

APRIL 2025



FEASIBILITY STUDY REPORT

FOR THE PROPOSED WATER INNOVATION CENTRE FOR THE JUBALAND STATE OF SOMALIA

LUGLOW, 30KMS NORTH OF KISMAAYO, JUBALAND – STATE OF SOMALIA



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ACKNOWLEDGEMENT ON ACTUALIZATION FOR THE CLIMATE- RESILIENT WATER RESOURCE MANAGEMENT PROJECT IN SOMALIA (CRWRM)

Before commencement of the Water Innovation Centre Feasibility Study that we were contracted and obligated to do. We ("*herein the consultant*") had a sit-down and brief inception meeting on looking at the Climate Resilient Water Resource Management in Somalia Project came to life to address the water challenges solutions and give life to a sustainable best practice to conserve , manage and efficiently use the Regions' water resources in long term to serve its citizens in Jubaland and Hirshabelle States in Somalia. The active program is set to address the challenges including but not limited to:

Alternating drought & flood (climate change hazards).
Poor Coordination and actual management of water resources.
Limitations in institutional capacity and data to assess water availability, demand, and use.
Cultural norms that undermine women participation in decision making in water resource use and management
Absence of clear roadmap on transboundary water management.

Additionally, the client broadly explained to us on the road maps set to achieve the program's objective. They included the :-
Institutional building and implementation capacity to implement the regional's intended water action plans.
Maintenance of Infrastructure for water sources long-term sustainability.
Water innovation plans and developments as a creative solutions to address on effective water management best practices as well as the positive after effects of that may impact the region's increased Agricultural yields, improved hygiene and sanitation and generally supporting the basic concept and necessity that water is life to all biotic.

We intend to support and gear the program on its water innovation plans for the program to give life to its objectives.

We appreciate the Regions' Government, its partners, donors and all stakeholders in giving birth to this positive humanitarian activity and co-ordinating to improve water sustainability in this region.

The Consulting Firm shall do its absolute best in issuing out a comprehensive Water Innovation Centre and alternative demonstrations on its Feasibility Study that shall be conducted and issued out.

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LIST OF ABBREVIATIONS

EU	European Union.
GIZ	German Corporation for International Cooperation.
CRWRM	Climate resilient water Resources Management
ADF	African Development Fund
AfDB	African Development Bank
AWD	Acute Water Diarrhea
CRM	Customer-Relationship-Management
MoEWR	Ministry of Energy and Water Resources.
JUWA	Jubaland Water Agency.
EIA	Environmental Impact Assessment
IDPs	Internally Displaced Persons.
IWRM	Integrated Water Resources Management.
NGOs	Non-Governmental Organizations.
MASL	Meters above Sea Level.
PPP	Public Private Partnership.
SWAT	Soil and Water Assessment Tool.
UNFP	United Nations Population Fund.
FDC	Flow Duration Curve.
CRM	Customer-Relationship-Management
DRP	Drought Response Project
EIRR	Economic Internal Rate of Return
ENPV	Economic Net Present Value
G.I.	Galvanized Iron
GIS	Geographic Information System
HR	Human Resources
ICT	Information and Communication Technologies
IDP	Internally Displaced Persons
IoT	Internet of Things
IWRM	Integrated Water Resource Management
JWC	Jubba Water Company
JWSC	Juba Water Supply Company
KfW	Kreditanstalt für Wiederaufbau
KPI	Key Performance Indicator
KUWSU	Kismayo Urban Water Suppliers Union
M&E	Monitoring & Evaluation
NGO	Non-Governmental Organization
O&M	Operation and Maintenance
PBA	Performance-Based Allocation
PPP	Public-Private Partnership
QM	Quality Management
RWPM	Raw Water Pumping Main
SCADA	Supervisory Control and Data Acquisition
SOP	Standard Operating System
TL	Team Leader
ToR	Terms of Reference
TSF	Transition Support Facility
TWG	Technical Working Group

EXECUTIVE SUMMARY

The Ministry of Water and Energy Resources (MoEWR) in partnership with GIZ – German Corporation for International Cooperation have contracted Vital Care Consultancy Limited (“*herein the Consultant*”) to carry out consultancy services for the Feasibility Study for Water Innovation Centre for the Jubaland State of Somalia.

The project is intended to achieve the purpose to augment water supply provision and agricultural solutions to Luglow Location and environs from Jubba River Sub Surface water resource.

This feasibility study examines and advises on the potential for establishing a Water and Gender powered Transformative water Innovation Centre in the Jubaland State of Somalia. The project is spearheaded by the Ministry of Energy and Water Resources (MoEWR) with support from the GIZ – German Corporation for International Cooperation under the Climate Resilient Water Resource Management (CWRM) project, funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) and co-funded by the European Union.

The center is envisioned as a transformative model to enhance water security and agricultural productivity through innovative and sustainable practices.

The study evaluates multiple facets of the proposed project, including technical feasibility, Environmental and health impacts, financial sustainability, and capacity-building potential. Key components to be assessed include the construction of a dam, solar water pumping systems, a water distribution network from the Juba River, overhead storage tanks, and demonstration agricultural farms such as greenhouses.

Additionally, innovative technologies like bio-sand filters and interlocking blocks will be analyzed for their potential to generate community income and improve water access.

Findings from the study will guide the planning and implementation of the center to ensure it meets the immediate and long-term needs of internally displaced persons (IDPs), returnees, and host communities, particularly in the Kismayo Region. The study also emphasizes community engagement, climate resilience, and sustainable development as key priorities, with the overarching goal of building local capacity and improving livelihoods.

The final recommendations will support the Ministry in making informed decisions for the successful rollout of this pioneering project in Jubaland.

1.1 HISTORY AND STATE OF THE REGION IN REGARDS TO WATER SUSTAINABILITY.

Since the collapse of Somalia's central government in 1991, the country has experienced significant instability, marked by civil unrest and violence. Despite these challenges, recent years have seen a renewed focus on governance, peacebuilding, and development. Jubaland State, situated in southern Somalia, comprises the regions of Lower Juba, Middle Juba, and Gedo, with a population of approximately 1.3 million people. The region has faced serious water scarcity issues, exacerbated by climate change, irregular rainfall patterns, and deteriorating infrastructure.



The region has long experienced irregular rainfall patterns, with both the short rains (Deyr) and long rains (Gu) often falling below average levels. Recent years have seen a significant decline in annual rainfall, exacerbating water scarcity and increasing dependence on groundwater. This over-reliance has led to unsustainable abstraction rates, depleting water tables and making access to clean water increasingly challenging. Contaminated dug wells and inadequately regulated private boreholes further complicate the situation, heightening the risk of waterborne diseases.

The humanitarian impact of these water shortages is severe. Approximately 1.3 million people are affected, with many communities experiencing critical water shortages that disrupt daily life and livelihoods. The lack of water has led to significant losses in livestock and agricultural production, exacerbating food shortages and increasing vulnerability among households. Health statistics reveal a rise in waterborne diseases, including cholera and dysentery, further straining limited healthcare resources and increasing morbidity rates.

Economically, the water crisis has resulted in substantial losses, including decreased agricultural productivity, increased health-related costs, and livestock losses. Families face financial difficulties due to reduced agricultural income and higher expenditures on water and healthcare, disrupting livelihoods and hindering economic development.

Additionally, no feasibility studies have been conducted in the targeted or surrounding areas to assess the quality of water retention, soil fertility, topography, and other environmental factors crucial for sustainable water resource management. To address these challenges, the Ministry of Energy and Water Resources has categorized Jubaland's water needs into three priority levels: immediate, medium-term, and long-term solutions. In response, the Ministry with the support of climate resilient Water Resource Management project (CWRM) funded by German Federal ministry for economic cooperation and development (BMZ) and co-funded by the EU plans to establish an Integrated Learning Centre to address productive water resource management needs comprehensively.

Recognizing the urgent need for a coordinated approach to tackle these challenges, the Ministry has established the Water and Gender Transformative Innovation Centre. This facility is designed to operationalize sustainable solutions for water management and agricultural practices in the region, thereby enhancing the resilience of vulnerable communities.

The purpose of this study is to outline the procedure for conducting a comprehensive feasibility assessment for the proposed dam, solar pumping system, and pipeline system extending from the Jubba River, overhead storage tanks, and demo agricultural farms (greenhouse project).

1.2 STRUCTURE OF THE FEASIBILITY STUDY REPORT.

The report includes the following chapters.

CHAPTER ONE – INTRODUCTION.

The Chapter presents the background, objectives and structure of the report.

CHAPTER TWO – STUDY AREA.

The Chapter presents the climate of the area and its effects.

CHAPTER THREE – KEY CHALLENGES FACING THE AREA.

The Chapter highlights the major challenges Luglow Area, Kismayo Area and Jubaland Region faces.

CHAPTER FOUR – SOIL ANALYSIS AND RECOMMENDATION.

The Chapter outlines the characteristics of the soil based on soil sample analysis and agricultural recommendation.

CHAPTER FIVE – WATER RESOURCES STUDY.

The Chapter presents on the hydrological assessment for the Jubba River and potential Water Resources.

CHAPTER SIX – PROJECT COMPONENTS AND DESIGN CONSIDERATION.

The Chapter presents the project component, technical specification and design considerations.

CHAPTER SEVEN – ENVIRONMENTAL IMPACT ASSESSMENT (EIA).

The Chapter states and recommends on the Environmental, Health and Social Impact from the project.

CHAPTER EIGHT – COMMUNITY ENGAGEMENT AND FEEDBACK.

The Chapter captures and illustrates on the local community's insights and feedback on the proposed project.

CHAPTER ONE:

1.3 INTRODUCTION.

Sustainable and reliable water supply is key towards the achievement of [Climate resilient Water Resource Management project \(CWRM\)](#) and [German Federal ministry for economic cooperation and development \(BMZ\)](#) under [GIZ developmental water solutions and sustainability programme](#) for clean water and sanitation while contributing to good health and wellbeing.

Increasing water accessibility is widely seen as the main policy to stimulate growth in other sectors including agriculture and commerce thus improvement of local livelihoods. In comparison to other parts of the world and particularly Eastern Africa, the urban water supply coverage in Somalia is low due to protracted internal conflicts that has affected investment in water resources and water supply infrastructure. Further, the challenge of poor governance has affected the local water services institutional capacity to achieve sustainability. The internal conflict has also undermined the region's resilience policy towards climate variability and climate change

The internal conflict has brought about internally displaced persons (IDPs) including refugees hence putting further pressure on the limited water resources and water supply infrastructure. According to the Project local communities have fled to Kismayo due to the fighting between Al-Shabaab and government and allied forces, droughts and sometimes flooding in the riverine area since 2017. This is in addition to the more than 70,000 returnees from the Kenya Dadaab camp who have settled in Kismayo and further 60,000 IDPs who had settled earlier in Kismayo. This influx into the town have led to stretching of the already meagre communal resources, where acute malnutrition affecting about 14% of people.

There is not enough clean water, sanitation and health care facilities which has led to common ailments such as the Acute Water Diarrhoea (AWD) and frequent Cholera outbreaks. The IDPs have no income or income generating activity to foster the sustainability of the water supply. Alternative sources of water such as from the desalination plants are too expensive.

The region's strategy towards improved water accessibility is working with partners and other development agencies to meet their current and future needs. The opportunity to achieving this, lies on the perennial river systems such as the Jubba River that is estimated to be close to Luglow Area and Kismayo Town.

1.4 NEED FOR THE STUDY

The need for the study was to recognize the urgent need for a coordinated approach to tackle these water challenges.

Hence, the Ministry plans to establish the Water and Gender Transformative Innovation Centre which shall be designed to operationalize sustainable solutions for water management and agricultural practices in the region, thereby enhancing the resilience of vulnerable communities.

The study also outlines the procedure for conducting a comprehensive feasibility assessment for the proposed dam, solar pumping system, and pipeline system extending from the Jubba River, overhead storage tanks, and demo agricultural farms (greenhouse project).

1.5 OBJECTIVE OF THE STUDY

The overall objective of the assignment is to conduct thorough feasibility study for a water Innovation Centre in Luglow, Jubaland State for reliable and sustained present and future water supply solutions.

The study will be informed by the Climate resilient Water Resource Management project (CWRM) pillars on social equity, environmental integrity and economic efficiency. Social equity is from the understanding of the social-economic status of the residents in Luglow, Goobweyn and Kismayo Town. The affordability of the water services is key in tariff formulation. In addition, involvement of stakeholders in the project is paramount. The water supply system has to maintain economic sustainability in trade-offs has to apply in the operation and business model of the water service company considering the social status of the population. Infrastructural investment in water resources is huge, and thus the project needs to prioritize areas of immediate concern including proposals for phased development.

CHAPTER TWO

1.6 STUDY AREA.

The feasibility study focused on the Jubaland State of Somalia, encompassing the administrative regions of Lower Juba, Middle Juba, and Gedo.

Particular emphasis was placed on [Luglow area](#), [Kismayo](#) and adjacent communities which face acute water scarcity and agricultural challenges.

The region spans from the banks of the Jubba River to the semi-arid hinterlands, covering diverse landscapes including flood plains, alluvial soils, and degraded rangelands. With an estimated population of approximately 120,000 comprising internally displaced persons (IDPs), returnees, and host communities.

The study area is characterized by irregular bimodal rainfall patterns, high evapo-transpiration rates, and overexploited groundwater aquifers. Key water sources include seasonal river flows, shallow wells, and boreholes, many of which are contaminated or unsustainably managed. The study will map and assess these resources to determine optimal citing and design for the proposed infrastructure.

