absence of value chain and agro-processing facilities and good quality seeds, as well as the siltation of canals and water control structures will eventually be addressed by private and other non-governmental actors without outside interventions provided that a viable economic setup is created.

In addition, it is probable that the current extent of irrigation agriculture in the basin already exceeds the available water resources in the Shabelle in drought years. Several policy options exist to address this issue, which have been discussed in the Water Resources chapter.

7. Livestock

7.1 Introduction

The most prevailing farming system in the Shabelle basin is the pastoralist system. The basin hosts a large population of cattle, sheep, goats, and camels. As is common for the pastoralist farming system, livestock water productivity is low. However, most livestock are grazed on semi-arid pastures that utilize water (i.e. rainfall) that cannot be used for crop production or other productive purposes. Only a fraction of rainfall over the semi-arid grasslands will reach surface water bodies or the groundwater system. The rest represents low-value water that evaporates or is used to grow pasture. Livestock are efficient in making productive use of this low-value water.

Because of their mobility, pastoralists move between different seasonal pastures across the region—following local rainfall and pasture—and are not constrained by country or watershed boundaries. A discussion on the livestock farming system in Shabelle, therefore, cannot be confined to Shabelle basin alone and must also include neighboring basins and even countries.

At the same time, there are few interlinkages between the riparian zone and the surrounding semi-arid lands where livestock farming dominates. While pastoralists sometimes buy irrigated fodder, their herds typically stay away from the irrigated areas along the Shabelle. Further, even though irrigated agriculture in the Shabelle includes some livestock, this mainly concerns a mixed farming system and not nomadic pastoralism. Moreover, almost no runoff from local catchments in Somalia reaches the Shabelle system and water used by pastoralists does not affect river flow. Hence, in terms of water resources management, the riparian zone and the pastoralist livelihood system in the surrounding drylands effectively represent two separate systems.

This chapter will briefly discuss the relevance of the livestock sector to Somalia and the challenges it faces. It will then focus on how to make better use of the natural resource base to strengthen the pastoralist livelihood system.

7.2 The Relevance of the Livestock Sector in the Shabelle Basin

The significance of livestock in the Shabelle basin—and Somalia in general—is related to 1) economic and livelihood factors, 2) food security and nutrition, and 3) cultural values.

<u>Economic and Livelihood Factors</u>

Livestock is the leading economic sector in Somalia where animal production and marketing (both for domestic and export markets) have persisted despite over two decades of civil war and instability. Livestock have historically and culturally been the main source of livelihoods for most households, with over 60% of the population directly or indirectly engaged in the sector.

In recent years, the livestock subsector accounted for about 75 percent of total agriculture exports, which in turn accounted for about 50% of total exports (MoEWR). Foreign exchange earnings from export of livestock—either as live animals, meat, or animal products—are among the principal revenue sources that are used for essential food imports. It is noted that Somalia remains food deficient and requires imports to achieve food security.

The importance of livestock is clearly illustrated by the fact that 90% of the crop area in Hiran in the Gu season is basically reserved for livestock feed. Hence any improvement in the livestock sector will contribute significantly to economic development and food security of Somalia.

Box 7.1: Livestock export

Traditionally, Somalia's livestock exports have mainly been in the form of live animals. The main export destinations are Middle East countries including Saudi Arabia, Yemen, United Arab Emirates (UAE), Oman, and Qatar. In the 1960s and 1970s, live animal exports from Somalia comprised about 70% of Saudi Arabia's live animal imports. In addition, livestock is exported to East African countries, with neighboring Kenya the main destination.

However, Somalia faces several problems in exporting live animals, key among them being limited market infrastructure, specifically for transport and information transfer. In addition, live animal exports increase the risk of cross-border disease transmission, which leads to frequent bans by importing countries.

Note that three key livestock export ports are located in the Shabelle basin: Mogadishu, Merka, and Barawe.

Flood Security

The livestock subsector is critical to achieve food security in the country. On an annual basis, average per capita consumption of milk is 330 litres, while this is 22 kilograms for meat (MoEWR 2021b). In addition, milk provides essential nutrients, specifically for children. Further, during periodic droughts—when food in rural areas is scarce—camels continue to produce milk, underscoring their critical role in food security.

Cultural Significance

For pastoralists, livestock are their most important possessions. Apart from being the economic and food security bedrock of rural Somalia, they serve as high-value assets used as collateral, act as a 'bank on four legs', are used to access cash, and serve as valuable trade items exchanged for food and other essentials. Further, they represent a way of life that is cherished.

7.3 Challenges to the Pastoralist Sector

While pastoralism is generally resilient and well-adapted to make use of marginal lands, it is vulnerable to drought and land degradation. For many years, large areas of grasslands in the world—including Somalia and the wider East African region—have been gradually degrading while climate change is reportedly increasing the frequency and intensity of drought events.

This affects the pastoralist sector in three critical ways: 1) drying up of water sources for the animals, 2) declining forage resources, and 3) herders are forced to sell animals to raise cash for buying food for their families. Because of declining livestock prices and high grain prices during a major drought, the number of animals that must be sold is typically more than those required to bring animal numbers in balance with fodder availability. It compromises the ability to reconstitute a viable pastoral existence in the post-drought period (Sommer 1998). Further, droughts are associated with conflicts over pasture and water resources, loss of income, possibly famine, poverty, and rural-urban migration.

Moreover, land degradation in combination with more frequent and more intense drought events have long-term impacts on the natural resource base on which the pastoralist system depends. Since drylands are fragile, land degradation is not easily reversed, and it will be difficult to recover carrying capacity once it is lost. Thus, intensified drying and associated land degradation will reduce the quantity and quality of forage and will impair the capacity of the land to sustain livestock.

Table 7.1: Water related climate impacts on pastoralism

Increased aridity
land degradation; loss of forage; diminishing carrying capacity of the land increase in competition for land resources; associated conflicts
Higher temperatures
higher water demand for animals
More frequent and more intense droughts
higher risk of shortage of forage drying out of rivers and small reservoirs; constraining options for watering animals intensified land degradation near remaining watering points
More frequent and more prolonged floods
intensified land degradation
Increased seasonal and interannual variability of rainfall and associated river flow
higher risk of periodic water shortages for watering animals intensified land degradation (and competition) near remaining water points

Source: Nile State of Basin 2020

It is evident from Table 7.1 that careful management of the drylands and associated water resources is required to arrest land degradation and preserve and strengthen the pastoralist sector.

7.4 Preliminary Policy Implications

Improving Livestock Productivity: From Evaporation to Transpiration

The potential for improving livestock productivity is substantial. It comprises three main elements: 1) better animal management strategies, 2) improving the value chain, and 3) improved land and water management.

Karimi et al. (2012) asserts that the first element—better animal management strategies—is the most important one with the highest potential. However, this subject is outside the scope of this basin diagnostic—which is concerned with water resources management. The same applies to element number two: improving the value chain. Extensive literature exists on how to improve these two factors, and the reader is referred to this body of work.

It is acknowledged that improving livestock productivity requires addressing all constraining factors in concert and in the right order. Nevertheless, this paragraph will focus on how to make better use of the natural resource base to strengthen the pastoralist livelihood system.

Three key observations are made regarding the natural resource base in the pastoralist zone in the Shabelle basin:

1. Average annual rainfall in this region amounts to 439 mm (FAO WaPOR, 2008-2020 data set); this represents a significant water resource.
2. Reference evapotranspiration—which is evapotranspiration that would occur if moisture availability were unlimited—is high and exceeds 2000 mm per year for the Shabelle basin in Somalia. Hence rainfall that does not infiltrate in the soil will quickly evaporate and is no longer available for plant growth.
3. Some 183 mm of the average annual rainfall (439 mm) in the pastoralist zone is lost through evaporation (FAO WaPOR, 2008-2020 data set). Note that evaporation is water that is lost without productive use. It represents a huge waste of scarce water resources.

The above implies that—in a nutshell—interventions to increase fodder and water for the livestock sector should focus on increasing the percentage of rainfall used for transpiration, at the expense of rainfall lost through evaporation.

This endeavour involves two aspects: 1) land management at landscape scale, and 2) efforts to rehydrate the ephemeral riverbeds—and adjacent riverine zone—in the pastoralist region. The first is a major challenge. The second is easier but will require investments and will face maintenance and sustainability issues.

Box 7.2: Green water

The portion of rainfall in the pastoralist zone that does not reach the river or groundwater system is substantial. It is referred to as green water. Green water is distributed and not available for use outside its immediate vicinity. It is separated into transpiration and evaporation. Transpiration is the portion of rainfall that is used to produce biomass while evaporation returns to the water cycle without productive use. In dryland areas, transpiration primarily originates from direct rainfall that is stored as soil moisture and used to grow fodder.

The relation between transpiration and biomass production is essentially linear for a given crop, climate, and nutrient status. Thus, increasing transpiration at the expense of evaporation would proportionally increase fodder production.

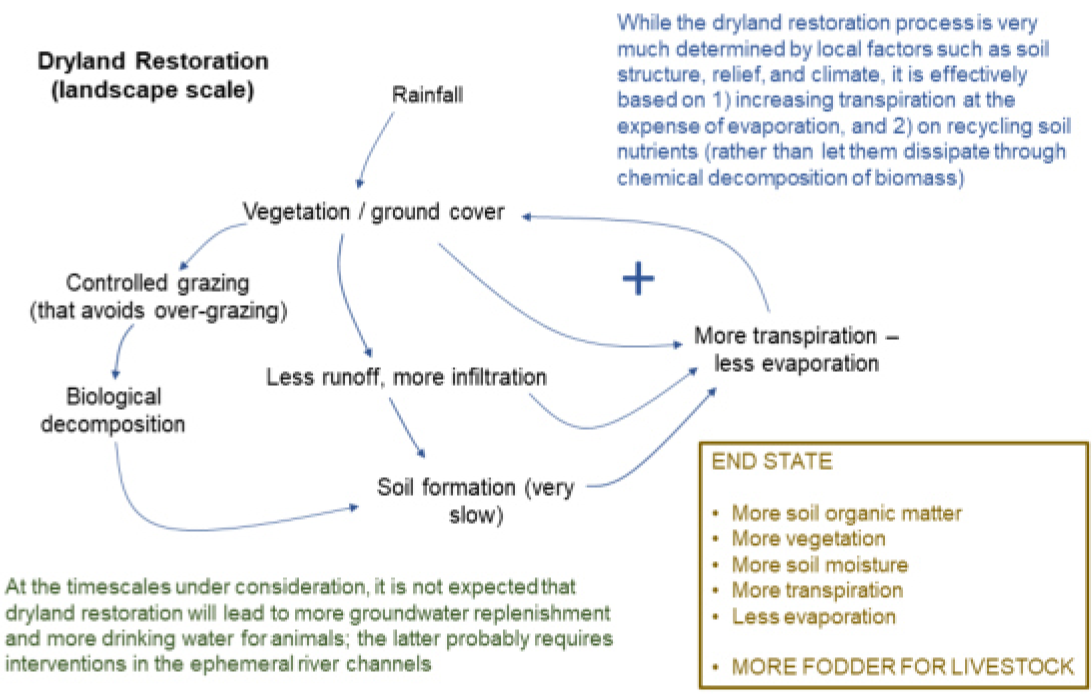
High transpiration and low evaporation in a landscape suggests permanent vegetation cover throughout the year. By contrast, a high evaporation-transpiration ratio points to barren lands. Hence the high proportion of evaporation compared to transpiration in the pastoralist zone in Somalia hints at a degraded landscape where large areas are without ground cover for some parts of the year.

Dryland Restoration

Dryland restoration in Somalia is exceedingly difficult because if involves a very fragile ecosystem that is subject to “the tragedy of the commons”. These are communal lands that are easily over-exploited because of uncoordinated grazing by individual herders—specifically in periodic drought years. Nevertheless, age-old traditional grazing rules and practices exist that aim to find a balance between the natural resource base and its sustainable use. It is probable that climate change and desertification have altered this equilibrium, and that grazing rules and land-use practices must adapt. How to achieve this is outside the scope of this study.

Figure 7.1 presents a conceptual diagram on how to restore drylands. It is noted that dryland restoration very much depends on local factors such as (micro) climate, soil depth and structure, relief, wildlife, and grazing practices. In addition, dryland restoration is a long-term undertaking and quick results should not be expected. Nevertheless, the schematic facilitates a structured discussion on this challenging subject.