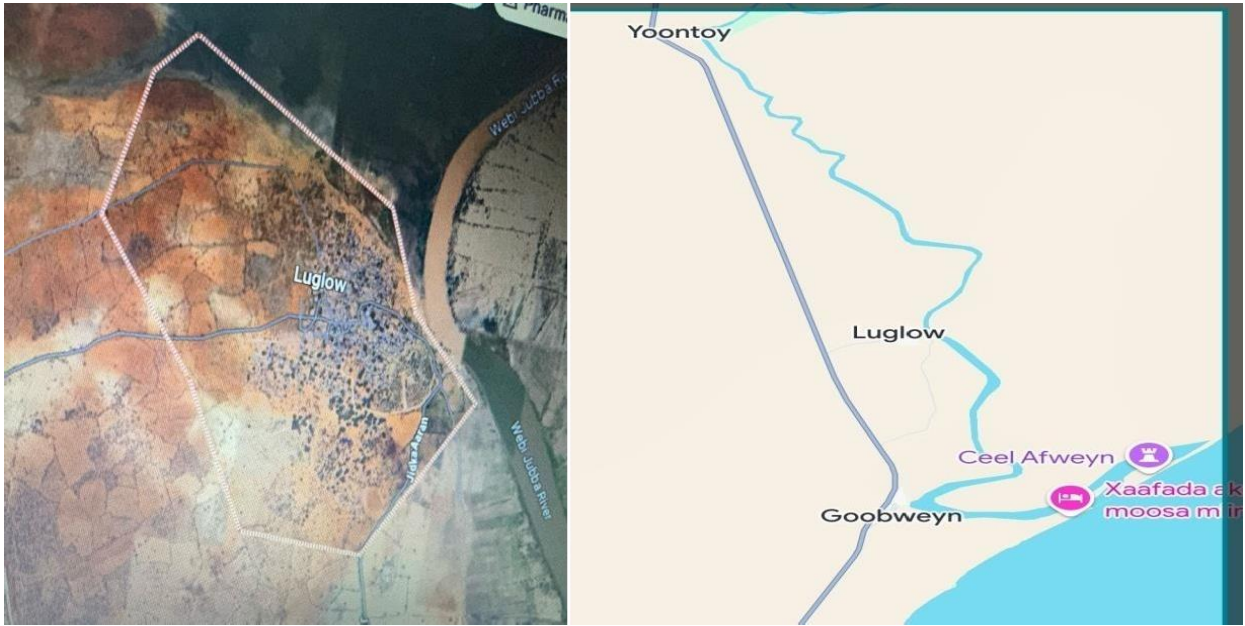


Figure 1 Map showing the location of Luglow within Kismayo



Figure 2 IDPS' camps in Luglow Area.

1.7: CLIMATE OF THE STUDY AREA

Luglow Area located near Kismayo in Somalia’s Lower Juba region experiences a hot and arid climate typical of the Horn of Africa.

The area is characterized by high temperatures year- round, with infrequent seasonal rainfall patterns.

1.8TEMPERATURE

Average Temperatures throughout the year generally range from 75°F to 88°F (24°C to 31°C), rarely dipping below 74°F (23°C) or exceeding 90°F (32°C).

1.9RAINFALL

The region experiences two main rainy periods: the **Gu** (April to June) and the **Deyr** (October to December). May typically sees the highest precipitation, averaging around 123 mm (4.9 inches). The driest months are January and February, with minimal rainfall averaging 4 mm (0.2 inches) and 3 mm (0.1 inches), respectively.

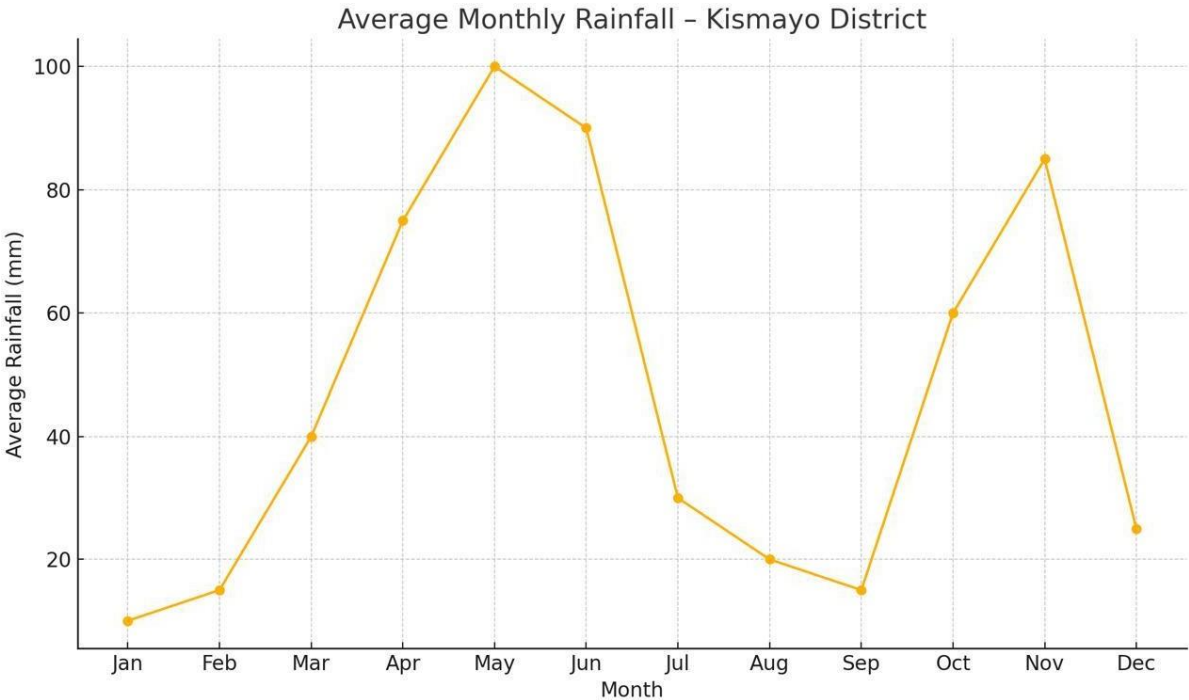


Figure 3 Average Monthly Rainfalls

1.10 WIND AND HUMIDITY

The area is known for being extremely windy, which can contribute to the arid conditions. Humidity levels are generally high, contributing to an oppressive atmosphere, especially during the hotter months

1.11 : ENVIRONMENTAL CHALLENGES

Luglow has been significantly affected by prolonged droughts, leading to severe food insecurity and displacement of communities. Many residents have sought refuge in makeshift settlements due to the harsh climatic condition

1.12 HOUSEHOLD TYPE

In Luglow Area, The households primarily consist of internally displaced persons (IDPs) who have fled drought, floods, and conflict from various parts of Jubaland and locals from Goobweyn Region.

1.13 HOUSEHOLD COMPOSITION AND SHELTER

Many families live in makeshift shelters constructed from materials like plastic sheets, wood, and cloth. These structures are vulnerable to destruction by strong coastal winds. Households are often large, with families comprising up to 10 or more members. Some IDPs have been relocated to Luglow by authorities.

1.14 LIVELIHOODS AND ECONOMIC ACTIVITIES

Employment opportunities in Luglow Area are limited. Some residents travel to Kismayo to find work from menial to trades jobs to support their families. A few households have established small businesses, like kiosks selling essential items, using financial assistance from humanitarian organizations.

1.15 INFRASTRUCTURE AND SERVICES

Recent projects have improved water access by constructing shallow wells, elevated tanks, and communal water kiosks. The area also lacks essential public services, including schools, health centers, and markets, which affects the quality of life for residents.

1.16 VULNERABILITIES

Inadequate shelter exposes families to health issues, especially respiratory illnesses among children. Many households face food shortages due to the scarcity of employment opportunities and limited aid.

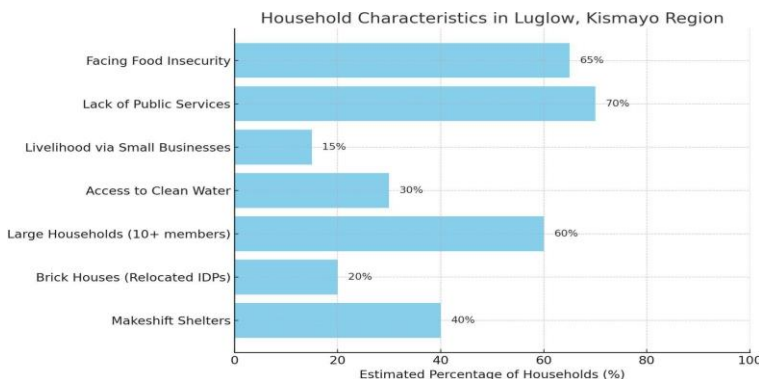


Figure 4: Household Characteristic in Luglow.

FINDINGS FROM THE AREA OF THE STUDY

Based on field observations, secondary data, and stakeholder consultations, the following key findings have been identified for the Luglow area, Kismayo District, Jubaland State of Somalia:

1.17 HYDRO-METEOROLOGICAL CONDITIONS:

Rainfall Patterns, Average annual rainfall (*Gu and Deyr seasons*) has declined by 15-20% over the past decade, with increasing inter-annual variability leading to prolonged dry spells. Temperature Trends, Mean temperatures have risen by approximately 1.2°C since 1990, exacerbating vapor-transpiration rates and water loss.

1.18 WATER RESOURCES:

Surface Water from the Jubba River provides a perennial source but experiences significant seasonal fluctuations, with peak flows during December - January. Groundwater, Over 60% of surveyed wells show declining water tables, dropping by 3-5 meters in the last five years due to unsustainable abstraction. Water Quality, 45% of tested wells exceed salinity standards; high turbidity and bacterial contamination are common in dug wells.

1.19 SOIL AND LAND CHARACTERISTICS:

Soil Fertility, Alluvial soils along the river banks are fertile and suitable for high-value crops, whereas upland areas exhibit low organic matter (<1%). Topography. The terrain consists of flat flood plains (0-2% slopes) transitioning to gentle undulating uplands (2-5% slope), offering multiple dam site options.

1.20 EXISTING INFRASTRUCTURE:

Irrigation being limited to small-scale gravity-fed canals; mechanical pumping is mainly diesel-driven, with high operational costs. Power, Grid electricity is absent; solar energy is underutilized despite high solar irradiance (>5.8 kWh/m²/day).

1.21 SOCIO-ECONOMIC CONTEXT:

Population: Approximately 200,000 residents in the Luglow catchment, including 15% internally displaced persons (IDPs). Livelihoods, Mixed agriculture- pastoralist; crop failures during droughts cause income losses up to 40% annually. Health, waterborne diseases (cholera, dysentery) account for 25% of clinic visits, especially during dry seasons.

1.22 ENVIRONMENTAL AND ECOSYSTEM FINDINGS:

Vegetation, Riparian forests have receded by 30% over two decades, reducing natural bank stabilization. Rangelands, Overgrazing has led to degradation, with bare soil patch exceeding 20% of communal grazing areas.

These findings highlight critical constraints and opportunities for designing sustainable water and agricultural infrastructure in the Luglow area.

CHAPTER 3

KEY CHALLENGES IN THE AREA

1.23 FOOD INSECURITY

Food insecurity is one of the most pressing challenges in Luglow, and it's driven by a combination of environmental, economic, and social factors:

Key Causes of Food Insecurity in Luglow:

1.24 DROUGHT & CLIMATE SHOCKS

Recurring droughts have devastated agricultural activities and livestock, which are the primary sources of food and income for many. Unpredictable rainfall patterns during the Gu and Deyr seasons worsen crop failure and reduce food production.

1.25 DISPLACEMENT & POVERTY

Most households in Luglow are displaced from other regions due to conflict or climate disasters. Displaced families often arrive with no assets, making them heavily dependent on aid and daily wage jobs that are hard to find.

1.26 LIMITED EMPLOYMENT OPPORTUNITIES

Jobs in Luglow are scarce. People, especially women, walk to Kismayo (15+ km) to do laundry or sell small items, earning very little. Without steady income, families struggle to afford basic food items.

1.27 AID DEPENDENCY WITH GAPS

Humanitarian aid is available but inconsistent. When food assistance is delayed or reduced, families go days with minimal or no meals.

1.28 MALNUTRITION AMONG CHILDREN

Many children suffer from acute malnutrition due to poor diet diversity and meal frequency. Health services are minimal or non-existent in the area, compounding the crisis.

1.29 COMMUNITY TESTIMONIES (FROM REPORTS)

Mothers report feeding their children once a day or only when aid is delivered, some families rely on neighbors or credit at small kiosks but struggle to repay.

Causes and Effects of Food Insecurity in Luglow

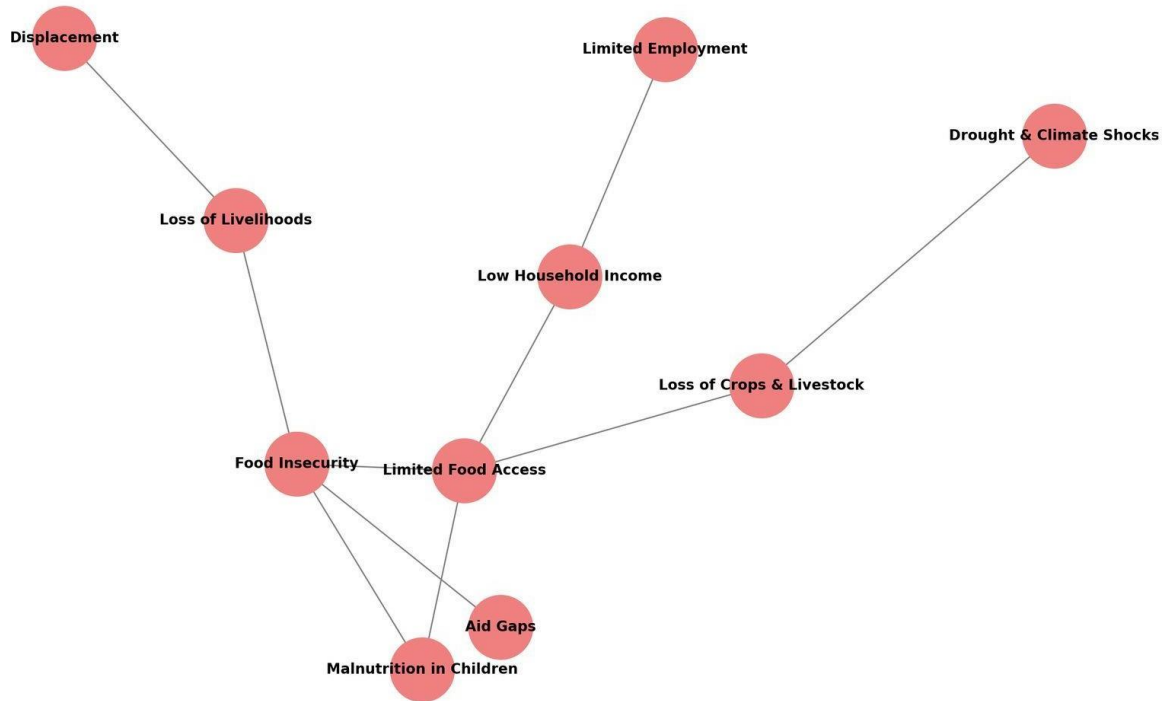


Figure 5: Food insecurity in Luglow

1.30 POOR SHELTER CONDITIONS

Majority lives in makeshift shelters made of plastic and branches, some relocated IDPs have received brick homes, but many still lack durable housing. Seasonal winds and rains frequently destroy homes.

1.31 LIMITED ACCESS TO CLEAN WATER & SANITATION

Water is sourced from shallow wells and communal kiosks. Hygiene and sanitation facilities are minimal or shared. Waterborne diseases are a constant risk.



Figure 6: Resident Transport water using Donkeys.

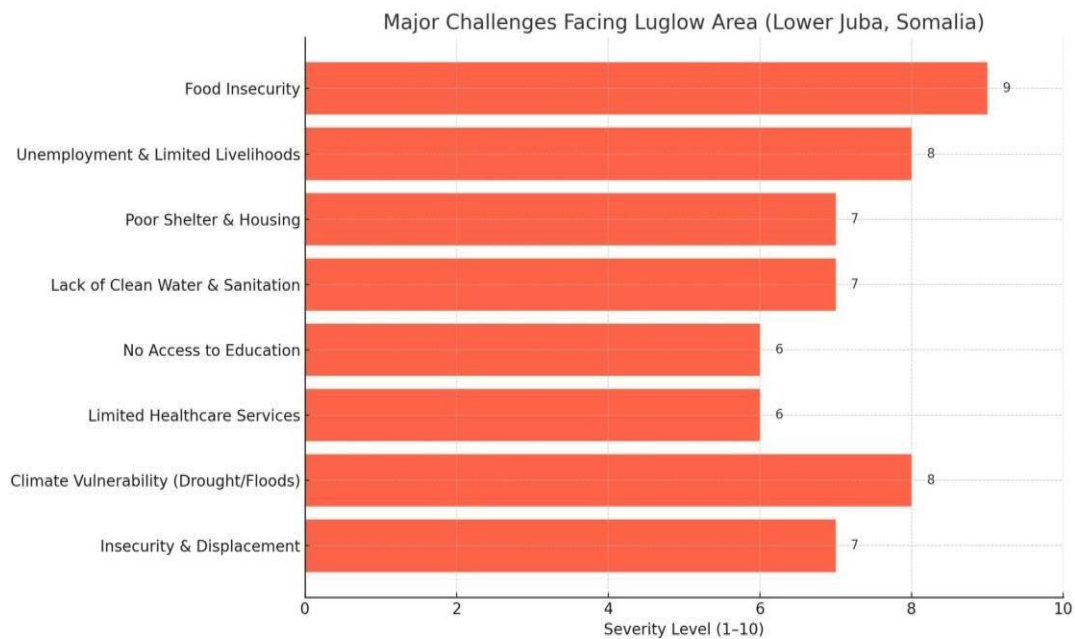


Figure 7: Challenges Facing the Study Area

CHAPTER 4

SOIL ANALYSIS

Soil analysis in the Luglow area, reveals the soil characteristics, challenges and considerations for agriculture and land use.

1.32 SOIL CHARACTERISTICS IN LUGLOW

A soil survey conducted along site areas indicates that the soils are predominantly clay with poor drainage and a high content of salts. Additionally, studies have shown that the soil generally exhibit high pH levels with deficiency in nitrogen and phosphorus, which are essential nutrients for crop growth.

1.33 LAND USE AND AGRICULTURAL POTENTIAL

The Luglow area is part of the inter-riverine regions of southern Somalia, characterized by clay and loam soils. These soil types, coupled with the climatic conditions, influence the agricultural practices and crop suitability in the region.

1.34 IMPLICATIONS FOR AGRICULTURE

The soil conditions in Luglow, marked by high salinity, nutrient deficiencies, and poor drainage, pose significant challenges for agriculture. Effective soil management practices, including the use of appropriate fertilizers and irrigation techniques, are essential to enhance soil fertility and crop productivity should agriculture be enhanced.

1.35 SOIL LABORATORY ANALYSIS

Soil samples were analyzed in the Soil Laboratory following standard soil analysis procedures. Parameters analyzed included soil particle distribution, pH, EC, CEC, Exchangeable cations (Ca, Mg, K, Na), CEC, Extractable Phosphorus, Nitrogen total, Organic Carbon, Calcium Carbonate and Gypsum. The results of these analyses

TABLE 1.: SOIL PROPERTIES FROM PROFILE PITS IN THE STUDY AREA

	Old soil profiles				News oil profile			
	Topsoil(50cm)		Subsoil(>50cm)		Topsoil(50cm)		Subsoil(>50cm)	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
pH	7.99	0.34	8.02	0.32	8.45	0.36	8.33	0.39
EC(mS/cm)	1.61	1.56	4.45	4.06	0.31	0.69	0.48	0.85
Ca(me/100g)	33.38	17.87	36.99	22.49	23.84	14.61	24.87	19.80
Mg(me/100g)	6.93	3.26	8.89	4.38	5.14	3.07	7.04	3.55
Na(me/100g)	0.96	1.98	2.34	3.65	0.78	1.43	3.43	4.57
K (me/100g)	1.56	1.23	1.14	1.59	0.42	0.33	0.24	0.20
CEC(me/100g)	31.49	22.22	29.63	10.80	21.86	21.72	32.17	27.07
P (me/100g)	2.45	3.01	1.33	1.63	4.25	8.13	2.14	3.08
Sand(%)	28.79	15.90	26.71	16.21	41.04	19.53	40.95	20.03
Silt(%)	29.02	11.96	28.89	13.70	30.49	11.62	27.65	12.24

Clay (%)	42.51	15.30	44.32	15.14	28.48	12.74	31.40	16.29
N(%)	0.08	0.05	0.05	0.02	0.07	0.04	0.05	0.03
SOC(%)	0.94	0.57	0.56	0.30	2.80	1.53	2.64	1.19
CaCO ₃ (%)	16.68	7.19	17.71	6.74	15.29	7.69	16.45	6.68
CaSO ₄ (%)	0.39	2.91	1.41	4.45	0.11	0.35	0.28	0.59
PBS(%)	32.34	35.36	24.67	33.41				
ESP(%)	3.01	6.80	8.25	15.31				



Figure 8: Soil Sample Collection.

CHAPTER 5:

WATER RESOURCES STUDY

1.36 Hydrological Assessment on River Jubba for Kismayo Water Supply

A simulation study based on the [Soil and Water Assessment Tool \(SWAT\) model](#) was adopted to address Jubba river basin delineation and hydrological analysis, assessment of the non-point source pollution as well as providing insights on the surface water resources trends and the potential effects of climate change.

Assessment of potential changes in the water balance due to climate change is particularly important for regions with limited water supplies such as the Jubba River basin. The potential impacts of climate change on the water resources in this basin will be evaluated for the near (2030s) and far (2050s) future. This will entail changes in various components of the water balance including precipitation, evapotranspiration, total water yield, soil moisture and river discharge.

This study combined three aspects: firstly, SWAT model calibration and validation for the Jubba basin and analysis of water balance components and water quality characteristics; secondly, statistical downscaling of climate change scenarios (rainfall and temperature) for the Jubba river basin and input to the SWAT model; and lastly, assessment of the response of the basin's hydrologic system to changes on downscaled climate variables.

The methodological framework followed for the study involved:

- a. Preparation of spatial and climate data into SWAT format
- b. Model setup, including watershed delineation and Hydrologic Response Units (HRUs) definition
- c. Model calibration and validation and analysis of the basin's water balance characteristics (including minimum and maximum probable flows)
- d. Down scaling of climate variables
- e. Application into the hydrologic model and analysis of the potential impacts on the basin's water balance.

There are few river gauging stations that have not been operating since 1990. However, much has changed in the landscape and also climate variability has altered the hydrological regime of most rivers in the region. There was therefore need to develop a full hydrological model based on Remote Sensing data with limited validation process

1.37 RAINFALL

The seasonal rainfall in the coverage area is characterized by bimodal seasons typical of the Eastern African region. The long rain season starts in March and extends to June while the short rains are experienced in November and December. The mean rainfall is about 500 mm per year with an annual range of between 50 mm - 1800 mm from historical data for period 2014 - 2024 using satellite rainfall data over the Jubba River Basin

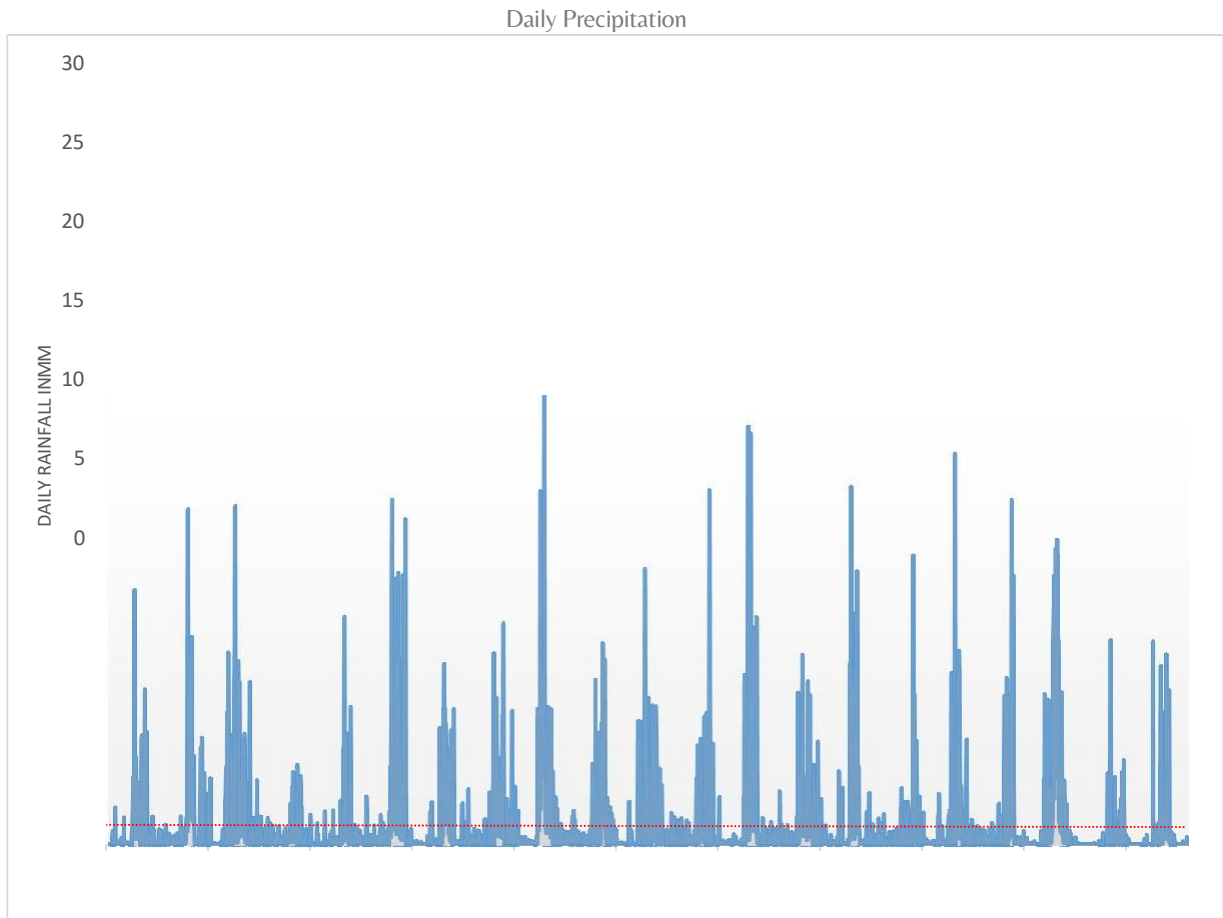


Figure 9. Daily precipitation for Jubba River basin (2014-2024)

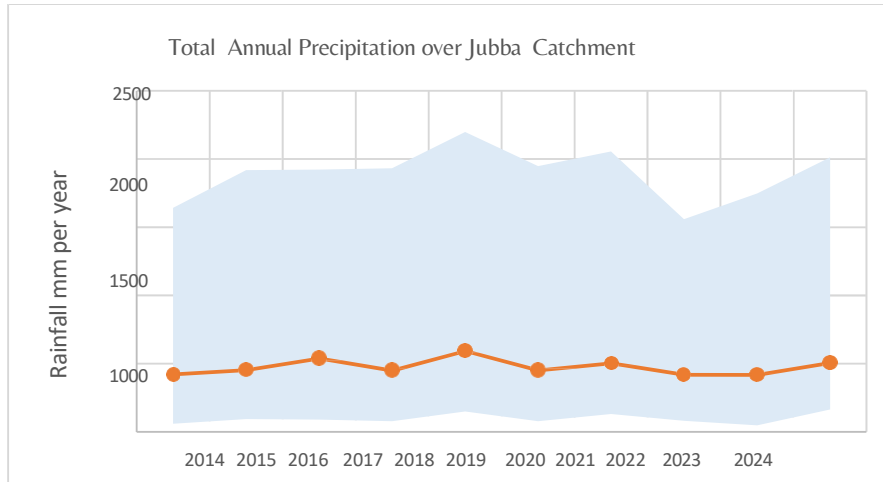


Figure 10. The annual precipitation for Jubba River basin showing the Max. and Min Ranges (2014-2024)

The rainfall is moderately high in the Ethiopian highlands, moderate in Kenyan highlands and low in the lower catchments of Somalia.

This influences the human activity, natural vegetation and run off generation with the catchments. The rainfall is more spatial erratic over the entire catchment with the upper catchments receiving more rainfall than the middle downstream to the lower catchments where the coverage Kismayo Water Supply is located.

In Kismayo, the rainfall is moderately higher, a good recharge for the shallow aquifers.

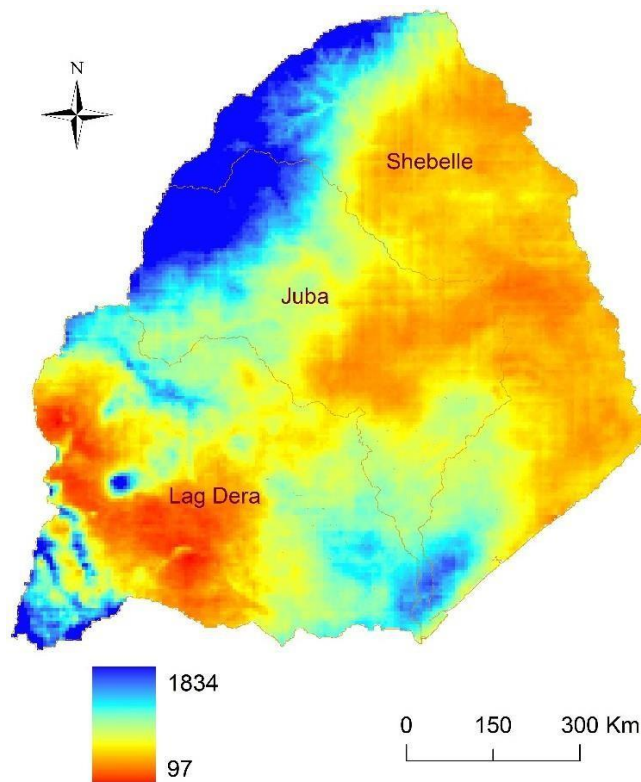


Figure 11. Annual rainfall for 2024 in Jubba River basin

1.38 ACTUAL EVAPO-TRANSPIRATION.

The annual actual evapo-transpiration (ET) range between 13 mm per year to 2,885 mm per year. The ET is influenced by the water availability from precipitation, surface river flow and the land use.