Figure 7.1: Dryland restoration at landscape scale



Increasing groundcover will reduce direct runoff and evaporation and leads to more infiltration of rainfall into the soil. This, in turn, leads to more biomass production. It is a positive feedback loop in which vegetation leads to more vegetation. However, there is a complicating factor. Soils in dryland areas are typically poor in terms of nutrients because of leaching and high temperatures that lead to chemical decomposition of biomass. The latter causes scarce nutrients to dissipate rather than to recycle and build soil organic matter. It points to the importance of controlled grazing—either by livestock or by wildlife—where biomass is recycled through biological decomposition. Undisturbed natural grasslands in the semi-arid zone have evolved in a symbiotic relationship with large herds of moving herbivores, which perpetuated a cycle of vegetation growth and biological decomposition. Mimicking such system through pastoralism is at the basis of the 'holistic management strategy' introduced by Allan Savory. He asserts that overgrazing and the absence of grazing are equally destructive in the long term and accelerate desertification.

Dryland restoration at landscape scale is a massive undertaking that, therefore, cannot be based on human interventions alone and will require an approach that mimics nature. Using livestock management practices that resemble the movement of ancient herds of herbivores that have created this type of landscape is something that is worth exploring. In addition, it may very well conform with the intricate and long-standing traditional pasture management systems that have been employed by the pastoralist people in this environment.

Additional recommendations include 1) prevent unnecessary bush burning—which also dissipates scarce nutrients, 2) prevent or forbid charcoal production for commercial purposes, and 3) prevent systematic overgrazing.

Rehydrating the Riverine Zone

Fig 5.8 has presented a causal diagram on flood mechanisms caused by land degradation. It depicts how removal of vegetation amplifies the rainfall-runoff response and leads to erosion of river channels—provided there is adequate slope (fig 7.2). Floodwater will concentrate in the incised channels and lower the groundwater table, and progressively dry-out the adjacent alluvial valleys. It will reduce the productivity of these valleys, reduce baseflow, and adversely impact on the riparian vegetation. The processes described above take place at all scales. Once these processes have taken off, they typically accelerate.

Figure 7.2: Incised channel

A combination of check-dams, sand-dams, micro-reservoirs, leaky weirs, swales, small-scale water harvesting structures, and vegetation can arrest channel erosion and rehydrate the surrounding landscape. In flatter areas, low dikes parallel to the river can channel part of the flood-wave to flat alluvial areas where this water can infiltrate (fig 7.3). Most of these measures are small scale and not complex. To ensure their sustainability, the importance of biological processes is emphasized. Living processes—when not over-exploited—are regenerative, self-sustained, and do their work free of charge. For instance, tree roots and reeds can stabilize channel banks while ground cover will slow down runoff and promote infiltration or rainfall.

Figure 7.3: Dikes parallel to the river trap part of the flood-wave and rehydrate large alluvial areas (Keita, Niger)

Sustainability is a major challenge when implementing interventions in the river channel. Streamflow in the semi-arid zone is very flashy and river channels are unstable because of the high sediment load. Hence it is difficult to construct permanent structures in the riverbed. Interventions, therefore, should be both very solid and small enough not to obstruct the flood-wave.

Rehydrating the riparian zone will over time increase baseflow and recharge local aquifers that can feed shallow wells for watering animals in period drought years. Micro reservoirs also provide watering holes. In addition, riparian vegetation—specifically trees—provide fodder for camels and goats.

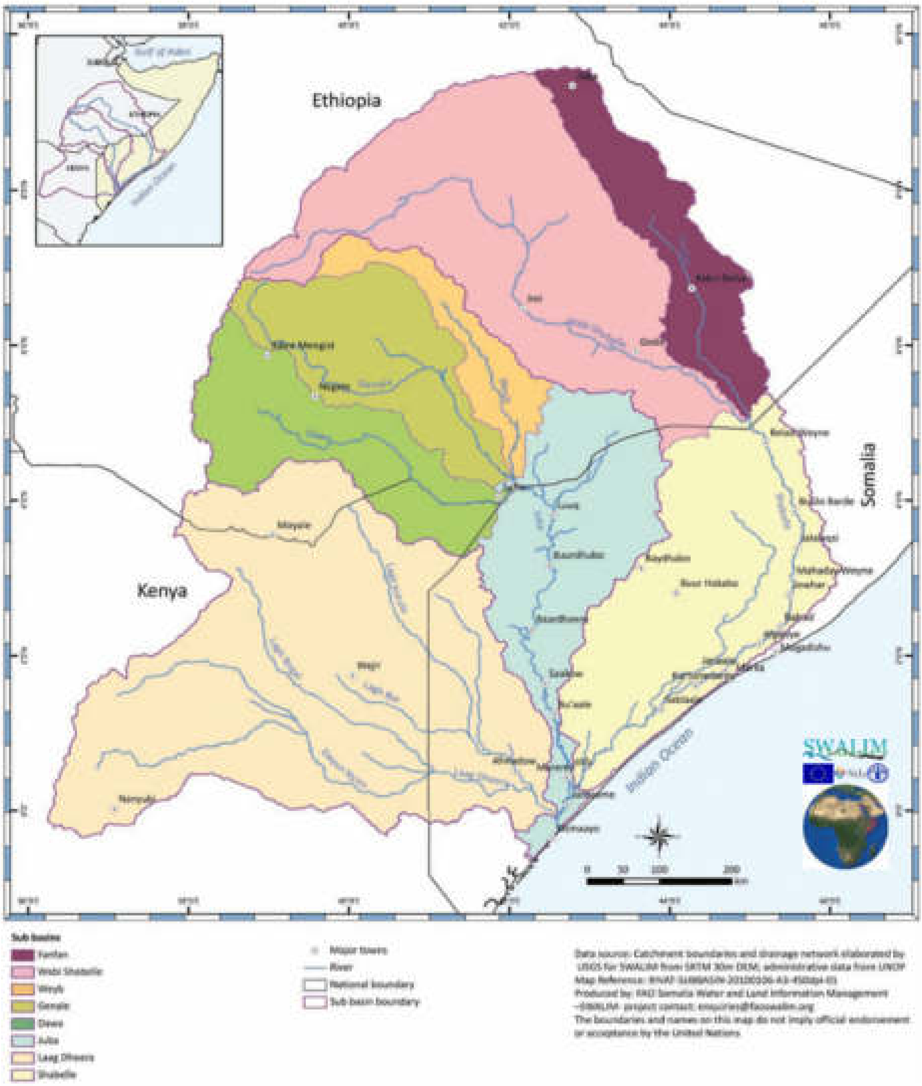
Close consultation with local communities and stakeholders is essential when planning interventions that may lead to an increase of water availability in the dry season. Establishing new watering holes may attract outside herds that will change the existing grazing patterns and could result in overgrazing and conflicts over pasture. Water availability and grazing opportunities must remain in balance if the intervention aims to arrest land degradation and ultimately foster land restoration.

8. Transboundary Aspects of the Juba-Shabelle Basin

8.1 Introduction

The Shabelle river is part of the larger Juba-Shabelle basin that Somalia shares with upstream riparians Ethiopia and Kenya. Both rivers technically form a joint basin as during years of exceptionally high flow the waters of the Shabelle will reach the Juba before entering the Indian Ocean. At this point there is also no exact information as to what extent the two basins are hydrologically linked through groundwater resources. While from a hydrological perspective, both basins hence don't necessarily need to be dealt with jointly, it makes sense to look at them together from a political perspective as this significantly broadens the basket of potential benefits.

Figure 8.1: Juba-Shabelle River Basin



The Shabelle and Juba basins are the only perennial rivers in Somalia and are the major backbone for the country's agricultural production. The total catchment area of the Juba comprises an area of 221,000km². The total catchment area of the Shabelle is slightly larger, comprising approximately 297,000km² (Basnyat and Gadain 2009).

Table 8.1: Basin share and population of the Juba-Shabelle by country

	Kenya	Ethiopia	Somalia
Basin share Juba (%)	5	60	30
Basin share Shabelle (%)	-	64	36
Basin population Juba (million)	0.45	4.8	1.2
Basin population Shabelle (million)	-	10.2	2.2

(Source: Basnyat and Gadain 2009, LandScan 2019).

The average annual runoff of the also varies between the two basins. With approximately 5,900 hm³ runoff in the Juba is much higher than in the Shabelle (Basnyat and Gadain 2009). The current annual runoff in the Shabelle is not agreed upon. Whereas measurements in Somalia indicate an average runoff of 2,400 hm³ at the border, Ethiopia reports an average river flow of 3,900 hm³. Researchers indicate that the latter number is more reliable (Petersen and Gadain 2012, Michalscheck et al. 2016). Most of the runoff of both rivers (estimated at 90%) is generated in the Ethiopian highlands (Basnyat and Gadain 2009, based on flow data from 1963-1990). Cooperation with upstream riparians is hence crucial for Somalia to ensure sufficient continued water flows to sustain livelihoods, ecosystems and ultimately safeguard internal political stability.

Distribution of population across the basin is very unequal between the riparians, with the largest population found in Ethiopia (compare table 8.1). However, to a large extent people living across the basin in all three countries are ethnic Somali (of different clans) sharing the same language and other cultural features. Most water consumption in both basins to date occurs downstream in Somalia. While exact numbers are missing water abstractions for irrigation, domestic consumption and livestock in Somalia has been estimated at 601.5 hm³ for the Shabelle and 206.3 hm³ for the Juba (Michalschek et al. 2016). **It hence should be noted that while water resources of the Juba are more than double, most water abstraction to date is happening in the Shabelle basin.**

At present there is only **one major water reservoir in the Shabelle basin, the Melka Wakana reservoir** which is used for hydropower production in upstream Ethiopia along the Wabi-Shabelle and has a max. storage capacity of 763 million m³ (Abdulhamid 2017, also compare chapter 5).

Figure 8.2: Melka Wakana in the Wabi-Shabelle basin, Ethiopia

Source: Google Earth

Also in the Juba basin there is currently only one major reservoir situated within Ethiopia (where the river is known as the Genale Dawa River). **The Dawa III (GD-3) multipurpose dam** was finalized in 2020. The dam has a capacity of 2.5 billion m³ and serves hydropower production as well as the expansion of irrigation agriculture. It is also reported that the GD-3 helps to reduce severity of flooding in Ethiopia and possibly also in Somalia (MoW 2009).

The **limited information available about water resources development in Ethiopia and the absence of transboundary collaboration on water issues complicates basin planning in Somalia**. In addition, this lack of cooperation undermines trust and provides ground for speculations. In 2016 for instance the Shabelle in Somalia for the first time dried-up completely which resulted in a lot of speculation about the actual causes and potential abstractions in Ethiopia. The absence of cooperation on the Shabelle coupled with ongoing and planned future developments in upstream and downstream locations increase the likelihood of disputes around water allocation and management in the future.

While cooperation over shared transboundary water resource may at this point be a difficult topic to address, as explained in the next sub-chapters, the three riparian countries have strong links beyond water resources, providing ample ground for expanding collaboration in other fields. All three riparians share important cultural and economic connections. For instance, ethnic Somali livening in Ethiopia and Kenya, maintain close family-ties in Somalia.

Furthermore, pastoralism and a thriving livestock sector, which is of high economic importance, is a strong economic factor, connecting populations and economies across the three countries. Pastoralists in all three countries continue to follow traditional grazing routes across national boundaries. There is hence a constant crossing of borders by people and livestock. The large regional grazing areas are effectively managed as a common transboundary resource. Moreover, the people managing this resource in Ethiopia and Kenya are ethnic Somali, creating yet another strong connection between the three countries.

All three countries benefit from this setup. Livestock is commonly traded between Ethiopia and Somalia as huge volumes of livestock from the Ogaden in Ethiopia are exported through ports in Somalia – primarily Berbera in Somaliland where Ethiopia owns 19% of the port. Kenya is also a favorable destination for Somali livestock. About 60-70% of the livestock traded in the regional livestock hub of Garissa (south-eastern Kenya) come from Somalia (Ng'asike et al. 2020).

Thus, discussions on the Shabelle and Juba waters should be considered in this much larger context as it provides a broader set of entry points for collaboration and trust-building that can be used to facilitate stronger collaboration on water issues as well.

8.2 Lack of cooperation over shared river basins

There is currently **no bilateral or trilateral institutional arrangement for cooperation over water resources between the riparian countries of** the Juba-Shabelle. As reported by interviewees, there are no contacts at technical or political level (formal or informal) between the respective Ministries in Somalia and Ethiopia. There are currently also no mechanisms for information and data sharing.

However, all three countries are members to regional organizations, including the Intergovernmental Authority on Development (IGAD) and the African Union (AU), that also deal with water issues. The Somali Ministry of foreign Affairs and International Cooperation (MoFA) for example is involved in IGAD activities on formulating a Water Protocol and in the Horn of Africa Initiative on Security and Energy.

In the course of negotiations around the IGAD Water Protocol, Somalia attempted to bring the three riparian countries together to start a dialogue on transboundary water issues. A **tripartite transboundary water platform** was initiated which held several meetings. However, Ethiopia's participation remained limited and the platform finally collapsed in 2019 when the dispute over the maritime border between Kenya and Somalia escalated (Somalia signed oil exploration contracts despite ongoing investigation by the ICJ). In the past, the IGAD Secretariat was also active in initiating meetings to review the proposed water developments along the Dawa sub-basin in the three riparian countries. While flooding is a key transboundary concern for Somalia, **no formally institutionalized flood warning mechanism** exists between Somalia and Ethiopia at this point. Some informants point to an existing traditional early-flood warning system in the Juba basin where communities upstream warn those downstream of upcoming flood events (but this seems to be a rather ad-hoc system limited to the Juba basin).

While cooperation over the shared water resources would be beneficial for Somalia there are several **obstacles for increased water collaboration between the three countries**. These include:

- lack of (minimum) knowledge base that is accepted by all three riparians,
- difficult historical relations coupled with mistrust (esp. military interventions of Kenya and Ethiopia in Somalia and suspected "hidden agendas"),
- a lack of functioning government in Somalia over a period of 30 years,
- political instabilities and insecurity in the basin areas of all three countries,
- existing disputes over other issues between riparians (like the maritime boundary between Kenya and Somalia),
- limited incentives/interests by upstream Ethiopia to engage in collaboration as transboundary negotiations may ultimately lead to unfavorable impacts on water allocations available for Ethiopian development plans,
- focus of Ethiopia on more imminent issues, such as currently the conflict in Tigray,
- lack of water-related technical and diplomatic skill-set on the side of Somalia.

There is currently **no agreed information-base to discuss the use of the Shabelle** waters. For instance, there is no agreement on the hydrologic regime of Shabelle, the total amount of water crossing the border, or the volume of water abstracted in Ethiopia, Kenya and Somalia. The absence of reliable data and a shared knowledge base complicates any possible future discussions on equitable use of the Shabelle waters or the development of joint projects. It is noted that this could nonetheless be an opportunity as this knowledge could be developed jointly – with co-benefits of trust-building and compatibility of datasets.

Formal **political relations between the three countries have been difficult**, with Ethiopia (and Kenya) repeatedly intervening in Somali politics in an attempt to counter pan-Somalian aspirations and (later) to fight islamist groups. While relations with Ethiopia under the current Somali Federal Government have significantly improved[3], these "historical burdens" weight heavily.

Several attempts by **international cooperation partners to promote transboundary cooperation and initiate platforms for trilateral cooperation have failed** so far. For example, the ongoing SECCCI project ("Support for Effective Cooperation and Coordination of Cross-border Initiatives in Southwest Ethiopia Northwest Kenya, Marsabit-Borana and Dawa, and Kenya-Somalia-Ethiopia") reported that activities related to transboundary dialogue on the Juba-Shabelle had been put on hold, primarily because of the sensitive political nature of the topic (Khan 2020).

Ethiopia currently faces several major internal political and security challenges that absorb significant amounts of attentions. Some of these, including the conflict in Tigray, have very direct consequences for Somalia. It has for instance been reported that Tigray soldiers stationed in Somalia (via AMISOM) have been disarmed and/or confined in bases. This has significantly weakened AMISOM and the fight of the Somali Federal Government against al-Shabab.

[3] Since about 2018 Somalia and Ethiopia increased their bilateral relations. Together with Eritrea they have also established a trilateral alliance, supporting each other on various regional issues.

Finally, all **three basin countries have unilateral plans for further developing the water resources** in their respective parts of the basin, primarily focused on increasing irrigation for agricultural development (see next two sub-chapters). In the absence of any institutionalized cooperation and coordination mechanism, the unregulated expansion of these different plans will lead to an overallocation of water resources and likely create conflicts between different actors (within and across countries).

8.3 Downstream development plans in Somalia

The Juba and Shabelle rivers play a significant role for crop production in Somalia and extensive irrigation agriculture is taking place in both basins. Between the 1920s and the onset of civil war in 1991 several irrigation schemes and flood mitigation structures had been built in both basins – a total of 32 medium and large-scale structures in both basins (SWALIM and FAO 2007). It is reported that a total of 222,950 ha of land could have been irrigated with that infrastructure (Elmi 2013). However, most of these barrages, canals and one dam are not currently operational and require major rehabilitation (compare chapter 5 & 6).

Despite lack of recovery of water infrastructure, irrigation is happening and steadily increasing within and beyond the irrigated areas of pre-war schemes. While exact numbers of currently irrigated land are not available, a World Bank/FAO (2018) publication suggests that at this point 110,800 ha are irrigated in the whole Juba-Shabelle basin. If correct, this would only comprise 15% of the total potential irrigable land (World Band and FAO 2018). Based on earlier and more conservative numbers (65,000 ha, 2007), Michalscheck et al. (2016) estimated that Somalia extracts approximately 715 million m³ water from the Juba-Shabelle system for irrigation – 550 million m³ in the Shabelle and 216 million m³ in the Juba (Michalscheck et al. 2016). This number is likely to be higher at current state.

The federal as well as state governments have emphasized that rehabilitating the pre-war irrigation and flood control infrastructure in the Juba-Shabelle basin is of key priority to improve water availability for livelihood development (MoPIED 2020). If this was to be fully realized, water demand would surpass supply in the Shabelle river basin – particularly considering that a lot of additional irrigation has developed outside the former irrigation schemes. However, there would still be room for development in the Juba.

Before onset of the civil war, Somalia already had plans to further expand water utilization. However, none of these plans considered demands and future development plans in Ethiopia. These proposals included the development of an additional 88,282ha of controlled irrigation in the Shabelle, demanding 1,175 m³ of river water (compare table 8.2, Elmi 2013). There are no indications that these plans will be implemented.

Table 8.2: Proposed irrigation shemes in the Shabelle basin before the civil war

Proposed irrigation scheme	Irrigated area (ha)
Jowhar	2,600
Balcad	16,200
Afgoi	2,500
Janaale	4,000
Kurtunwaarey	29,742
Sablaale	28,740
Haarway	4,500
Total	88,282

In the Juba basin, Somalia had developed the "Juba Valley Development" master plan in 1989 which, amongst others, foresaw the construction of the Baardheere Dam Project (BDP), a multi-purpose dam for generating 140 MW of electricity and irrigating 5,000 ha of land in downstream areas of the Juba basin (see table 8.3). The BDP was never realized because of political reasons and the lack of funding (which Somalia initially tried to get through the World Bank, compare Salman 2011).

Table 8.3: Proposed projects in the Juba basin before the civil war

Proposed project	Details
Baardheere Dam Project	75m high dam with a storage capacity of 5,700 Mm^3 and a hydropower capacity of 140 MW
Irrigation schemes	120,000ha irrigated land in downstream areas of the Juba
Homboy irrigation	4,500 ha of irrigated land

It is evident that, at least for the Shabelle basin, there is a large deficit of water supply and not much room for realizing these additional irrigation projects (compare Elmi 2013, Michalscheck et al. 2016., Sebhat 2015). This becomes even more apparent when considering upstream demands and ongoing developments in Ethiopia.

8.4 Upstream water development plans in Ethiopia

While consumptive use of water of the Juba-Shabelle is (currently) smaller in Ethiopia, there are plans to significantly increase irrigation schemes within the coming years. **Today, small-scale irrigation along the Wabi Shabelle in Ethiopia is taking place along the river banks all the way between Gode town and the city of Ferfer** (the latter being close to the border with Somalia). Major large-scale irrigation schemes only exist in the area of Gode, of which some are government and others privately owned and operated. Other schemes are much smaller and are run by small-scale farmers and cooperatives.

Figure 8.3: Irrigation along the Shebelle River near the city of Gode, Ethiopia

Source: NASA

There are plans in Ethiopia to significantly increase the use of water resources in the Juba-Shabelle basins for irrigation and hydropower purposes. In its master plan for the Wabi Shabelle ("Wabi Shabelle River Basin Integrated Development Master Plan Study Project") Ethiopia identified around 41 small-scale, 77 medium-scale and 31 large-scale irrigation projects in the basin, covering **an estimated potential of 237,905 hectares of irrigable area** (Awulachew et al. 2007, see Table 1 for large-scale irrigation projects). A more recent report from the Ethiopian Somali Regional State (2013), referring to an unpublished Regional Task Force report, even estimates the potential of irrigable land to be about 500,000 ha (Ethiopian Somali Regional State 2013).

Table 8.4: Proposed large-scale irrigation projects in the Abis Shabelle, Ethiopia

Project	River (sub-basin)	Potential (ha)
Gololcha - 1	Gololcha	10,000
Gololcha - 4	Gololcha	10,000
Kora	Kora (Upper Wabi)	2,300
Ukuma	Ukuma (Upper Wabi)	2,500
Dhakafu	Dhakafu (Gololcha)	3,000
Keserera	Keserera (Golocha)	3,000
Kombolcha	Kombolcha (Gololcha)	3,500
Robe 2	Kombolcha (Gololcha)	4,000
Umecho	Umecho (Ramis)	10,000
Erer	Erer	4,000
Kungo-1	Erer	4,600
Gode West	Erer	10,000
Gode South	Erer	23,000
Bohd-bar	Erer	5,000
Madiso	Erer	12,000
Lio-Uen	Erer	18,000
Upper – R1	Erer	4,800
Mustahie	Erer	3,800
Bul-doho	Erer	21,000

Bisidmo	Bisidmo (Erer)	1,000
Ijalola	Ijalola (Erer)	1,000
Reko Alola		600
Reko Berbala		700
Jerer	Jerer (Fafem)	1,000
Segeg	Daketa	1,500
Daketa	Daketa	2,500
Fafem - I	Wabi Shebele	1,500
Alimad	Wabi Shebele	1,200
Gedow	Wabi Shebele	1,000
Digni	Wabi Shebele	2,100
Lower-R1	Wabi Shebele	2,600

Source: (Awulachew et al. 2007)

In the Juba basin (Genale Dawa respectively), Ethiopia initially identified 93 schemes which it later on to 9 dams/multipurpose projects which the country initially aimed to realize between 2013 and 2035 (Elmi 2013).

Table 8.5: Selection of proposed projects in the Genale-Dawa basin, Ethiopia

Dam project	Water storage capacitiy (million m^3)	Purpose
GD-3 (operational)	2,900	Irrigation, 245 MW hydropower, river regulation, flood control, fishery, tourism, urban water supply
GD-6	3,000	200 MW hydropower
GD-2	1,046	Irrigation, 130 MW hydropower, river regulation, flood control, fishery, tourism
GD-5	3,000	Multipurpose dam, 106 MW hydropower
GD-7	-	185 MW hydropower
GD-9	-	82 MW hydropower

So far implementation of these plans in the Shabelle basin is delayed and seem to be moving ahead only slowly. Only the Gode West and Gode South schemes have been (partly) realized so far and one of the schemes at Golocha has just been initiated (Ethiopian Somali Regional State 2013, Gebremalak 2020). In the Juba basin only the GD-3 has been realized. The dam started operation in 2020 with some delay because of issues related to resettlements of residents. The GD-5 and GD-6 are currently in the proposal stage. Recently, the Ethiopian Prime Minister publicly encouraged local investors to provide funding for GD-6.

In case all originally planned upstream developments would be realized, water **availability downstream would be seriously threatened and surpass supply** in the Shabelle basin (compare table 8.6). This is however not the case for the Juba, where room for additional abstractions would still remain (Michalscheck et al. 2016). The calculations of flow reduction in table 2 below have been calculated based on the official information provided in the Ethiopian master plan, assuming irrigation water in the amount of 2000 m³ per hectar/year.

Table 8.6: Impacts of Ethiopian development plans for the Shabelle

Year	Planned infrastructure changes	Water flow (hm³) at border	Percentage change in water flow (compared to base year)
2005 (base year)	14 610 ha irrigated	3900	
2010	44 457 ha irrigated; + i.a. Gode West, Upper Rer Issie	2600	-33
2020	94 492 ha irrigated; Gololcha-I, Dhaketu, Daketa and Segeg	2500	-34
2035	194 797 ha irrigated + additional 25 600 ha in the lower valley due to the WS18	750	-81

Source: (Michalschek et al. 2016, based on data from MoWR 2005).

Direct investments in agri-business in Ethiopia are also likely to impact on the Juba-Shabelle basin as some of these lands are situated in the basin, possibly using basin water for irrigation. For example, a Turkish company acquired 4,000 ha in Berda-Quorrax kebele in 2011 for the production of cotton and other cash crops. Also a Somali Investor (Al-amano agro farm) reportedly bought 500 ha of land in South Gode (Ethiopian Somali Regional State 2013).