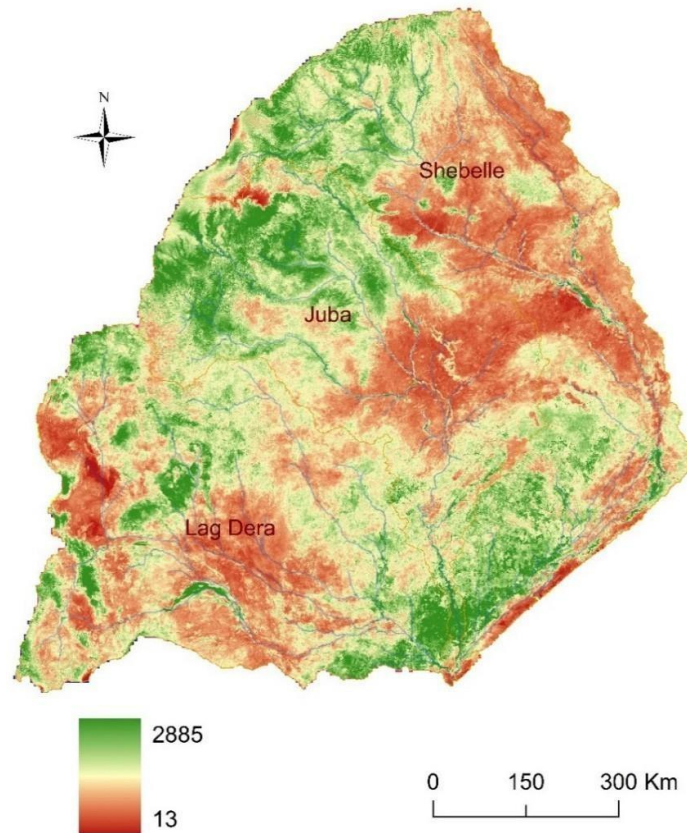


Figure12.The annual evapo transpiration for Jubba River basin

The high ET in the lower river basin implies that net precipitation is exceeded and the landscape derives additional water use from the surface water. In effect the surface runoff for the river basin is generated majorly from the Ethiopian highlands and partly from the Kenyan highlands.

1.39 DISCHARGE ANALYSIS

MEAN DAILY FLOW

Figure 12 shows the daily discharge for Jubba River at Kismayo for 12-Year Period from 1 Jan 2014 to 31 Dec 2024. The daily discharge time series shows the surface flow variability where high peaks and low flows can be estimated. The instantaneous high peak of 1591 m/s was realized while a low flow of 1.7 m/s. The hydrological analysis shows an increasing trend on mean in the river basin. High variability of high and low flows is also observed attributable to land cover changes and climate change. The discharge analysis was validated based on limited river gauging data in the study area

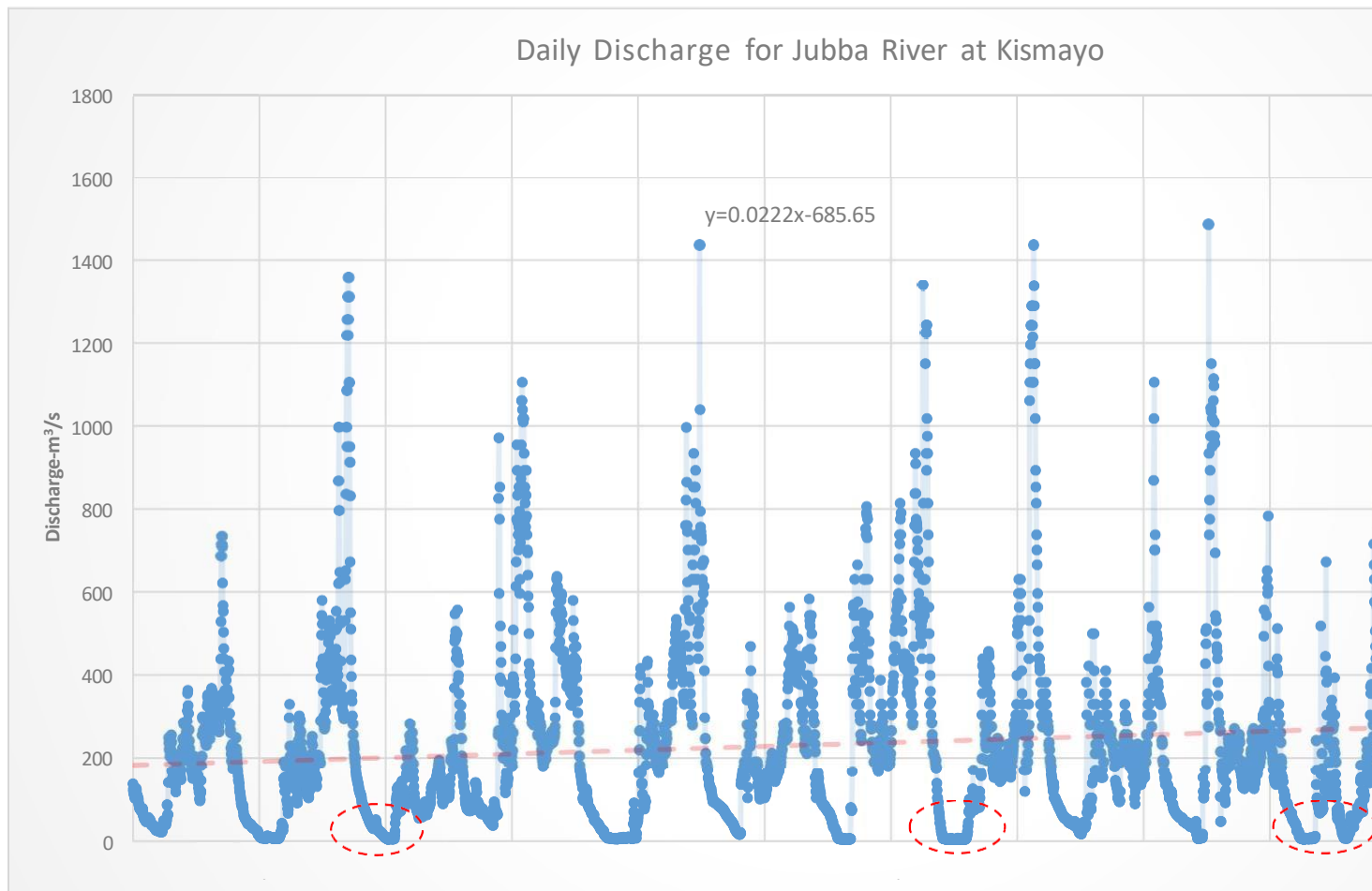


Figure13. Daily discharge for Jubba River at Kismayo for the period 2014 - 2024

5.4.1. MEAN MONTHLY FLOW

The monthly mean daily discharge is temporally distributed over the year with high flows experienced in the months of May and October and low flows in Jan to March (Figure13)

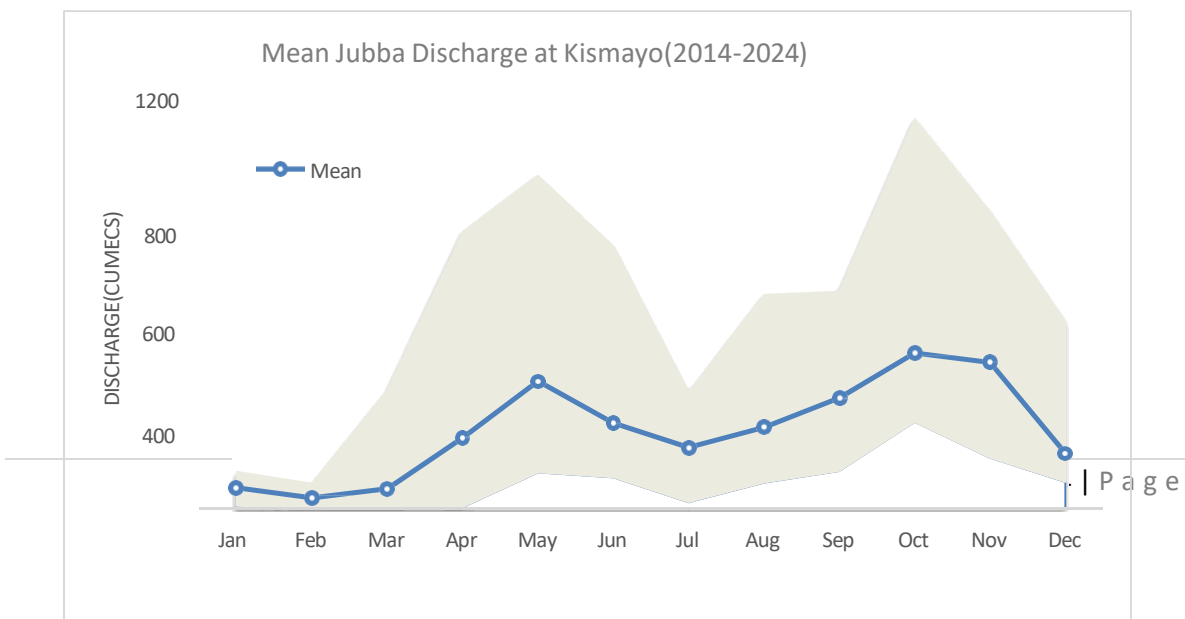


Figure14. Temporal variability of daily discharge for Jubba River at Kismayo(2014-2024)

Field survey showed a discharge range of between 180 – 200 m/s which corresponds to the simulated discharge outflow for Jubba River.

Figure 14 shows the long term mean monthly discharge for Jubba River at Kismayo for 45- Year Period from Jan 1979 to Dec 2024. The discharge analysis shows the inter-seasonal variability and the runoff trend over time. The analysis shows increasing surface runoff that is characterized by higher peaks and low flows. This trend is in line with most climate change projection models that have indicated increasing precipitation in the Eastern Africa Region. However, due to rapid land use change, the hydrological propagation of the surface run-off as resulted in the high peaks and also extreme low flows in the river system

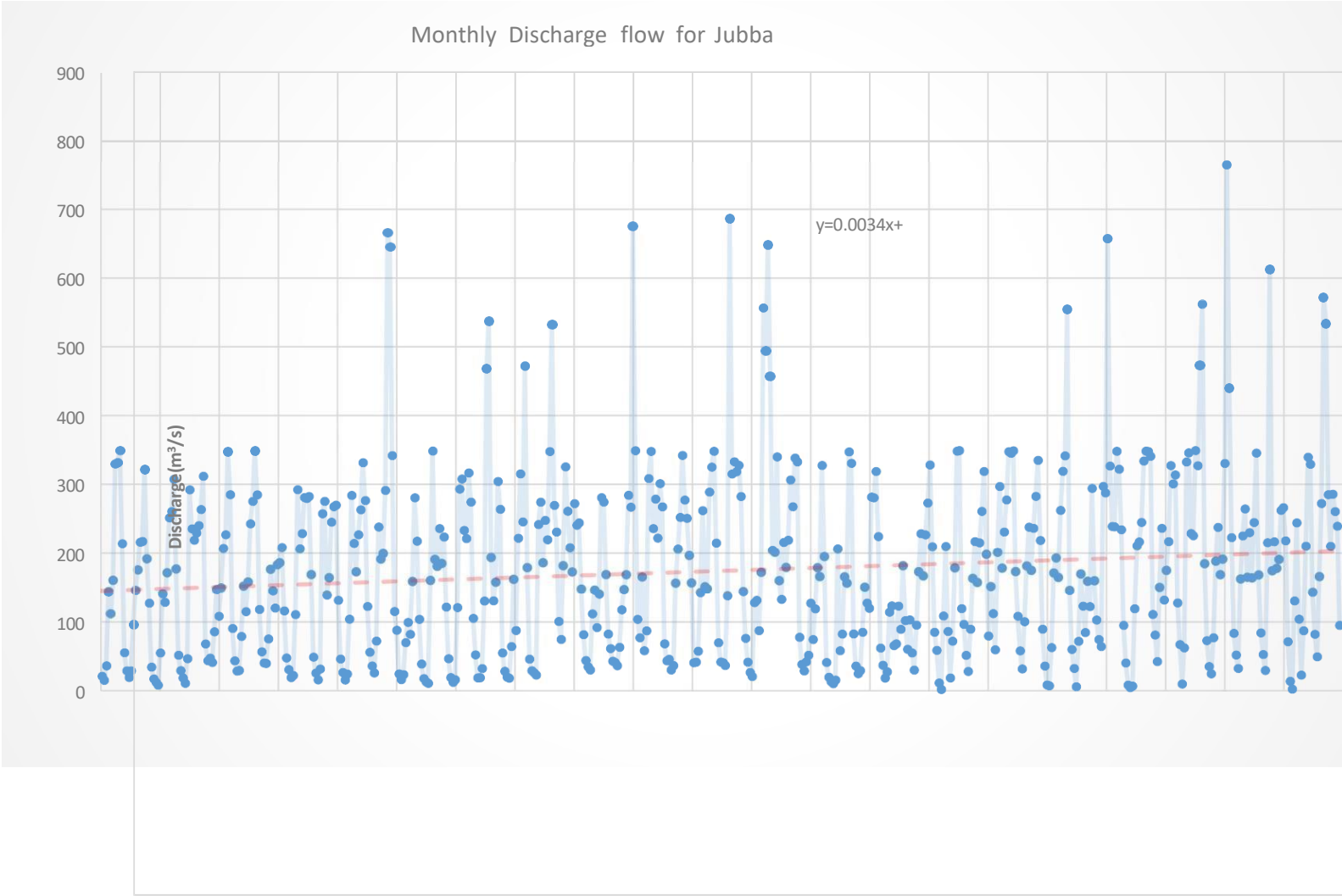


Figure15.Monthly discharge for Jubba River at Kismayo for the period 1979-2024

1.40 FLOW DURATION ANALYSIS

DAILY FLOW DURATION CURVE

A general pattern of stream flow for Jubba River at Kismayo was characterized using the statistical analysis of the mean daily discharge for a 12-year period from 1 Jan 2014 to 31 Dec 2024. The present natural flow variability is best described the temporal range of water availability