However, reliable data and information on irrigation in the basin and amounts of water used are not available.

8.5 Upstream water development plans in Kenya

In Kenya, the Laag Dheera sub basin contains several tributaries that join the Juba in Somalia, thought with little runoff contribution. Water abstraction is limited to some small-scale irrigation. The underlying Merti Aquifer, shared between Kenya and Somalia, is of some interest to the former. Water from the aquifer currently provides water primarily for rural communities and refugees in the Dadaab camp. Kenya is interested in further developing the Merti aquifer. Some design studies, such as for the Habaswein-Wajir Water Supply Project, have been conducted but not yet implemented.

8.6 Managing impacts of floods in Somalia

The **major transboundary issue from a Somalia perspective are floods** and flood management (also compare flood chapter). Collaboration with Ethiopia could significantly lower vulnerability to floods in Somalia as flood waves flow relatively unhindered. Somalia would benefit from the construction of reservoirs in Ethiopia to store excess flood waters and release these during times of low flow. Storing surplus water in Ethiopia would also decrease water loss to evaporation which is higher in Somalia than in Ethiopia (and could hence also free-up additional resources used for irrigation purposes in both countries).

At the same time, excessive use of water for irrigation in Ethiopia would be critical for Somalia as this would limit water available to Somalia.

However**, preventing damage from floods as well as decreasing the loss of water during flooding (in the absence of storage capacity) is not entirely dependent on Ethiopia**. Many options exist to address this problem within Somali territory (compare chapter 4). Increasing flood relieve canals and storage capacity in Somalia, like the Jowhar or the proposed Duduble reservoirs in the Middle Shabelle, could significantly lower flood damage in Somalia and simultaneously provide water storage for use during times of low flow. What is most important, however, is that excessive flood waters are stored (in surface storage or for recharging groundwater) to make this water available for consumptive uses. This is ever more important considering that upstream developments are likely to increase water scarcity, particularly in the Shabelle basin.

8.7 Options for collaboration and benefit sharing

Despite the current lack of cooperation between the riparians of the Juba-Shabelle, the **basin countries are connected by a range of social and economic factors** that provide a good basis for cooperation and opportunities **for benefit sharing in the basin** that could be explored in more depth.

Opportunities for benefit-sharing provide several concrete options that could be explored further: Ethiopia and Somalia could both benefit from **collaboration on flood mitigation** which is an issue of concern in both countries. By storing access flood water upstream in Ethiopia (e.g. in Melka Wakana) impacts of floods could be decreased in the downstream areas within Ethiopia and Somalia. This approach would also provide additional water that could be released during dry periods, minimizing the overall loss of unproductive water. Also, a regulator at Mustahil—which is the location of a natural sill in Shabelle river some 40 km north of the border between Somalia and Ethiopia—could attenuate flood flows in the downstream Shabelle.

Furthermore, both countries could look into more optimal use of water resources, optimising the allocation of costs and benefits. While upstream Ethiopia is likely to be more suitable for electricity production the middle and lower basin are more suitable for agriculture. While Ethiopia could hence (partially) abstain from water abstraction for maximum agricultural production (at least in the Wabi Shabelle) it would benefit from energy production to fuel its industrialization process, and additionally sell surplus energy to Somalia.[4] Somalia would benefit from more reliable water flows for irrigation agriculture as well as from access to electricity. Somalia in turn could also provide additional trade-related benefits such as access to its ports for Ethiopia's export industry.[5] In this case, also Ethiopia may benefit from reduction in impacts of flooding on Somali road infrastructure.

Finally, while direct benefits from water cooperation may loom larger for Somalia, the indirect benefits are more pronounced for Ethiopia. Cooperation with Somalia to ensure more predictable water flows for Somali farmers, would **support stabilizing Somali areas bordering Ethiopia**. Ethiopia would benefit from decreasing threats of terrorism spreading into its own territory and likely also allow for gradual decrease of its (costly) military presence in Somalia.

Additionally, stronger collaboration with Somalia over shared water resources would allow Ethiopia to **access international finance for infrastructure developments** in the basin as many international financing institutions require de-facto consent by downstream countries. This point may become increasingly important considering the current economic decline over the past 1.5 years and the delay in many of the planned infrastructure projects in the basin.

It is therefore crucial to pay closer attention to these indirect benefits and bringing them into the equation to identify incentives for upstream Ethiopia to gain from transboundary water cooperation.

Preliminary policy implications

Considering the **high political sensitivities of the subject of transboundary water cooperation** in Ethiopia as well the internal political instabilities in Ethiopia and Somalia, realizing cooperation at formal state levels may currently be challenging. It would therefore be advisable for Somalia to **follow a pragmatic approach** that could entail the following aspects:

1) **Realize unilateral flood protection and water storage activities** to mitigate impacts of floods and droughts as much as possible. While this may only be possible to some degree (e.g. considering upstream abstractive activities), there are several steps that can be taken to achieve improvements from the current situation (compare suggestions in the floods and irrigation chapters). Most importantly, these excessive flood waters need to be stored in either surface reservoirs or used for recharging groundwater to make them available for consumptive uses. This is ever more important considering that ongoing and planned upstream developments are likely to increase water scarcity, particularly in the Shabelle basin.
2) I**dentify possible entry-points for transboundary collaboration, that can be pursued once a window-of opportunity arises** and prepare for engaging on these topics with Ethiopia. This should initially comprise topics and activities that are relatively uncontested and provide complementary benefits to actors and embrace mutually-shared interests. Such activities could, for example, include the proposition of joint research activities and pilot projects in areas that are of joint concern, such as on floods, high salinity levels or the low productivity rates of existing irrigation schemes. Such research and pilot activities could simultaneously help to improve the limited knowledge base and support more long-term building of trust.
3) Preparing for future collaboration on transboundary water issues with Ethiopian and Kenyan counterparts also requires to **significantly increase related knowledge and capacities amongst Somali government actors**. Starting negotiations on shared water issues without

[4] This would obviously require extending the East African Power Grid to Somalia, requiring significant investments. However stronger cooperation between the countries would facilitate the access of such funding.

[5] Access to Somalia's ports is of great interest to landlocked Ethiopia and greater infrastructure and trade integration has therefore been a key element in the trilateral negotiaotions that started in 2018 between Somalia, Ethiopia and Eritrea. The federal Government of Somalia is now also planning to promote investments in trade corridors linking Somali ports to neighboring countries, including Ethiopia (MoP 2020). The Shabelle valley forms the natural route for a road to connect the large population of the Ogaden in Somalia to Mogadishu port.

sufficient knowledge about water supply and demand within the country, concrete development plans/options as well as inadequate technical and diplomatic skill-set will ultimately make discussions with Ethiopia and Kenya more difficult and may result in sub-optimal outcomes.

It may furthermore be promising to embed water discussions in broader context of bilateral collaboration and, at least initially, focus on stronger engagement with Ethiopia on issues beyond shared waters (as has already kick-started over the last couple of years). For instance, the Horn of Africa Initiative launched in 2019 between Somalia, Ethiopia, Kenya, Djibouti and Eritrea to increase trade and economic ties may be a good platform to work on issues of transport connectivity.

Overall, Somali actors need to be aware that there is little they can do to “push” Ethiopia into any form of collaboration on the shared water issues. Somalia should pursue a very careful approach that focuses on building trust and engaging in honest discussions that provide enough room for considering all countries’ perspectives and development interest. Ultimately all riparian countries need to feel that they can benefit adequately from cooperation in order to make significant progress.

Part II: Strategic Action Plan

Introduction

While the Basin Diagnostic (BD) in part I outlines the current state and key challenges of Integrated Water Resources Management IWRM in the Shabelle basin, the following **Strategic Action Plan (SAP) aims to address the identified water management challenges in a realistic and feasible way**. For this purpose, the SAP defines objectives and priority actions that need to be implemented to address the water related management issues that were identified in the BD and are aligned with the National Water Resources Strategy (NWRS) published in July 2021. Based on this SAP, more detailed action plans and River Basin Management Plans can be developed at the basin and sub-basin level which focus on long-term measures, programmes, policies and frameworks.

It is acknowledged that several projects, programs and interventions are ongoing in the water and related sectors in the Shabelle basin, implemented by a diverse set of actors – several of which already address some of the proposed actions outlined below. However, these activities are not always well coordinated and, so far, lack an overall strategic framework. **It is therefore a major aim of this SAP, to provide such an overarching framework for addressing priority issues in the Shabelle basin which is coordinated by the MoEWR of the Federal Government of Somalia.**

Overall, the objectives of the SAP for the Shabelle basin are to:

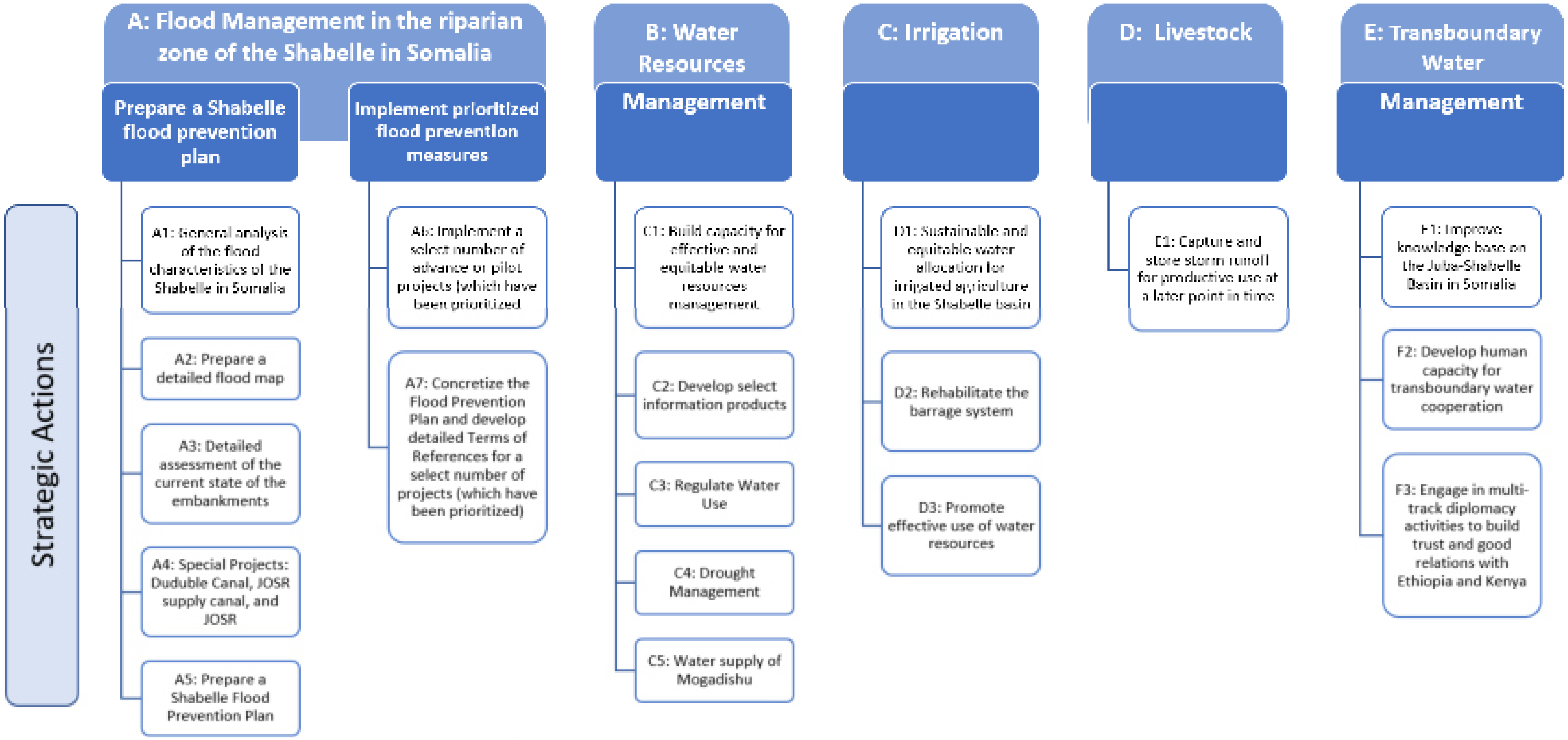
- Provide an integrated set of interventions to address prioritized issues identified in the Basin Diagnostic,
- Serve as a basis for development of projects and other measure and to streamline various activities ongoing in the basin,
- Move away from the current ad-hoc response to water-related emergencies in the basin to a more systematic approach that addresses water resources issues in the basin in an integrated and sustainable manner.