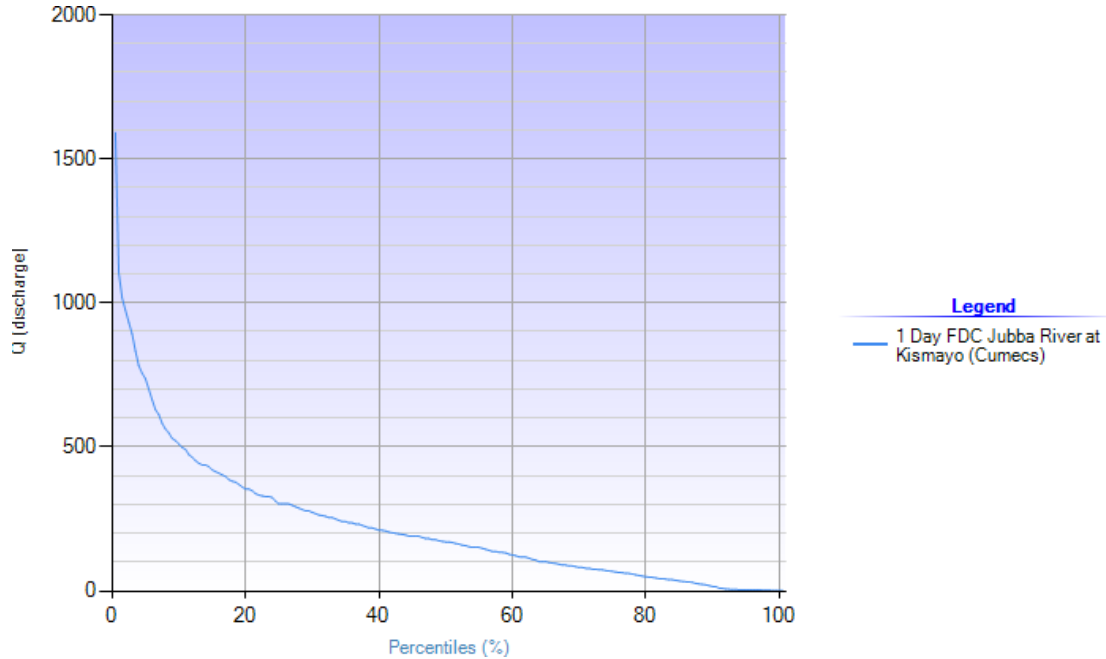


Figure16.Day flow duration curve for Jubba River at Kismayo

Table2.Dayflow duration for Jubba River at Kismayo

FLOW DURATION TABLE	
Name: Jubba River at Luglow, Kismayo	
Time-Series: Simulated Mean Daily Flow–m/s Period of Analysisfrom:1-Jan 2014 to31-December-2024	
Seasonal flow duration analysis from Jan to Dec, Time Interval-1day	
	m/s
Mean daily flow	231.10
Q95	4.758
Q90	14.933
Q80	48.540
Q50	170.281

Table3. Water flow analysis using 1Day Flow Duration Curve for Kismayo Water Supply

Kismayo Water Supply	m/s	m/day	% of Future Water Demand	% of Ultimate Water Demand
Future Water Demand	0.59	51,000		
Ultimate Water Demand	0.87	75,000		
Water Supply–Jubba River				
Q95	4.76		12.4%	18.2%
Q90	14.93		4.0%	5.8%
Q80	48.54		1.2%	1.8%
Mean Daily Flow	231.1		0.3%	0.4%

The analysis showed that Jubba River at Kismayo Water Supply Intake has a mean daily flow of 231.1. The one-day interval seasonal analysis indicate that the reserve flow (Q95) is 4.76 m/s, Q90 is 14.93 m/s and a normal flow (Q80) of 48.54 m/s which represents 12.4%, 4.0% and 1.23% of the future water demand as shown in Table 12. This safe yield (Q95) to supply the urban population is guaranteed by the water source – River Jubba. The ultimate water demand increases the proportion of water abstraction to 18.2% of the safe yield. The Daily flow duration curve for the months under consideration is provided in Figure 23

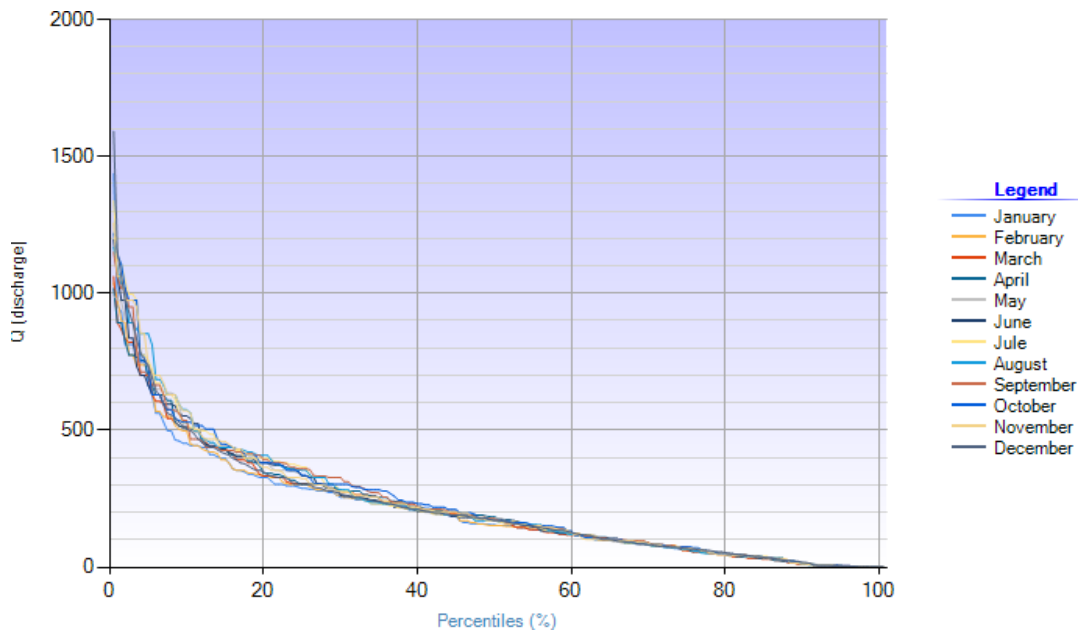


Figure 16. Dayflow duration-months for Jubba River at Kismayo

The year to year flow duration curve shows years of drought where the future water demand increases to 26% of the safe yield while the ultimate water demand increased to 40%. However, the water situation is limited to about 10-day period in the months February-March of the year

MONTHLY FLOW DURATION CURVE

The monthly (30-Day) flow duration curve provides the seasonal flow duration analysis for 45 years for the period 1979 – 2024

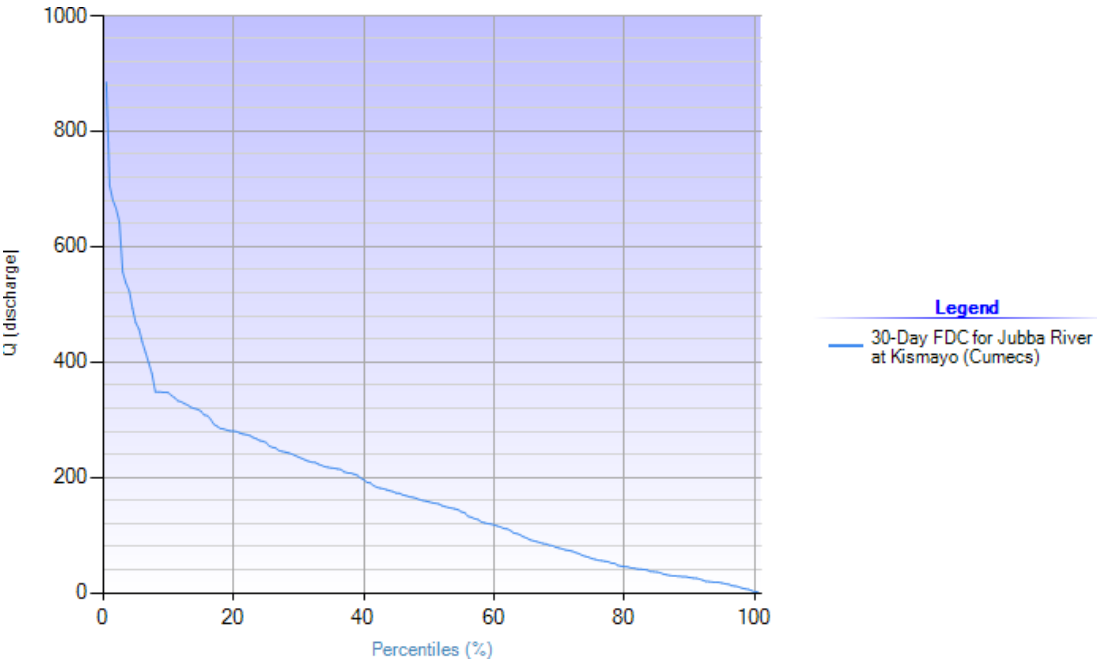


Figure17. Thirty (30) day flow duration curve for Jubba River at Kismayo

The flow duration curve indicates that the high peaks and the low flows occurs generally over a short time period and the monthly discharge are more flattened (balanced out) compared to the daily discharge.

Table4.Thirty (30) Day Flow Duration for Jubba River at Kismayo

FLOW DURATION TABLE	
Name:	Jubba River at Luglow, Kismayo Simulated
Time-Series:	Mean Monthly Flow–Cumecs
Period of Analysis from:Jan 1979 toDec-2024	
	m ³ /s
Meandailyflow	182.00
Q95	15.81
Q90	25.96
Q80	45.13

Table5.Water flow analysis using 30 Day Flow Duration Curve for Kismayo Water Supply

Kismayo Water Supply	m/s	m/day	% of Future Water Demand	% of Ultimate Water Demand
Future Water Demand	0.59	51,000		
Ultimate Water Demand	0.87	75,000		
Water Supply–Jubba River				
Q95	15.81		3.7%	5.5%
Q90	25.96		2.3%	3.3%
Q80	45.13		1.3%	1.9%
Mean Daily Flow	182.00		0.3%	0.5%

30-Day Flow Duration Curve indicates more balanced out water situation on a monthly time step with the ultimate water demand approximately 5.5% of the dry river flow (Q95). The implication of the analysis is that – ultimately a 30-day buffer storage maybe required to improve the water supply reliability during periods of drought.

The monthly 30-Day FDC clearly shows the temporal variability of water resources in Jubba River. January, February and March have the lowest water yield while the highest water yield is realized in September and October.

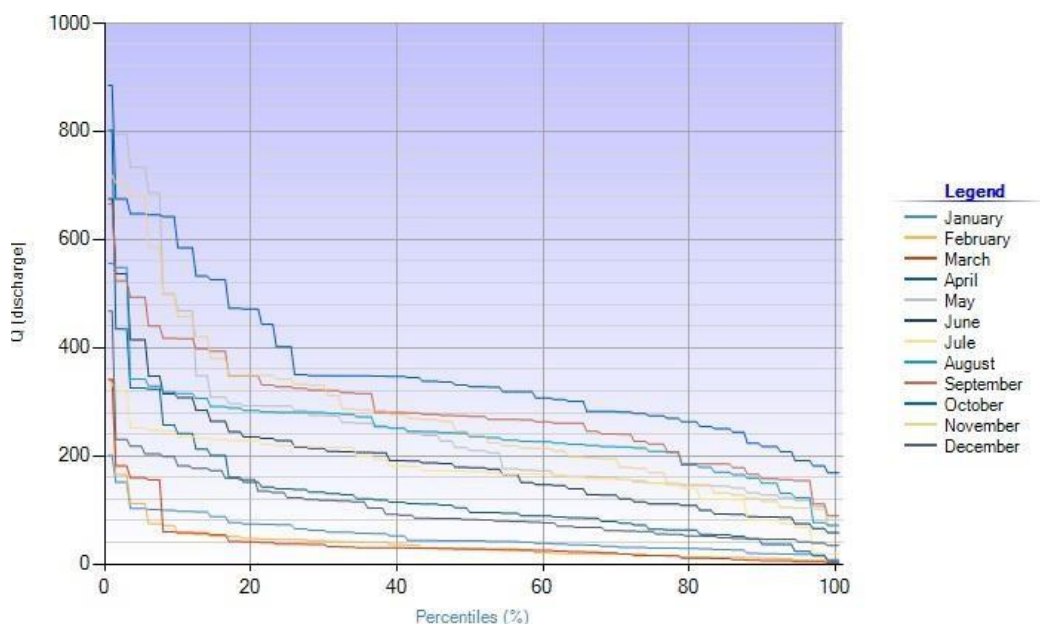


Figure18. Thirty (30) day flow duration-months for Jubba River at Kismayo

SURFACE-GROUND WATER INTERACTIONS

In this feasibility study, the hydrography separation technique that divides the stream flow into a quick component and a delayed component (base flow index) was used to give an indication of the groundwater resources within the catchment. The base flow index represents the proportion of river flow that originates from stored groundwater sources.

A high index of base flow would imply that the catchment is able to sustain the river flow during extended dry periods. The Eckhart filter method has been utilized where $\alpha = 0.97$ and BFI (Max) = 0.55 parameters were calibrated

The Average BFI of 0.66 indicates that the river relies on groundwater resources that has high storage capacity that is projected to provide stable flow regime in dry periods. However, the over-reliance on groundwater would influence the water quality (salinity) of the surface water during dry periods if the salinity levels of the groundwater are considerably high

ENVIRONMENTAL FLOW ASSESSMENT FOR JUBBA AT KISMAYO

Environmental flow requirements of rivers relate to a number of factors (Acre man and Durbar, 2004).

- The size of the river
- Its natural state “ type ” or perceived sensitivity
- A combination of the desired state of the river and, in practice, the use to which it is put.
-

For a river system, the river flows are set to achieve specific pre-determined ecological, economic or social objective – objective based flow setting. For Jubba River at Kismayo, the main objective is water diversion for urban water use with minimal environmental effects to the Jubba Estuary. The estuary is key in controlling salt intrusion along the river channel and is rich in aquatic life. The water demands for Kismayo is a high priority requirement that has high social and economic value.

In estimating the water deviation that can be abstracted from the river with minimal effect to. The ecological status of the river downstream, the river sensitivity to water diversion has to be assessed. The supporting physical elements such as channel form, water depth and the river flow provide good indicators.

Jones (2002) states that the probability of having a healthy river falls from high to moderate when the hydrological regime is less than two-thirds natural. Site-specific quantified rules need therefore to be provided depending on the environmental

status or considerations. Acreman and Durbar, 2004 provides a guide on the percentage of water diversion from Q95 that can be allowed for different environmental conditions with no or minimal effect on the ecological status of the river system

Table 6.

Table 6. Percentage of natural Q95 flow that can be abstracted for different environmental conditions of rivers

Environmental Condition % of Q95 that can be abstracted

<i>A</i>	0-5
<i>B C D E</i>	5-10
<i>Others</i>	10-15
	15-25
	25-30
	Special treatment

It should be noted that there are other environmental flow assessment approaches such as the functional analysis and hydraulic habitat modelling that provide the minimum flow that has to be maintained in the river to achieve certain environmental objectives. Such methods are robust and flexible but require extensive field studies.

Rivers with steep gradients and wide shallow cross sections have high sensitivity to flow reduction since small reduction in flow results in a relatively large reduction in the wetted perimeter. Conversely, lowland river reaches that are narrow and deep are less sensitive to flow reduction. The ecological status of the river downstream is determined by expert opinion of the perceived environmental functions of the river.

Based on the physical and environmental evaluation, River Jubba at Kismayo falls under the environmental condition.

The physical character of the river is moderate, while the aquatic environment in the estuary is flow-sensitive to low flows / prolonged high salinity levels in the river system.

Based on environmental flow assessment, the water diversion for Kismayo Water Supply has to be limited to 15% of Q95. Based on the flow analysis, the EFs within the limits of the future water demands that were estimated at 12.4% and slightly above limits for the ultimate water demands of 18.2%. On the monthly flow analysis, the EF is 3.7% and 5.5% of the future and ultimate water requirements.

WATER QUALITY ASSESSMENT

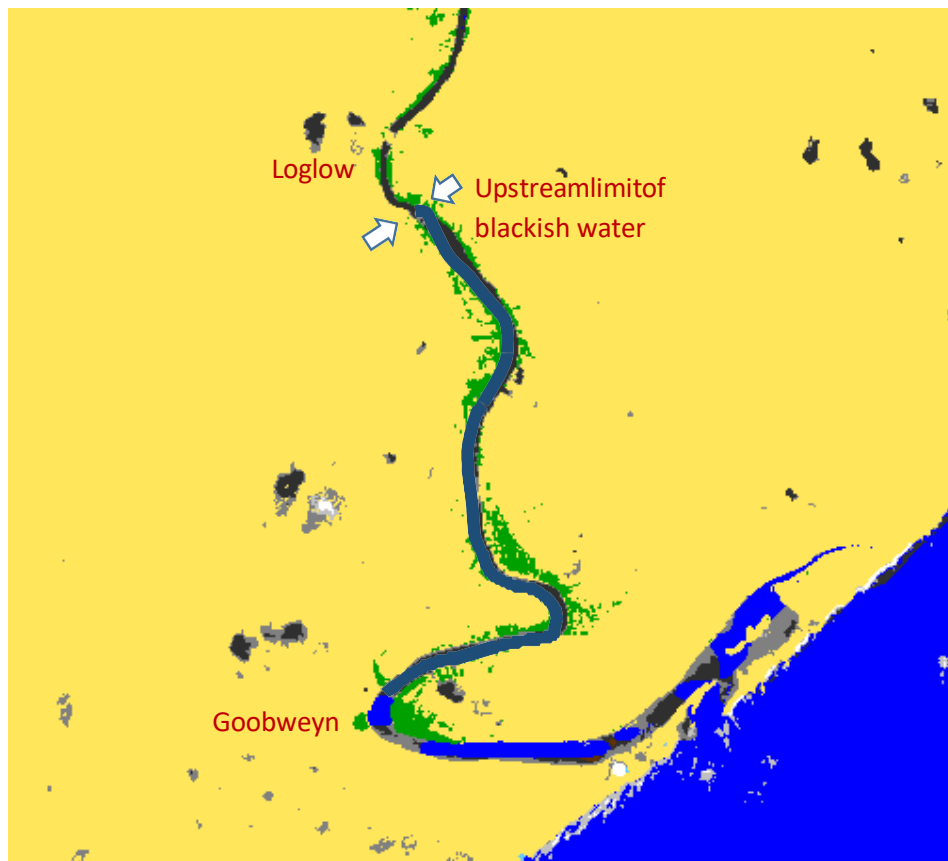
SALINITY INTRUSION PROFILE FOR JUBBA RIVER ESTUARY

The challenge of salt intrusion from the estuary arises based on the interaction between the surface water and seawater due to the tidal movements in the Indian Ocean.

The tides are semi-diurnal with maximum spring tidal range of about 3.5m and maximum neap tidal range of about 3.0m in Eastern African Estuaries. The spring tides occur twice each lunar month all year long.

However, the salt intrusion is more pronounced during periods of low river flows. The run-off velocity of the tidal wave increases the tidal wave but the tidal wave is middle height will be reduced by the land surface slope. Using the Gaillard approximation, the tidal wave height is approximated at 3.0m.

On evaluating the topology of the Jubba Estuary, the salt intrusion is estimated up to 12 km from the mouth of the estuary to the local area of Luglow. At location Goobweyn, the full effect of the tidal wave is expected to be realized, 5.6 km from the ocean. A further 6.4 km upstream, the blackish water effect will be realized to the near local area of Luglow



(Figure 19).

Figure19.The salinity intrusion in Jubba River estuary, Somalia

SALINITY ASSESSMENT FOR JUBBA RIVER AT KISMAYO

Salinity measurements during the field survey showed that the surface river flow is good for domestic purposes

Table 7 .Salinity levels at Jubba River-13- August 2024

Location	EC- $\mu\text{S}/\text{cm}$	Permissible Limit- $\mu\text{S}/\text{cm}$
Luglow	410	2000
Goobweyn	404	2000

It should be noted that the in-situ salinity measurements were done during a relative high flow season. In Yoontoy, the shallow well (developed by UN International Organization for Migration

- IOM) – less than 100-m from the river indicated high salinity levels of 2520 $\mu\text{S}/\text{cm}$ while in Goobweyn, one shallow well within the proximity of the river was abandoned by the local residents due to high salinity. The influence of groundwater resources on the salinity of surface water in River Jubba is expected especially during dry periods.

According to a study by Sir M MacDonald & Partners Limited, 1991, a profile of salinity in River Jubba – gauge station Mareere for 1977 - 1990 indicate a temporal variability. The gauge station is located 135 km upstream of the location of the intake for Kismayo Water Supply

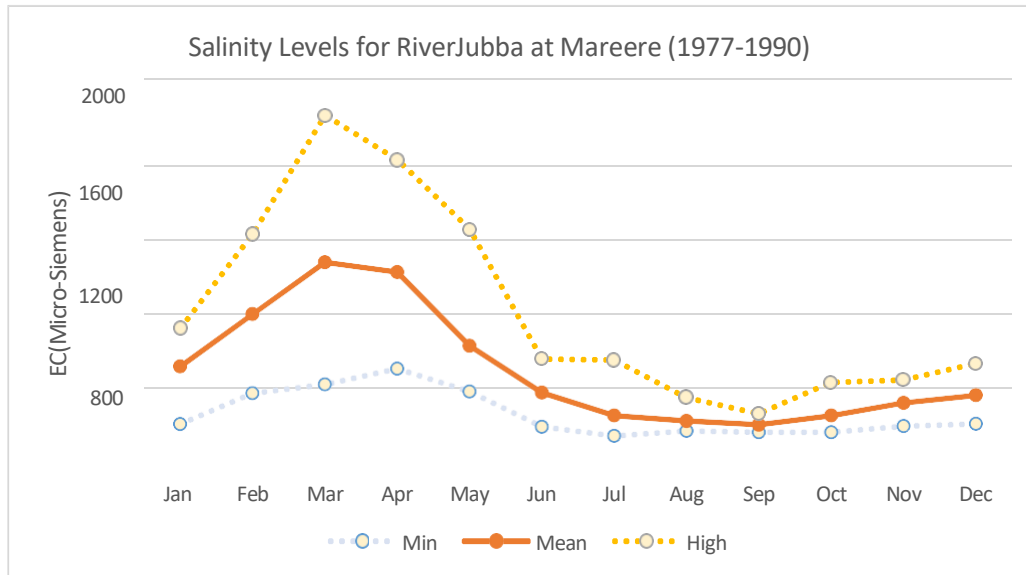


Figure 20. The monthly salinity levels for River Jubba at Mareere (1977-1990)

The average EC measurement of $400 \mu\text{S}/\text{cm}$ for Yoontoy/Goobweyn for August is projected to flow the upper limit with the salinity levels in March close to the permissible levels.

PHYSICAL, CHEMICAL AND BIOLOGICAL WATER QUALITY

Water quality is essential in determining the extent of water treatment and usage of water for domestic purposes. A full examination of the physical, chemical and biological characteristics is prerequisite especially for raw water supply. The water parameters have to meet set guidelines standards for domestic water provided by World Health Organization (WHO Standards). A sample of raw water from Kismayo Intake Site of River Jubba was analyzed and the results shown in Table 17 & Table 18. The water quality failed in true color, turbidity and total suspended solids in its physical properties that are attributed mainly to cultivated agriculture in the upper catchments. The Nitrates content was relatively high though within the permissible levels. Total dissolved solids were within the permissible levels for domestic water supply.

Total suspended sediments of $84 \text{mg}/\text{l}$ equivalent to 4.5 tonnes per day in the future water supply period. It is important to note that the results in the study were taken during moderate flow conditions and the sediment loads are expected to increase over the high flow period and conversely during the low flow conditions. Satellite images show agricultural intensification upstream of the intake point. This is indicative of the source of sediment in the river system.

The suspended solids settle quickly when kept still, a technique used by the local people in Luglow before disinfection by boiling.

Table8 .Physical and Chemical water analysis for River Jubba at Kismayo

Parameter	Unit	Results	Guidelines	Remarks
pH	pH Scale	6.96	6.5–8.5	Complied
True Color	Mg Pt/l	440	15Max.	Failed
Turbidity	N.T.U	105	5Max.	Failed
Electrical Conductivity	uS/cm	404	2000Max	Complied
Total Dissolved Solids	mg/l	258	1500Max	Complied
Total Suspended Solids	mg/l	84	Nil	Failed
Manganese	mg/l	0.001	0.1Max	Complied
Calcium	mg/l	4.8	250Max	Complied
Magnesium	mg/l	3.3	100Max	Complied
Fluoride	mg/l	0.03	1.5Max	Complied
Phosphates	mgPO4/l	0.18	2Max	Complied
Nitrates	mgNO3/l	24	50Max	Complied

Fecal coliform is an indicator of the potential presence of pathogens in fresh water. An E. coli bacterium is a normal component in the large intestines of humans and other warm-blooded animals, and can be excreted in their fecal material. Organisms causing infections or disease (pathogens) are often excreted in the fecal material of humans and other warm-blooded animals. E.coli bacteria are a good indicator of fecal pollution and the possible presence of pathogenic organisms. The levels of fecal coliform vary throughout the river profile. E.coli and Total Coliforms were within the allowable standard environmental limits (30counts/100ml) that can be disinfected by boiling. Plate 2, shows a possible pollution source in the water sampled from livestock and local population. However, for urban water supply system the water will require disinfection by chlorine



Plate1.Possible point source of contamination in Yoontoy, Kismayo

Based on the water quality results listed in Table 17 & Table 18, a full treatment is required for the raw water from River Jubba before the water is used for domestic purposes. The turbidity, color and TSS correction will be achieved through the flocculation, sedimentation and filtration processes while the bacteriological through disinfection by chlorine.

Table 9 .Bacteriological Analysis for River Jubba at Kismayo

Parameter	Unit	Results	WHO Standards	Remarks
<i>Luglow</i>				
E-Coli	CFU/100ml	1	Nil	Failed
TotalColiform	CFU/100ml	5	Nil	Failed
<i>Goobweyn</i>				
E-Coli	CFU/100ml	0	Nil	Complied
TotalColiform	CFU/100ml	3	Nil	Failed
AlumDosage	mg/l	55		
ChlorineDosage	mg/l	1.4		

The jar test undertaken at the laboratory to obtain the optimum alum concentration for raw water sample from Jubba River is shown in Plate 3.



Plate 2. The jar test procedure for optimum alum concentration for raw water sample for Jubba River (Salim, 2025)

The average alum concentration to achieve the permissible of turbidity and colour is 55 mg/l

Management of Turbidity

The water quality analysis has shown high levels of turbidity in the Jubba River System, which is largely attributable to the suspended solids. Suspended solids are soil particles that have a particle size of more than 2 microns. Whereas the current total suspended solids levels (13 August 2019) can be removed through the water treatment process, much higher turbidity levels are expected during flood periods. Flood periods normally last 2-3 months in April, May, and November of every year. Plate 3, shows the river flow during flood season in Jubba River at Kismayo Estuary.



Plate3. Jubba River at Kismayo Estuary during flood period with high turbidity

FAO-SWALIM, 2009 in field measurement of sediment concentration in Jubba River for the year 2007 and 2008 obtained a linear correlation between discharge and the suspended solids in the river. It is therefore imperative that an engineering solution is incorporated into the Kismayo Water Supply system to control high sediments during flood seasons.

Advancement in technology of raw water filtration and automatic backwashing has seen reduction of sediment loads in major water infrastructural works. In Kenya, the Galana food security project located at the downstream of Athi River at Galana has an advanced filtration system that can reduce the suspended sediments that range between 400 microns to over 5000 microns during flood periods and up to 150 microns during normal flow periods. The filters are designed to meet water quality requirement of the sprinklers (centre pivots) used in the project.

The filtration and automatic system when applied for urban water supply can adopt better filters (now available in the market) that can reduce all suspended sediments that are larger than 20

microns leaving out only clay particles which make up about 30-40% of suspended loads in most river systems. In effect, the advanced raw water filtration technology will reduce the sediments load to the water treatment plant by up to 70% during the flood period. During the flood season, it is estimated that the automatic backwashing (pressure triggered) will operate nearly every 20 minutes and the high sediment flow return back to the river system with minimal environmental concerns. The draw-back thus is the increased operation costs in terms of energy requirements for automatic backwashing in the water supply system.

The actual filter size and the percentage of sediment reduction can be determined in the detailed designs when the sediment distribution and sediment sizes are determined for flood periods in the river system. This is the only way that the water supply system will operate sustainably even during flood periods.

5.5. Flood Risk Assessment

Proxy Data on NDVI, Moisture content and topography was used to map the flood risk areas in the Lower Jubba River, Somalia. At the confluence of Lag Dera, Juba and Shebelle rivers upstream of local township of Luglow, the river drains into wetland with high flood risk during periods of high floods. The downstream has moderate but manageable flooding due to the low terrain as shown in Figure 21.