The SAP is structured around the same topical areas as the BD, including floods, water resources management, irrigation, livestock and transboundary water management. Each of these topics firstly outlines the strategic and practical objectives that are intended to be achieved in the respective area. This is followed by key strategic actions proposed for each topic. These strategic actions are furthermore specified in terms of the expected results aimed for as well as detailed actions, specifying the activities that ought to be taken to address the water management issues for the specific areas.

The topic of water governance has been excluded in the SAP. Most actions required to improve water governance in the Shabelle go beyond activities to be taken at the basin-level and are therefore not be covered here. However, several of the other topics make suggestions and outline activities that address governance issues. Furthermore, the reader is referred to the National Water Resource Strategy (NWRS) that covers this topic in detail (MoEWR 2021).

Implementation of the SAP will, as a next step, require prioritizing and detailing interventions as well as identifying actors who will take the lead in project implementation (at Federal, State, or Local level). While some interventions can be fast-tracked or tested in pilot projects, others will require the preparation of a comprehensive Terms of Reference that must be based on detailed surveys, field visits, and technical studies. Examples of the latter are the rehabilitation of Duduble Flood Relief Canal or Jowhar Off-stream Storage Reservoir.

Structure of the SAP



A: Flood Management in the riparian zone of the Shabelle in Somalia

Strategic Objectives:

1. Prevent loss of life and property from flooding
2. Prevent that flooding impedes economic activities and ensure that communication and transport networks remain operational
3. Prevent that flooding disrupts agricultural activities and causes loss of crops or livestock
4. Encourage storage of flood waters for productive use at a later point in time

Practical Objectives:

1. Prevent breakage of embankments under any circumstances; incidental overtopping may be tolerated
2. Prevent inundation of urban areas and critical infrastructure
3. Store as much flood water as possible
4. Direct excess floodwater towards designated areas where they do least damage and possibly be stored or infiltrated to groundwater

Strategic Actions	Expected Result	Cross References to NWRS per strategic action	Detailed Action Plan	Cross References to SAP	Time Scale
A1: General analysis of the flood characteristics of the Shabelle in Somalia	Determine current and potential flood characteristics such as frequency and magnitude of peak discharge	Sub-strategy 10: Plan and respond to climate variability and its impacts on water resources management and development (adaptation, mitigation and recovery) SO10b: Flood and drought risk management strategies and plans developed	1. Confirm or establish the current rating curve for Beledweyne	6, 38,	S
			2. Quality control of the historic discharge record of the Shabelle	6, 38	S
			3. Hydrologic analysis of the historic discharge record of the Shabelle	6, 38	S
			4. Preliminary assessment of the impact of climate change on the flood characteristics	6, 38	S
A2: Prepare a detailed flood map	a detailed digital map of the entire riparian zone of river Shabelle in Somalia that analyses, communicates, and visualizes flood risks; it	Sub-strategy 10: Plan and respond to climate variability and its impacts on water resources management and development (adaptation, mitigation and recovery)	5. Prepare a Lidar scan of the entire riparian zone of the Shabelle in order to develop a digital elevation model (DEM); the detailed DEM is the basis for all planning of flood intervention infrastructure; note that the inverse topography of the Shabelle river amplifies the importance of the detailed DEM	6, 7, 8, 9, 10, 18, 20, 21, 22, 23, 34, 35, 36, 39, 48, 49, 50, 9, 60	S

Strategic Actions	Expected Result	Cross References to NWRS per strategic action	Detailed Action Plan	Cross References to SAP	Time Scale
	will present flood prone areas, existing infrastructure that affects flooding, and areas and infrastructure that need to be protected at all costs; this digital map will be the basis for the planning and analysis of all subsequent flood interventions	SO10b: Flood and drought risk management strategies and plans developed	6. Prepare a model (e.g. HEC RAS or similar) that highlights flooded areas and shows how the inundations progress after an embankment breach	23, 34	S
			7. Identify existing and obsolete irrigation canals or other infrastructure elements (such as roads) that impact, exacerbate, or prolong flooding	23, 34	S
			8. Identify natural depressions in the riparian zone that can potentially be used for water storage	23, 34, 48, 49	S
			9. Identify areas where floodwaters that cannot return to the main river can (temporarily) be stored without causing excessive damage; while the SAP aims to prevent all flooding, some bank overtopping may still occur in the short and medium term future	23, 24	S
			10. Identify areas where excess floodwater can infiltrate to the underlying shallow aquifer	23, 34, 48, 49	S
			11. Identify and delineate critical infrastructure and urban areas that must be prevented from flooding, such as the main cities (Beledweyne, Jowhar, Afgoye, etc.)	23, 34	S
			12. Identify areas where developments have encroached on the river channel	23, 34	S
A3: Detailed assessment of the current state of the embankments	a map and database of all flood defenses along the Shabelle river in Somalia together with an assessment of their effectiveness and state	Sub-strategy 10: Plan and respond to climate variability and its impacts on water resources management and development (adaptation, mitigation and recovery) SO10b: Flood and drought risk management strategies and plans developed	13. Prepare an inventory of all flood defenses along the Shabelle in Somalia	23, 34	S
			14. For each section, assess the state and effectiveness; this can be a preliminary assessment based on the Lidar scan, Google Earth, and interviews with people closely familiar with the area	23, 34	S
			15. Identify weak points in the Shabelle embankment and locations where bank overtopping historically occurs	23, 29, 30, 34	S
			16. Identify locations where farmers are cutting the embankment	23, 28, 34	S
			17. Identify channel sections (choke points) where excessive sedimentation is reducing the hydraulic capacity of the river	23, 34	S

Strategic Actions	Expected Result	Cross References to NWRS per strategic action	Detailed Action Plan	Cross References to SAP	Time Scale
			18. Analyze the flood mechanisms in areas where ephemeral tributaries join the Shabelle, and what protection measures and flood defenses exist in these areas	23, 34	S
			19. Analyze the impact of the state of the barrages (e.g. gates that are stuck or absent) and other infrastructure (such as bridges) on upstream flooding	23, 34, 55	S
A4: Special Projects: Duduble Canal, JOSR supply canal, and JOSR	a comprehensive assessment of the actions required to fully rehabilitate Duduble Flood Relief Canal and Jowhar Off-stream Storage Reservoir	Sub-strategy 10: Plan and respond to climate variability and its impacts on water resources management and development (adaptation, mitigation and recovery) SO10b: Flood and drought risk management strategies and plans developed	20. Prepare a comprehensive assessment of the actions required to fully rehabilitate Duduble Canal	23, 34, 48, 49, 50, 51	M
			21. Prepare a comprehensive assessment of the actions required to fully rehabilitate the JOSR supply canal	23, 34, 48, 49, 50, 51	M
			22. Prepare a comprehensive assessment of the actions required to fully rehabilitate JOSR	23, 34, 48, 49, 50, 51	M
A5: Prepare a Shabelle Flood Prevention Plan	a coherent, prioritized, and agreed-upon flood prevention plan for the riparian zone of the Shabelle in Somalia based on the information collected in the previous steps The Flood Prevention Plan will be implemented in a stepwise manner and incrementally increase protection against flooding in the riparian zone along the Shabelle in Somalia	Sub-strategy 10: Plan and respond to climate variability and its impacts on water resources management and development (adaptation, mitigation and recovery) SO10b: Flood and drought risk management strategies and plans developed	23. Combine all the information collected in the above steps to develop a coherent flood prevention plan for the riparian zone of the Shabelle river in Somalia that prevents the loss of life and infrastructure but also stores as much flood water as possible for productive use at a later point in time	All the above	M
			24. Review, amend, and finalize the above plan through a consultative process with all relevant stakeholders	23	M
			25. Prioritize the actions identified in the above flood prevention plan through a consultative process	23	M

Strategic Actions	Expected Result	Cross References to NWRS per strategic action	Detailed Action Plan	Cross References to SAP	Time Scale
A6: Implement a select number of advance or pilot projects (which have been prioritized)	immediate action and tangible results from measures that are likely part of any plausible flood prevention plan; these actions will be initiated prior to the completion of the comprehensive and agreed-upon Flood Prevention Plan	Sub-strategy 10: Plan and respond to climate variability and its impacts on water resources management and development (adaptation, mitigation and recovery) SO10b: Flood and drought risk management strategies and plans developed	26. Prohibit dumping of solid waste in the river channel and establish a solid waste management system in urban areas	23	M/L
			27. Prohibit encroachment on the river channel in urban and rural areas; educate residents and farmers accordingly	23	M/L
			28. Construct off-take structures at points where farmers regularly breach the embankment to irrigate their fields; note that embankment cutting is partly caused by failure of the irrigation water delivery system	23	M/L
			29. Strengthen embankments at a select number of critical points using durable and cost-effective solutions such as geotubes—which (re)use river sediment; the use of geotubes should be explored in the Shabelle since they prevent stability failure and embankment collapse while some seepage and occasional overtopping is tolerated; in addition, geotubes do not require maintenance and use locally available material. They therefore meet the three critical conditions for embankments along the Shabelle: 1) no maintenance, 2) no or low risk of embankment breakage, and 3) incidental overtopping can be accepted.	23	M/L
			30. Use geotubes (and river sediment) or other suitable methods to construct a select section of flood defences for urban areas and critical infrastructure	23	M/L
			31. Use geotubes (and river sediment) or other suitable methods to construct a select number of local small-size water storage reservoirs in natural depressions; solar pumps can be considered for irrigation purposes; ensure that flood water that has escaped from the river is channelled to these reservoirs	23	M/L
			32. Remove sediment from the river at critical points and use this sediment for preparing high-quality building material such as bricks and blocks of all sizes; this will increase the hydraulic capacity of the river while providing valuable materials for the construction industry	23	M/L

Strategic Actions	Expected Result	Cross References to NWRS per strategic action	Detailed Action Plan	Cross References to SAP	Time Scale
			33. Elevate sections of important roads that are vulnerable to flooding; roads need to be equipped with culverts as needed	23	M/L
A7: Concretize the Flood Prevention Plan and develop detailed Terms of References for a select number of projects (which have been prioritized)	actualized elements of the Flood Prevention Plan with a detailed Terms of Reference and cost assessment; implementation of these elements can start after securing funding	Sub-strategy 10: Plan and respond to climate variability and its impacts on water resources management and development (adaptation, mitigation and recovery) SO10b: Flood and drought risk management strategies and plans developed	34. Prioritize elements of the Flood Prevention Plan through a consultative process	23	M
			35. Develop a detailed Terms of Reference for the implementation of these elements	23	M
			36. Develop a detailed costs assessment for these elements	23	M

Note on Flood Prevention through Nature Based Solutions in the Dryland Zone

Nature Based Solutions are being advocated to complement civil works to prevent flooding in riparian zones. This is a sensible approach in climate zones with at least 1000 mm of annual rainfall that can support dense and permanent vegetation. The approach, however, is less likely to work at landscape scale in the dryland zone that is dominated by communal lands with a pastoralist livelihood system. Nature Based Solutions – which imply increasing vegetation cover and slowing down runoff in small stream through leaky weirs and other small interventions in combination with vegetation – are very useful in the dryland zone for various functions such as catchment rehydration, increasing baseflow, creating micro-climates, and increasing biomass production. However, the impacts of these very beneficial interventions are mostly at smaller scale. It will probably not impact on the flood hydrograph given the size of the Shabelle catchment. In addition, these interventions are hard to maintain on communal lands.

Dryland restoration at landscape scale is a massive undertaking that must be based on finding a new equilibrium between the natural resource base and its sustainable use. Because of the prevailing pastoralist livelihood system, it will imply changes to age-old traditional grazing rules. Achieving this new balance is very challenging in communal lands that are subject to the 'tragedy of the commons'. The latter means that pastures are easily over-exploited because of uncoordinated grazing by individual herders—specifically in periodic drought years. It has proven very difficult to restore these fragile ecosystems once they have been degraded. Hence quick results should not be expected. At best, this is a long-term undertaking with only gradual impacts on flood volumes. A complicating factor in the Shabelle basin is the fact that most runoff originates in Ethiopia. Somalia will have no influence on the programs and interventions implemented by its upstream neighbour.

In view of the above, the SAP has opted for an approach that is fully within the control of the authorities in Somalia and can achieve results in the short- and medium-term future. It comprises multiple interlinked components: 1) strengthening flood defences at critical points along the river, 2) a setup that can accommodate incidental overtopping but prevents embankment collapse, 3) increasing water storage capacity across the board to attenuate the flood wave and store water for productive use at a later point in time, and 4) the rehabilitation of the Duduble flood relief canal (and others) to direct part of the flood wave away from the main river – while making sure this water is not wasted.