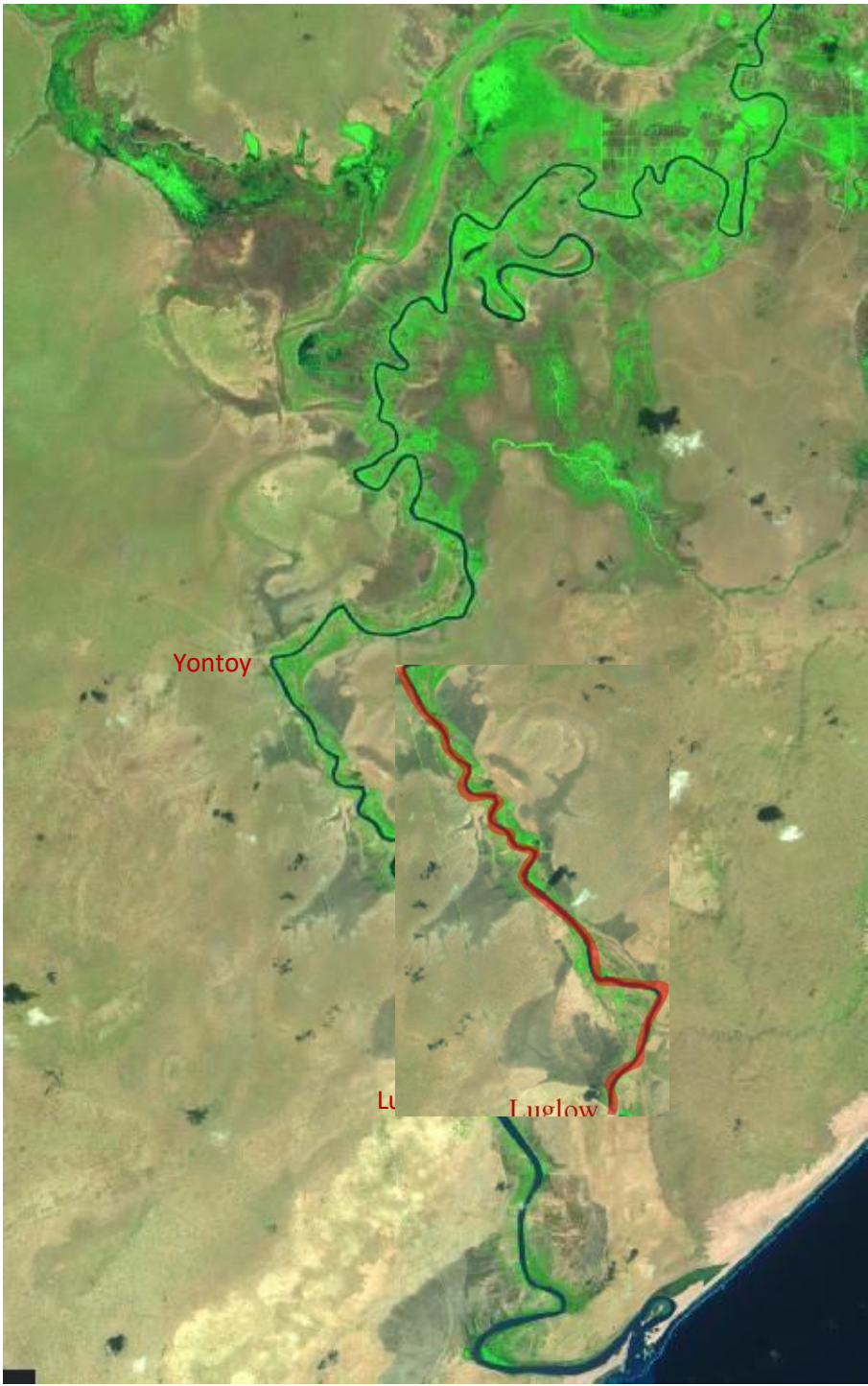


Figure21.Flood Hazard Map of River Jubba, near Port Town of Kismayo, Somalia.

CHAPTER 6:

PROJECT COMPONENTS & DESIGN CONSIDERATION

1.41 Water Infrastructure Design

Water pan Construction Size & Dimensions

The Volume: 20,000 – 25,000 m³, Surface Area: 8,000 – 12,000 m² (depending on depth and shape), Depth: 3 – 5 meters (ensuring minimal evaporation and seepage), Side Slopes: 1:2 or 1:3 (horizontal to vertical ratio) for stability

Catchment Area & Runoff Estimation

Catchment Size: 0.5–1.0 hectares (depends on rainfall and runoff efficiency), Rainfall Required: Approx. 500mm annual rainfall with proper runoff collection, Runoff Coefficient: 0.2 –

0.5 (depends on catchment type – rocky, paved, or compacted soil)

Excavation & Construction

Excavation Type: Open excavation using bulldozers, excavators, or manual labor, Compaction: Well- compacted soil layers to minimize seepage, Lining Options: Clay (if available), HDPE geomembrane, or concrete to reduce water loss

Inlet & Spillway

Inlet Structure:-Designed to reduce velocity and prevent sedimentation, Use of gravel traps or silt traps before entry, Spillway: Designed for safe overflow during heavy rains, Located at least 0.5m below embankment crest, Width depends on peak flow rate (~5 – 10m)

Embankment Specifications

Crest Width: 3 – 5 meters for stability, Crest Freeboard: 0.5 – 1.0 meter above maximum water level, Soil Type: Clayey soil preferred for embankment construction, Compaction: Layered compaction to at least 95% Modified Proctor Density.

Water Quality & Management

Sediment Control: Grass strips, silt traps, and check dams upstream, Fencing: Prevents animal contamination and human interference, Aeration: Prevents stagnation and improves water quality

Maintenance & Sustainability

Desilting Frequency: Every 3 – 5 years (depends on sediment load), Erosion Control: Vegetation on embankments and controlled grazing, Regular Inspections: Check for cracks, seepage, and structural stability

Figure 22: Excavation of water pan completed water pan



1.42 Solar Pumping System

Sustainable water transfer from the earth dam to the storage tanks and irrigation systems

Advantages

Some of the advantages of the solar pumping systems are, Zero fuel cost, Low maintenances, Reliable energy supply

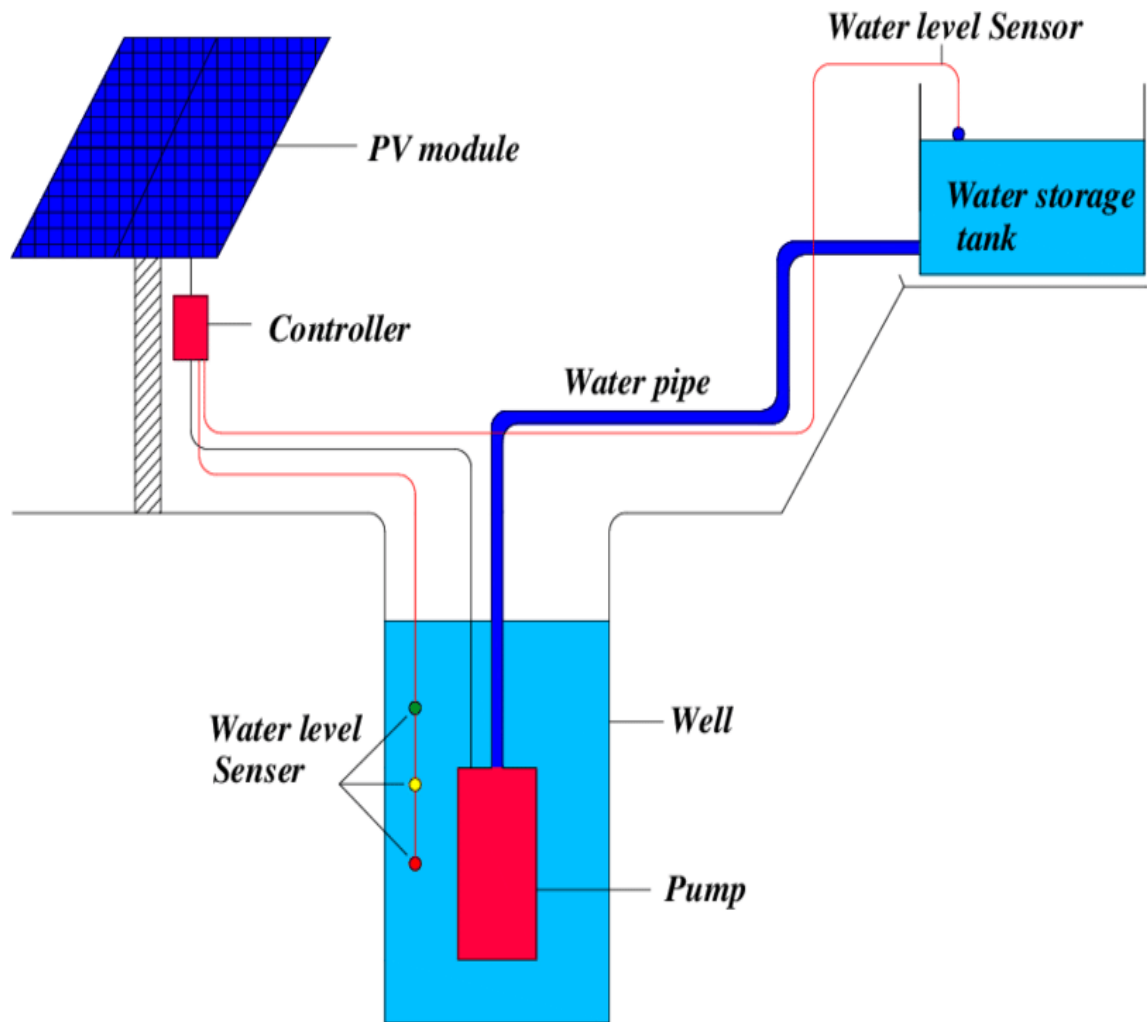


Figure23: Illustration diagram of the system

1.43 Overhead Storage Tanks

Objective

To ensure continues water supply to the greenhouses and farms via gravity-fed irrigation

Technical design specifications

Table 10: technical specifications

Component	Specifications
Tank materials	Steel
Capacity	10,000-15,000litres
Installation Height	10-12 meters
Distribution system	Drip irrigation system

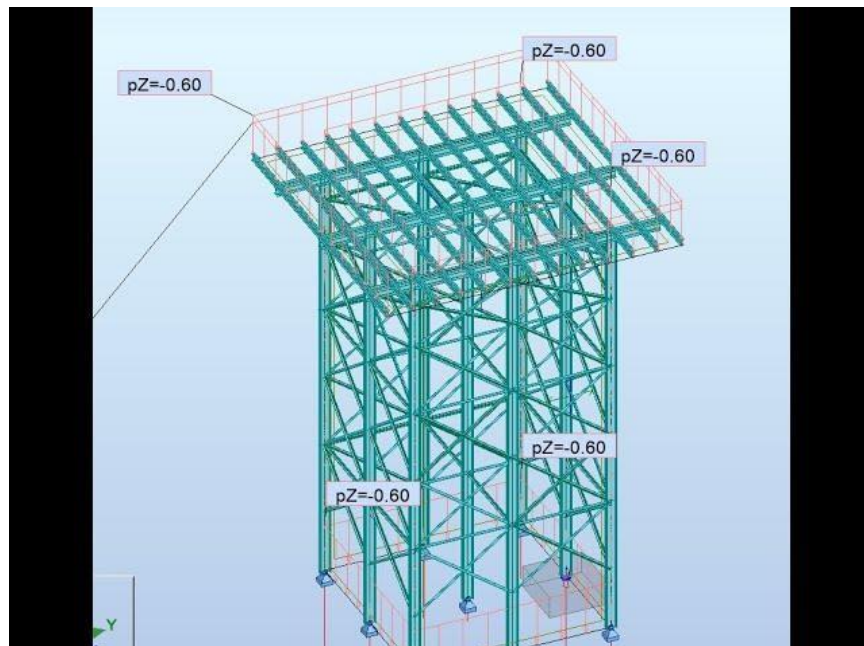


Illustration of elevated steel tank



Figure 24: Elevated steel tanks

1.44 Water Distribution Infrastructure

Components



Main pipeline network: 1.5–2.5 km of HDPE pipes, Drip & Sprinkler Irrigation: For efficient water usage. Storage Reservoirs: Raised tanks for gravity-fed distribution, Water Purification System: Filtration and chlorination for domestic use.

Figure 25: Pipeline excavations

1.45 Agricultural Systems

Demonstration Farms

Objective:

Train local women farmers in modern and sustainable agricultural techniques.

Design & Layout:

- Total Land Area: ~0.165 hectares
- Crop Selection: Drought-resistant crops: Sorghum, millet, legumes
- High-value vegetables: Tomatoes, onions, peppers

Training Modules:

Some of the training modules we have identify and we proposed are the following; Water-efficient irrigation methods, Soil fertility management, Organic pest control



Figure26: Women doing farming

1.46 Greenhouse Farming

Objective:

Extend growing seasons and improve crop yields.

Technical Specifications:

Component	Specifications
Frame materials	Galvanized steel
Covering materials	Polyethylene plastic
Temperature control	Passive ventilation + shade nets
Irrigation system	Drip irrigation
Crops grown	Tomatoes , cucumbers , strawberries

Table 11: Greenhouse technical specification



Figure27: Green house installation



Figure28: Completed installed greenhouse

1.47 Hydroponic Farming

Objective:

Maximize crop production without soil using nutrient-rich solutions

Technical Setup:

- NFT (Nutrient Film Technique) for leafy greens
- Deep Water Culture (DWC) for root crops

Advantages:

These are some of the advantages of hydroponic farming; 90% less water usage, higher crop yields and No dependency on soil quality

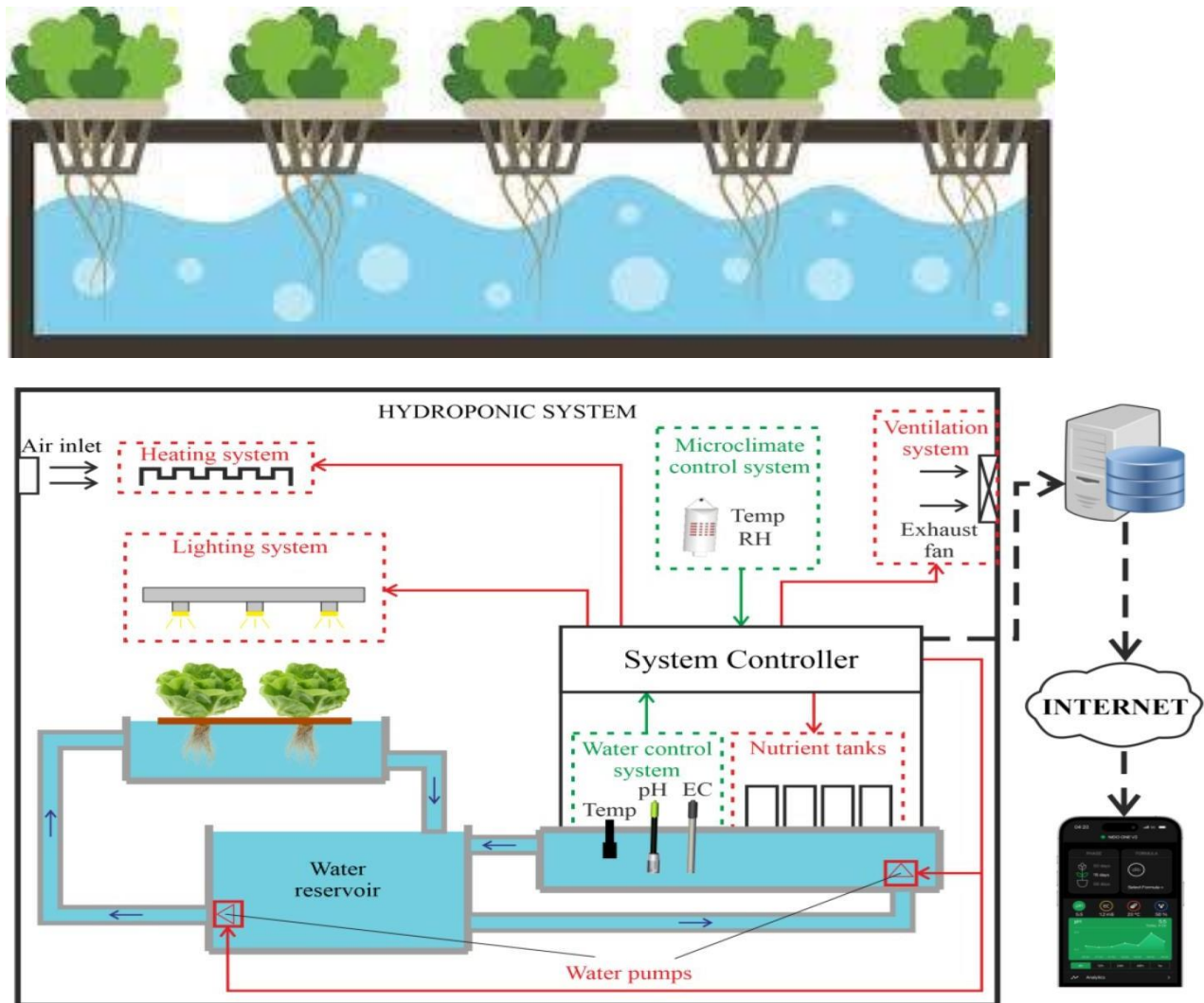


Figure 29: Hydroponic illustrations

1.48 Beekeeping

Objective:

Provide pollination services and additional income for local farmers.