It is noted that this approach is dominated by civil works. However, given the urgency of the problem and the severity of potential flood damage, caused by the inverse topography of the riparian zone, it is inevitable that civil engineering will take centre stage for now. If Nature Based Solutions prove a viable and effective proposition in the Shabelle basin – that can be scaled up – the role of civil works can be gradually reduced in a future iteration of the Flood Prevention Plan.

B: Water Resources Management

Strategic Objectives:

1. Equitable and effective use of water resources that supports socio-economic development for the people living in the Shabelle basin while maintaining environmental integrity
2. Avoid structural overuse of water resources that will risk water deficits and generalized crop failure, could lead to water conflicts at various scales, or could imperil environmental integrity in periodic drought periods
3. Avert damage from the impacts of periodic floods
4. Encourage storage of excess water resources for productive use at a later point in time

Practical Objectives:

1. Regulate water abstractions— in a consultative and participatory process with all major stakeholders—and ensure that total water use does not exceed an agreed-upon and hydrologically sustainable ceiling that takes environmental aspects into account
2. Store as much Shabelle water as possible—either in groundwater or in surface water reservoirs—for productive use at a later point in time
3. Ensure that no water resources leave the Shabelle system without productive use, for instance through evaporation; note that productive use includes maintaining environmental integrity
4. Develop agreed-upon mechanisms to allocate water resources in periodic drought periods in a consultative and participatory process with all stakeholders

Strategic Actions	Expected Result	Cross References to NWRS per strategic action	Detailed Action Plan	Cross References To SAP	Time scale
B1: Build capacity for effective and equitable water resources management	improved water resources management capacity at all levels in terms of staffing, technical skills, institutional arrangements, water data, information products, models, etc. It is noted that most this subject has been addressed by the recently published	Sub-strategy 7: Undertake capacity building & knowledge exchange interventions SO7a: Water sector capacity is progressively built Sub-strategy 2: Establish water sector institutional framework SO2a: Water sector institutional framework developed SO2b: Water sector institutions established and developed	The reader is referred to the National Water Resources Strategy apart from activity 37 (below)		

Strategic Actions	Expected Result	Cross References to NWRS per strategic action	Detailed Action Plan	Cross References To SAP	Time scale
	National Water Resources Strategy.		37. In close cooperation with MoAI, establish the Shabelle Basin Authority to manage the barrage system in a synchronous manner, and allocate water resources as per the agreed-upon plan (see 54)	54	S/M
B2: Develop select information products	accurate information on key aspects of the Shabelle system in Somalia that is required for informed decision making regarding sustainable allocation and management of the Shabelle waters.	Sub-strategy 13: Systematize monitoring and information management SO13a: Hydrological and environmental monitoring networks are developed	38. Establish the hydrologic regime of the Shabelle and determine the frequency of extreme drought and flood events; determine the volume of Shabelle waters that is available for sustainable use	1, 2, 3, 4	S
			39. Map the shallow aquifer that underlies the riparian zone along the Shabelle and establish the sustainable offtake potential; identify current and potential recharge areas	6	M
			40. Determine the environmental flow requirements for various reaches of the Shabelle	1, 2, 3, 4, 38	M
			41. Map the existing irrigation areas and assess current water demand and water use; determine the maximum extent of sustainable irrigation given the available water resources	38	M
			42. Develop a hydrological model for the Shabelle basin; at a minimum this model should cover the entire Shabelle catchment area in Somalia; preferably, this model should be linked to existing models for the Shabelle basin that also include the Ethiopian part of the catchment	1-4, 6	M
			43. Define practical water quality indicators with the aim to monitor and evaluate the quality of the Shabelle waters and identify pollution sources (point-source and non-point-source)	42	S/M
			44. Prepare a preliminary assessment of the water quality of the Shabelle; prepare follow-up actions based on the preliminary assessment	42, 43	S/M

Strategic Actions	Expected Result	Cross References to NWRS per strategic action	Detailed Action Plan	Cross References To SAP	Time scale
B3: Regulate Water Use	active and effective control over the use of the water resources of the Shabelle by the responsible authorities	Sub-strategy 11: Improve water sector regulation SO11a: Water permitting system developed and implemented SO11b: Compliance monitoring and enforcement strategy developed and implemented	45. Develop a permit system that regulates water abstractions	38, 41	M
			46. Monitor water abstractions and ensure compliance with the permit	45	M/L
			47. Develop agreed-upon mechanisms to ensure that unauthorized water abstractions—e.g. for unregulated irrigation expansion—are prevented	38, 41	M
B4: Drought Management	an agreed-upon mechanism to allocate water resources during periods of water shortage in combination with measures to increase water availability during drought years	Sub-strategy 10: Plan and respond to climate variability and its impacts on water resources management and development (adaptation, mitigation and recovery) SO10b: Flood and drought risk management strategies and plans developed	48. Create and expand water storage reservoirs at all scales—including the JOSR but also small-scale reservoirs in natural depressions inside and outside irrigation schemes	23	M/L
			49. Encourage recharge of groundwater by excess floodwater	23, 39	M/L
			50. Develop a sustainable system for conjunctive use of groundwater, surface water, and water from storage facilities during periods of water shortage; the setup of this system is site specific and will differ per area and irrigation scheme	23, 38, 41	M/L
			51. Develop a mechanism that has been agreed-upon by all stakeholders to allocate water resources during periods of water shortage; it may include compensation mechanisms for those who do not receive water in these periods	23, 38, 41, 50	M
B5: Water supply of Mogadishu	Secure water supply for domestic and industrial purposes for Mogadishu	Sub-strategy 19: Improve provision of water and sanitation services (WSS) SO19a: Sustainable frameworks for the provision of WSS SO19b: Delivery of sustainable and safe WSS services is improved	52. Carefully manage groundwater abstractions for Mogadishu to prevent salt-water intrusion		M/L
			53. Develop a water supply strategy for Mogadishu and secure timely investments for wastewater management, water treatment and delivery facilities, and measures to make better use of rainwater resources		M

C: Irrigation

Strategic Objectives:

1. Prevent flooding of irrigated areas
2. Provide secure water supply for irrigated agriculture in the Shabelle basin
3. Avoid structural overuse of water resources and prevent generalized crop failure because of water shortages during periodic droughts
4. Promote the effective use of water and prevent waste of scarce water resources

Practical Objectives:

1. Prepare and implement a Flood Prevention Plan
2. Determine the sustainable volume of Shabelle waters available for irrigated agriculture
3. Monitor abstractions to the main canals and ensure compliance with the agreed-upon allocations
4. Promote effective use of drainage water, for instance by encouraging infiltration to groundwater
5. Develop agreed-upon mechanisms to allocate water resources in periodic drought periods in a consultative and participatory process with all stakeholders

It is acknowledged that improving water productivity in agriculture—irrigated and rainfed—will require interventions outside the water sector such as improvements in value-chain infrastructure, improved farming practices, or better farm-gate prices. The SAP, however, only focuses on water-related interventions since this is within the mandate of the MoEWR. Collaboration with the respective technical ministries should be established to pursue the required interventions outside the water sector.

Strategic Actions	Expected Result	Cross References to NWRS per strategic action	Detailed Action Plan	Cross References to SAP	Time Scale
C1: Sustainable and equitable water allocation for irrigated agriculture in the Shabelle basin	Agreed-upon water allocation for each irrigation scheme that is fair and sustainable, and considers other water uses and the environmental integrity of the Shabelle	Sub-strategy 11: Improve water sector regulation SO11a: Water permitting system is developed and implemented	54. In close cooperation with MoAI, develop an irrigation-scheme water allocation plan through a consultative and participatory process with all major stakeholders; the plan will be based on the information products developed under B2, such as the hydrologic regime of the Shabelle, the maximum extent of irrigated agriculture in the Shabelle basin, and the instream flow requirements	23, 38, 39, 41, 50	M
			55. In close cooperation with MoAI, coordinate a permanent dialogue between the main water users—particular the groups that are upstream and downstream of each another—to ensure that each party understands, agrees with, and adheres to the agreed-upon water allocation plan (see above); this task may be implemented through the Shabelle Basin Authority	54	M/L

Strategic Actions	Expected Result	Cross References to NWRS per strategic action	Detailed Action Plan	Cross References to SAP	Time Scale
			56. In close cooperation with MoAI, establish transparent procedures for when to initiate the drought management plan (see B4)	54	M
			57. In close cooperation with MoAI, rehabilitate barrages and main canals; priorities are Sabuun, Balcad, and Janaale	23, 38, 39, 41, 50, 54	L
C2: Rehabilitate the barrage system	A functioning system of barrages and intake structure that maintains adequate head in the main irrigation canals; it is noted that a centralized water off-take system that uses the barrages—in contrast to many smaller off-take points from the main river—enables monitoring of water abstractions and ensures compliance with the agreed-upon irrigation-scheme water allocation plan (see D1)	Sub-strategy 17: Improve water security for irrigation and agriculture SO17b: Water security for irrigated agriculture and livestock sectors is improved	58. Whenever requested, assist MoAI in promoting effective water management and reforming irrigation practices to reduce inefficient water use, specifically by replacing flood irrigation with more effective practices		M/L
C3: Promote effective use of water resources	Reduce wasteful use of water resources and improve water productivity in irrigated agriculture in the Shabelle	Sub-strategy 17: Improve water security for irrigation and agriculture SO17b: Water security for irrigated agriculture and livestock sectors is improved SO17c: On-farm irrigation technologies and water use management improved	59. Whenever requested, assist MoAI to identify locations for small scale reservoirs within existing irrigation schemes; assist MoAI in developing a system for conjunctive use of groundwater, surface water, and water from small scale reservoirs during drought periods	6, 39, 41	M/L
			60. Ensure that drainage water that leaves the irrigation scheme is channelled to areas where it can infiltrate to the groundwater	6, 23	M/L

D: Livestock

Strategic Objectives:

1. Ensure that rainfall over the grazing areas is used for biomass production rather than for evaporation without productive use
2. Provide secure drinking water for animals
3. Ensure that the proper balance between pasture and the availability of drinking water for animals is always maintained

Practical Objectives:

1. Prevent overgrazing and make certain that some level of ground cover is always maintained
2. Reduce flash runoff in ephemeral streams
3. Base the establishment of drinking water sources for animals on the available pasture

It is acknowledged that improving livestock productivity will require interventions outside the water sector such as improved animal management and improvements in value-chain infrastructure. The SAP, however, only focuses on water-related interventions since this is within the mandate of the MoEWR. Collaboration with the respective technical ministries should be established to pursue the required interventions outside the water sector.

Strategic Actions	Expected Result	Cross References to NWRS per strategic action	Detailed Action Plan	Cross References to SAP	Time scale
D1: Capture and store storm runoff for productive use at a later point in time	Water stored in shallow aquifers in ephemeral riverbeds and small reservoirs that can be used for watering animals in the dry season	Sub-strategy 18: Improve water security for livestock & wildlife SO18: Water security for livestock and wildlife sectors is improved	61. Establish a combination of check-dams, sand-dams, and other small-scale water harvesting structures in ephemeral streams—in combination with vegetation—that captures storm runoff and encourage infiltration in the riverbed and adjacent riparian zone		M/L
			62. Establish small reservoirs and associated small-scale water harvesting structures in small streams that capture and store storm runoff		M/L
			63. In flatter river reaches in a wide alluvial valley, establish low dikes parallel to the river that capture storm runoff and encourage infiltration in the shallow aquifer		M/L
			64. Ensure close consultation with the local communities to make certain that increased water availability in the dry season for watering animals will not lead to overgrazing and conflicts over pastures	61, 62, 64	M/L

E: Transboundary Water Management

Strategic Objectives:

1. Ensure an equitable and reasonable use of water resources that supports socio-economic development for all people living in the Juba-Shabelle basin while maintaining environmental integrity
2. Promote data and information exchange with neighbouring riparians
3. Promote benefit sharing through collaboration in development, management and utilization of water resources for economic, social and environmental services
4. Regulate water abstractions in a consultative and participatory process with all major stakeholders from the three riparian countries to ensure that total water use does not exceed supply and take environmental requirements into account
5. Develop good neighbourly relations and collaborate constructively over shared water and related issues

Practical Objectives:

1. Create foundations for transboundary water cooperation with Ethiopia and Kenya over the Juba-Shabelle basin resources
2. Identify win-win outcomes that optimize mutual economic, social and environmental services. Drought vulnerability is an immediate and borderless issue that affects all riparians
3. Avert damages from the impacts of periodic floods and droughts through a coordinated approach
4. Strengthen water availability for socio-economic development

Strategic Actions	Expected Result	Cross References to NWRS per strategic action	Detailed Action Plan	Cross References to SAB	Time frame
E1: Improve knowledge base on the Juba-Shabelle Basin in Somalia	Create knowledge base to be able to discuss the use of the Juba-Shabelle water resources and enable informed future dialogue processes on water sharing and development with Ethiopia and Kenya.	Sub-strategy 4: Establish a basis for transboundary basin management SO4a: Understanding of WR in transboundary basins/aquifers is developed	65. Develop river and subsurface water flow models	38,	S/M
			66. Assess exact current water balance (water availability and water use) in the Juba & Shabelle basins of the Somali parts of the basin and determine the water that is still available under current and potential future development scenarios (considering upstream developments and climate change). • Map irrigated areas and types of crops to derive more accurate numbers on water use in the Shabelle and Juba basin • Determine accurate numbers on current water inflow at the border to Ethiopia • Conduct study on the actual water balance of the Juba-Shabelle systems	38, 40, 41, 54	S/M
			67. Engage basin stakeholders in Somalia (including local governments, civil society, private actors etc.) through dialogue process to determine priorities for transboundary cooperation and to identify existing cross-border		M

Strategic Actions	Expected Result	Cross References to NWRS per strategic action	Detailed Action Plan	Cross References to SAB	Time frame
			collaborations at local and regional levels that could be strengthened/which can be built upon		
E2: Develop human and institutional capacity for transboundary water cooperation	Improved water resources management capacity in terms of staffing, technical skills and institutions to formulate water resources development options and to explore and pursue appropriate avenues for transboundary water dialogue	Sub-strategy 4: Establish a basis for transboundary basin management SO4b: Principles for transboundary WRM & cooperation developed and agreed Sub-strategy 7: Undertake capacity building & knowledge exchange interventions SO7a: Water sector capacity is progressively built	68. Strengthen the established transboundary advisory committee at the FGS through e.g. ensuring that all relevant ministries are involved (including MFA, MoA etc.) and ensuring that all transboundary water issues are channelled through this committee		S/M
			9. Strengthen consultations/dialogues between FGS, FMS and districts to discuss issues of transboundary concern, address existing conflicts, coordinate water allocation issues (within Somalia) and co-develop principles for transboundary water cooperation; use such meetings for capacity development; this task may be implemented through the Shabelle Basin Authority	54, 55	M/L
			70. Conduct water diplomacy trainings with key staff from FGS (including the transboundary advisory committee) focusing on issues such as negotiations skills, IWL, data sharing mechanisms etc.		S/M
			71. Support joint research activities and pilot projects in areas that are of mutual concern, such as on flood management, high salinity levels or the low productivity rates of existing irrigation schemes		M/L
E3: Engage in multi-track diplomacy activities to build trust and good relations with Ethiopia and Kenya	Take deliberate steps to build the foundations for cooperation over shared water resources at multiple levels, focusing on building trust amongst various stakeholders	Sub-strategy 4: Establish a basis for transboundary basin management	72. Conduct an assessment on transboundary benefit-sharing possibilities and identify potential joint investment projects with Ethiopia and Kenya		M/L
			73. Continue collaboration within the Horn of Africa Initiative to expand relations in trade, joint projects such as on road infrastructure, accessing ports etc. (and possibly involve MoEWR in the process)		S/M
			74. Evaluate whether and under which conditions the IGAD negotiations on the development of a regional Water Protocol could be revived		S/M

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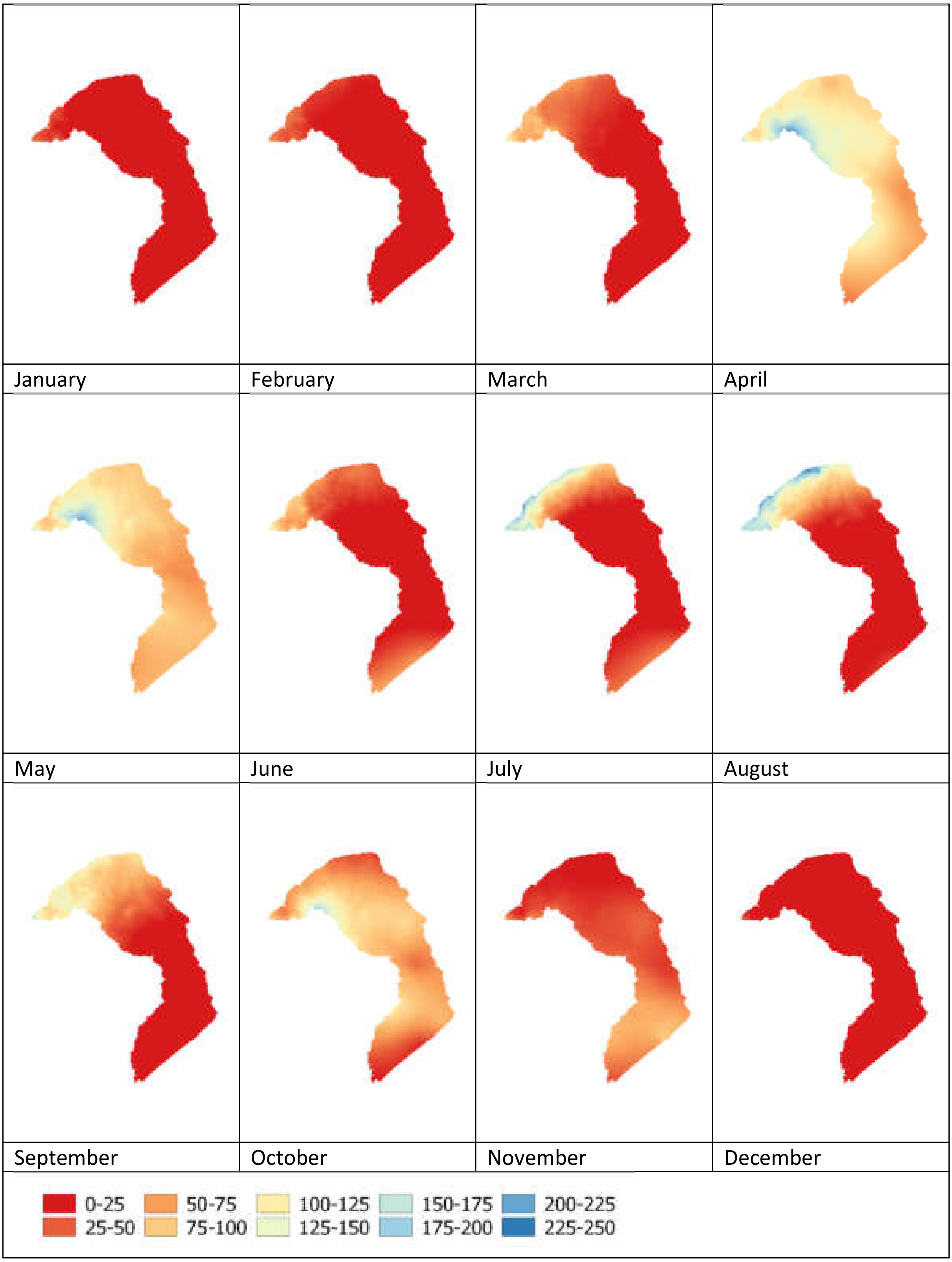
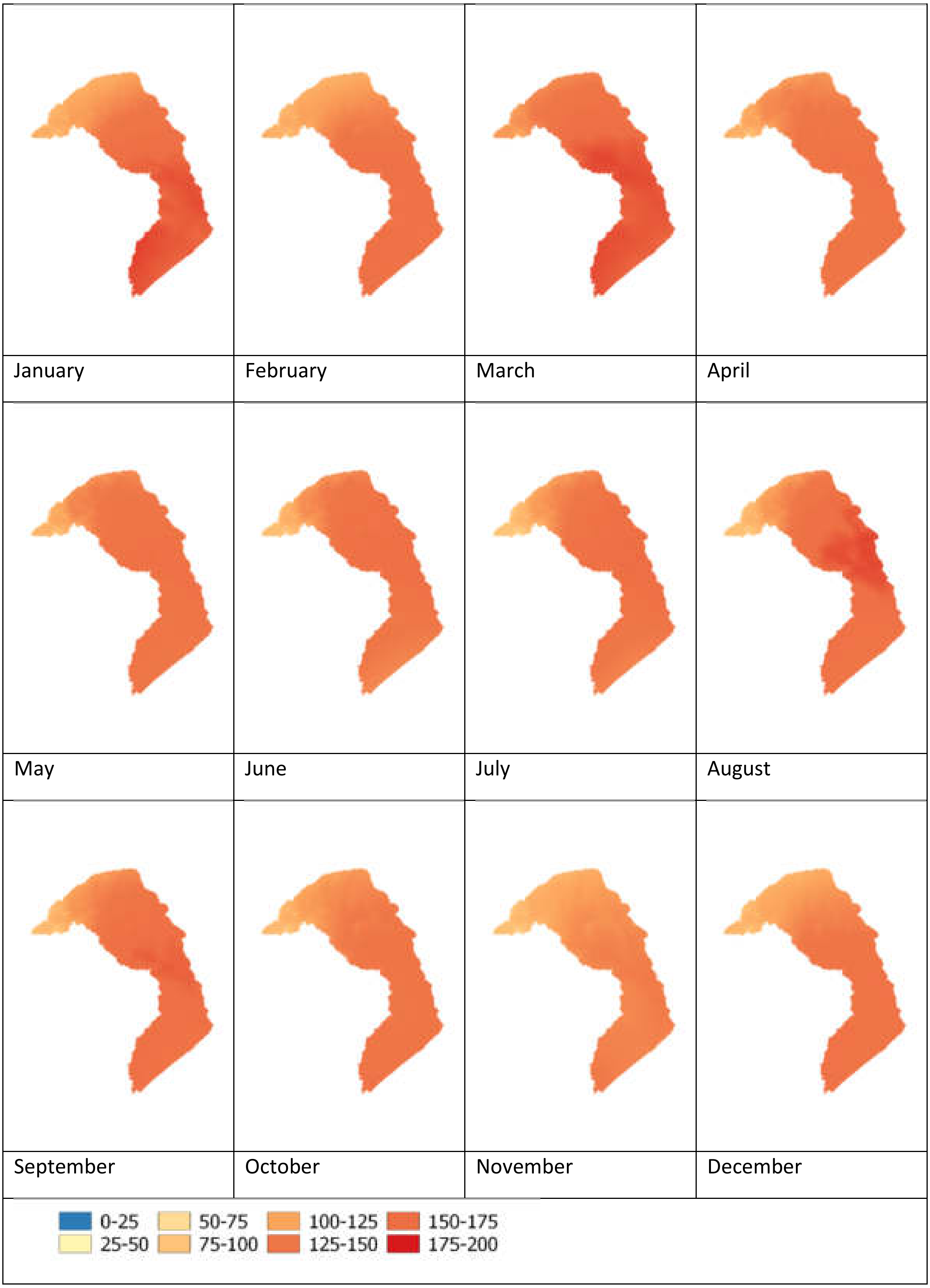
Annex

Annex A.1: Average monthly rainfall in mm over Shabelle basin

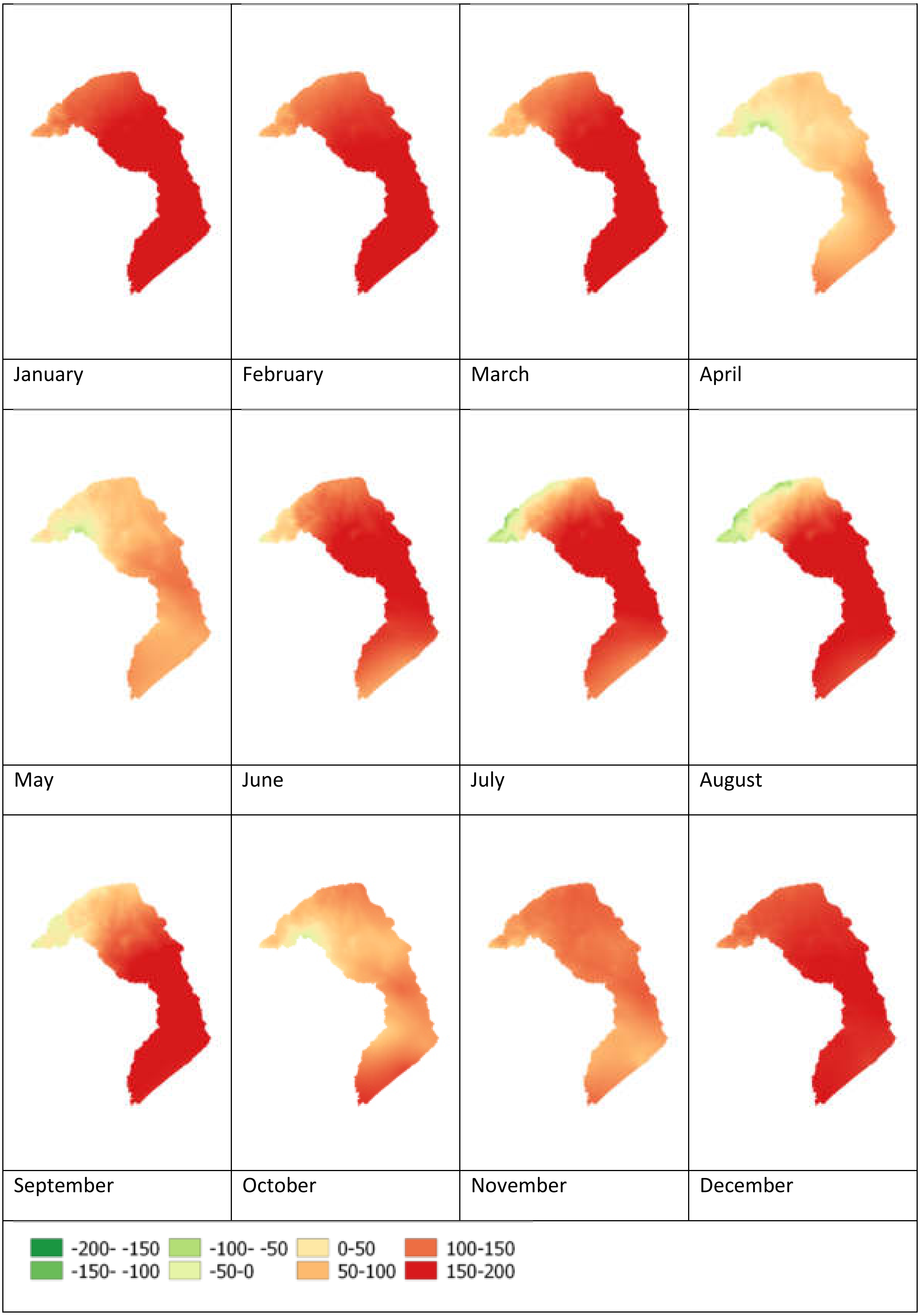


Source: CRU

Annex A.2: Average monthly ET0 in mm over Shabelle basin



A.3: (A3) Average monthly moisture deficit (ET0-P) in mm over Shabelle basin



Source: CRU

Annex A.3:Farming systems in the Shabelle basin

Lower Shabelle Region Gu Season irrigated farming system

#	Crop Name	Farm operations	Month when operation takes place	Cropping pattern	Approximate yields Kg/Ha
1	Maize	Land preparation	March	70%	900
		Planting	April, May		
		Irrigation (furrow)	May, June		
		Weeding	May, June		
		harvesting	August		
2	Sesame[6]	Land preparation	July	15%	250
		Planting	August, September		
		Irrigation (flood)	August, September		
		Weeding	September, October		
		Harvesting	November, December		
3	Vegetables (Tomato 74%, Onion 14%, lettuce, spinach 2.6%, carrots 3.5%, sweet pepper 4%, okra)	Land preparation	June, July (Nursery in June)	5%	Onion 6,000
		Planting	July		Tomato 7,500
		Irrigation (basin)	July		Carrots 12,000
		Weeding	August, September, October		Spinach 7,000
		Harvesting	September, October		Sweet pepper 3,500 Lettuce 5,000
4	Bananas	Land preparation	January, February, March	1%	25,000
		Planting	April, May, October		
		Irrigation (basin)	Every 2-3 weeks after planting until Jilal where it is done 1-2 weeks		
		Weeding	Every 2-3 weeks after planting until 8th month. Light weeding is done every 6 -8 weeks after 12th month		
		harvesting	April, May, June, July, etc (9-12 months after planting depending on crop management)		

[6] Sesame planting is set to coincide and benefit from Haggai rains, some sesame planted as a cash crop is inter-planted in maturing maize fields.

Lower Shabelle Region Deyr Season irrigated farming system

#	Crop Name	Farm operations	Month when operation takes place	Crop-ping pattern	Approximate yields Kg/Ha
1	Maize	Land preparation	September	70%	900
		Planting	October		
		Irrigation (furrow)	October, November, December		
		Weeding	October, November		
		Harvesting	December, January		
2	Sesame	Land preparation	October, November	15%	250
		Planting	November		
		Irrigation (Flood)	October, November		
		Weeding			
		Harvesting	February		
3	Vegetables (Tomato 74%, Onion 14%, lettuce, spinach 2.6%, carrots 3.5%, sweet pepper 4%, okra)	Land preparation	August (Nursery in June)	5%	Onion 6,000 Tomato 7,500 Carrots 12,000 Spinach 7,000 Sweet pepper 3,500 Lettuce 5,000
		Planting	August		
		Irrigation (basin)	August		
		Weeding	August, September, October		
		Harvesting	September, October, November, December		
4	Bananas	Land preparation	January, February, March	1%	25,000
		Planting	April, May, October		
		Irrigation (basin)	Every 2-3 weeks after planting until Jilal where it is done 1-2 weeks		
		Weeding	Every 2-3 weeks after planting until 8th month. Light weeding is done every 6 -8 weeks after 12^{th} month		
		Harvesting	April, May, June, July, etc (9-12 months after planting depending on crop management)		

Tree crops including citrus, mango, papaya, and coconut are grown together with bananas as perimeter crops or on own fields. However, in Afgoye district pump fed citrus (oranges, lemon and grapefruits) are grown in standalone orchard

Middle Shabelle Region Gu Season irrigated farming system

#	Crop Name	Farm operations	Month when operation takes place	Cropping pattern	Approximate yields Kg/Ha
1	Maize	Land preparation	March	75%	900
		Planting	April, May		
		Irrigation (furrow)	May, June		
		Weeding	May, June		
		harvesting	August		
2	Vegetables (Tomato 74%, Onion 14%, lettuce, spinach 2.6%, carrots 3.5%, sweet pepper 4%, okra)	Land preparation	June, July (Nursery in June)	7%	Onion 6,000
		Planting	July		Tomato 7,500
		Irrigation (basin)	July		Carrots 12,000
		Weeding	August, September, October		Spinach 7,000
		Harvesting	September, October		Sweet pepper 3,500
					Lettuce 5,000
3	Bananas	Land preparation	January, February, March	1%	25,000
		Planting	April, May, October		
		Irrigation (basin)	Every 2-3 weeks after planting until Jilal where it is done 1-2 weeks		
		Weeding	Every 2-3 weeks after planting until 8th month. Light weeding is done every 6 -8 weeks after 12th month		
		harvesting	April, May, June, July (9-12 months after planting depending on crop management)		
4	Sesame	Land preparation	October, November	15%	250
		Planting	November		
		Irrigation (flood)	October, November		
		Weeding			
		Harvesting	February		

Limited rice production takes place in middle Shabelle during both Gu and Deyr season. However, rice was a major crop in middle Shabelle before the collapse of the Rice Growers Association (MISHAGA). MISHAGA had rice millers that allowed local milling for the association as well as for individual farmers

Middle Shabelle Region Gu Season irrigated farming system

#	Crop Name	Farm operations	Month when operation takes place	Cropping pattern	Approximate yields Kg/Ha
1	Maize	Land preparation	September	40%	900
		Planting	October		
		Irrigation (furrow)	October, November, December		
		Weeding	October, November		
		Harvesting	December, January		
2	Sesame	Land preparation	October, November	50%	250
		Planting	November		
		Irrigation (flood)	October, November		
		Weeding			
		Harvesting	February		
3	Vegetables (Tomato 51%, Onion 24%, lettuce 7%, Spinach 3.4%, Carrots 3.4%, Sweet pepper 7%, Okra 1.1%)	Land preparation	August (Nursery in June)	4.0%	Onion 6,000
		Planting	August		Tomato 7,500
		Irrigation (basin)	August		Carrots 12,000
		Weeding	August, September, October		Spinach 7,000
		Harvesting	September, October, November, December		Sweet pepper 3,500 Lettuce 5,000
4	Banana	Land preparation	January, February, March	1%	25,000
		Planting	April, May, October		
		Irrigation (basin)	Every 2-3 weeks after planting until Jilal where it is done 1-2 weeks		
		Weeding	Every 2-3 weeks after planting until 8th month. Light weeding is done every 6 -8 weeks after 12th month		
		Harvesting	April, May, June, July (9-12 months after planting depending on crop management)		

Hiran Region Gu Season irrigated farming system

#	Crop Name	Farm operations	Month when operation takes place	Cropping pattern	Approximate yields Kg/Ha
1	Maize (Grown as a fodder crop)	Land preparation	March	50%	-
		Planting	April, May		
		Irrigation (furrow)	May, June		
		Weeding	May, June		
		harvesting	August		
2	Onion and Tomato	Land preparation	June, July (Nursery in June)	5%	Onion: 6,000 Tomato: 7,500
		Planting	July		
		Irrigation (basin)	July		
		Weeding	August, September, October		
		Harvesting	September, October		
3	Sorghum (Grown as a fodder crop)	Land preparation	March	40.0%	-
		Planting	April, May		
		Irrigation (furrow)	May, June		
		Weeding	May, June		
		harvesting	August		
4	Sesame	Land preparation	October, November	5%	250
		Planting	November		
		Irrigation (flood)	October, November		
		Weeding			
		Harvesting	February		

Hiran Region Deyr Season irrigated farming system

#	Crop Name	Farm operations	Month when operation takes place	Cropping pattern	Approximate yields Kg/Ha
1	Maize	Land preparation	September	35%	900
		Planting	October		
		Irrigation (furrow)	October, November, December		
		Weeding	October, November		
		Harvesting	December, January		
2	Sesame	Land preparation	October, November	20%	250
		Planting	November		
		Irrigation (flood)	October, November		
		Weeding			
		Harvesting	February		
3	Onion and tomato	Land preparation	August (Nursery in June)	5.0%	Onion 6,000 Tomato 7,500
		Planting	August		
		Irrigation (basin)	August		
		Weeding	August, September, October		
		Harvesting	September, October, November, December		
4	Sorghum	Land preparation	September	40%	300
		Planting	October		
		Irrigation (furrow)	October, November, December		
		Weeding	October, November		
		Harvesting	December, January		

Annex A.4: Photos agricultural production in the Shabelle basin

Source of all photos: Cactus Analysis and Management Services

Maize milling in Middle Shabelle, Jowhar

Sunflower in Middle Shabelle (Jowhar)

Oil press machine - Sunflower seed, Middle Shabelle (Jowhar)

Vegetable transplanting and irrigation, Middle Shabelle (Jowhar)

Vegetables (Dhania) ready for harvest, Middle Shabelle (Jowhar)

Sesame stacked for drying – Lower Shabelle

Banana harvesting and transporting to market – Lower Shabelle

Tomato harvesting ready for transport to market – Lower Shabelle

Annex A.5: List of Interviewees

NAME	Organization
Ahmed Mohamed Hassan	Ministry of Energy and Water Resource (MoEWR)
Mohamed Fatih Sheikh	Ministry of Energy and Water Resources (MoEWR)
Abdullahi Elmi Mohamed	Ministry of Planning, Investment and Economic Development (MoPIED)
Abdullahi Hassan Hussein	Ministry of Agriculture (MoA)
Asli Duale	Somalia Water Partnership, Women Education and Voicing Entrepreneurship (WEAVE)
Abdulrashid Omar	Hiiraan Development Program (HDP)
Guled Ahmed Willik	Power OffGrid and Jiko Biogas
Abdullahi Ali Yusuf	Al-Mizan Trading Co.
Jochen Wenniger	IHE Delft
Christopher Print	Food and Agriculture Organization of the UN (FAO)
Paul Githumbi Ndiritu	Food and Agriculture Organization of the UN (FAO)
Abdullahi Roble	Roble Consulting Limited
Klas Sandström	World Bank (WB)
Toshihiro Sonoda	World Bank (WB)
Abdul Qadir	United Nations Development Programme (UNDP)
Christophe Hodder	United Nations Environmental Programme (UNEP)
Abdulkadir Abdi Mohamed	Somali Central Region Association for Animal Production and Health (CERELPA)
Ahmed Yakub	CEFA – Il seme della solidarietà
Omer Mussa Hussien	Ethiopian Water Consultant
Muktar Abdi Ali	Ethiopian Water Consultant