Technical Setup:

- Beehives: Kenyan Top-Bar Hives
- Bee Species: African honeybees
- Estimated Production: 10–15 kg of honey per hive annually



Figure30: Woman using bee hive to harvest honey



Figure 31: Honey harvestings

1.49 Sustainable Construction & Income Generation

Interlocking Blocks Production

Objective:

Reduce construction costs and generate local employment.

Technical Specifications:

- Material: Cement + Sand + Clay
- Production Capacity: ~500 blocks/day
- Market Demand: Assessed for feasibility

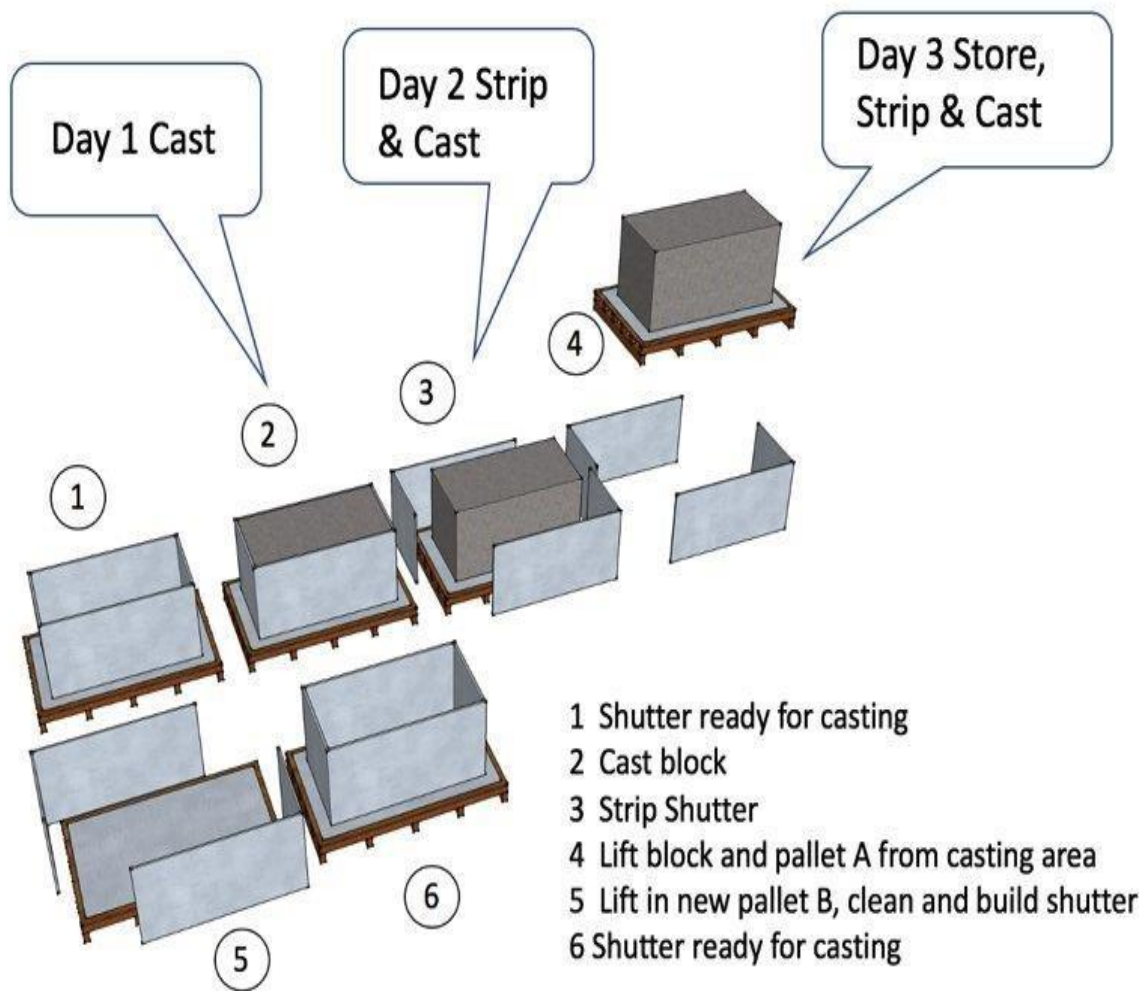


Figure 32: Illustrations of Processing of making interlocking blocks

1.50 Bio-sand Water Filtration

Objective: Provide clean drinking water for farmers and surrounding communities.

Technical Setup:

- Filter Material: Gravel + Sand + Charcoal
- Flow Rate: ~15–20 liters per hour
- Maintenance Requirement: Minimal

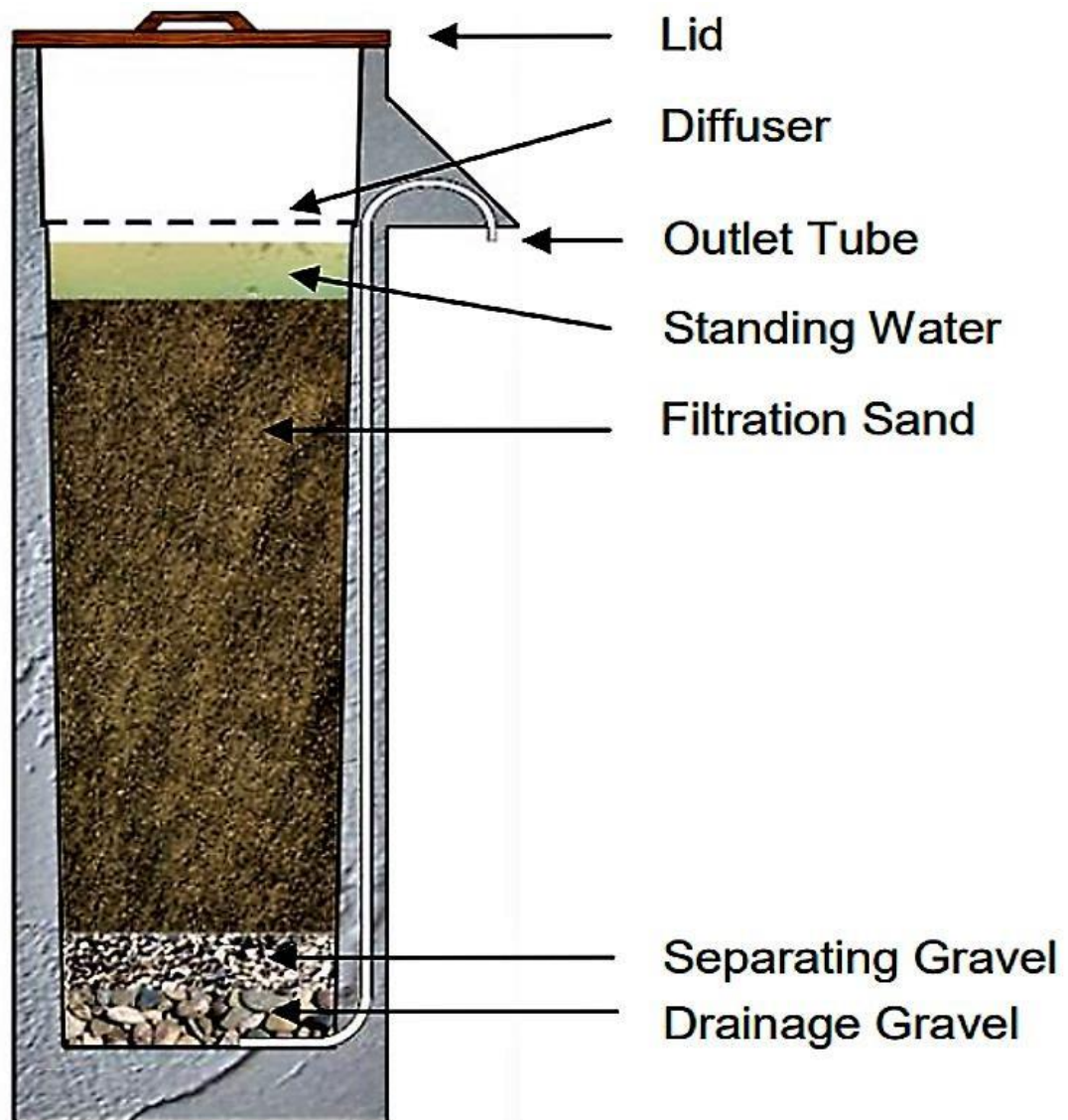


Figure33: Illustration of bio sand filtration

Community Training & Research Centre

Objectives:

- I. Training Programs:
- II. Efficient irrigation methods
- III. Soil conservation techniques
- IV. Renewable energy applications in farming
- V. Research on Local Crop Varieties: Improving resilience to climate change.

General Description

The proposed structure is a single-story institutional building designed for a Water Innovation Centre (WIC), housing a classroom and an office. The design emphasizes durability, ventilation, and natural lighting, suitable for an educational facility

Structural Components

Foundation of the centre will be Reinforced concrete strip footing, Walls, should be Made of masonry blocks with a cement plaster finish, External walls has to be 200mm thick for durability and insulation, Internal walls has to be 150mm thick for partitioning, Columns, Reinforced concrete columns providing structural stability, Beams: Reinforced concrete beams supporting the walls and roof structure.

Floor Plan & Layout

As per the drawing provided Building Size: 14.6m x 9.0m Rooms, Classroom: Spacious, designed for group learning, with multiple windows for ventilation. Office: A smaller enclosed space for administrative functions, Doors, Standard wooden or metal doors for security and access, Windows, Multiple W1-type windows for cross-ventilation and natural lighting.

Roof System

The type of the roof to be used is Gable roof with extended overhangs for weather protection, Roof Material: Galvanized corrugated metal sheets, durable for hot climates, Trusses: Timber trusses supporting the roof structure, Ceiling: Optional provision for false ceiling for insulation.

Finishes

Flooring finishing should be Concrete floor with smooth cement finish or tile finish for durability, Wall Finish, External: Cement plaster with weatherproof paint, Internal: Smooth plaster with painted finish, Roof Finish, Galvanized metal sheets with anti-corrosion coating.

Electrical & Mechanical Systems

Electrical, Standard wiring with provisions for lighting and power sockets. Plumbing, Basic water supply for office use if required, Ventilation, Natural cross-ventilation through large windows, Lighting, Combination of natural light and ceiling-mounted fixtures.

Construction Notes & Compliance

The structure should comply with local building codes and standards, Quality control checks should be performed on materials before use, Foundations and structural elements must be inspected before concrete pouring, Doors, windows, and roofing materials should be properly secured and weather-resistant.

Financial and Institutional Sustainability

Develop a cost-recovery model combining nominal water service fees with revenue from greenhouse produce sales to support operational expenses. Establish a multi-stakeholder steering committee comprising government, community representatives, and development partners to oversee project governance and financial management. Pursue grant funding and public-private partnerships to leverage additional resources and reduce financial risk.

Monitoring, Evaluation, and Learning

Set up a monitoring and evaluation (M&E) framework with clear indicators for water supply reliability, agricultural productivity, and health outcomes.

Schedule periodic evaluation reports and validation workshop to share lessons learned and adapt project activities as needed.

Document and disseminate best practices and case studies to promote replication in other regions of Jubaland.

CHAPTER 7:

CONCLUSION AND RECOMMENDATIONS

1.51 Conclusion

The feasibility study for the proposed Water and Gender Transformative Innovation Centre in Luglow, Kismayo highlights both the critical need for sustainable water resource management and the region's potential for climate-resilient agricultural development. The assessment confirms that the area's hydro geological and soil conditions, despite existing challenges, are suitable for implementing integrated water and agriculture solutions.

The proposed infrastructure—including a dam intake system from the Juba River, solar-powered pumping station, overhead storage tanks, pipeline network, greenhouses, and a learning centre—forms a comprehensive response to water insecurity, food production needs, and community capacity-building. Importantly, this integrated model ensures inclusive benefits for host communities, internally displaced persons (IDPs), and returnees while enhancing environmental resilience and local livelihoods.

1.52 Recommendations

Infrastructure Development

Proceed with detailed engineering designs for a small-scale dam on the Juba River, ensuring alignment with hydrological data and site topography. Install solar-powered pumping systems paired with overhead storage tanks to provide reliable, renewable water supply and reduce operational costs. Construct water distribution pipelines using corrosion-resistant materials and incorporate strategically located valve chambers for ease of maintenance.

Water Quality and Treatment

Implement community-scale bio-sand filters at key distribution points to improve water quality and reduce water borne disease incidence. Establish regular water quality monitoring protocols, testing for salinity, turbidity, and micro bail contamination, with results shared transparently with stakeholders.

Agricultural Demonstration and Capacity Building

Develop greenhouse demonstration farms using drip irrigation to showcase water-efficient crop production methods. Conduct training workshops for local farmers, IDPs, and returnees on sustainable agriculture practices, greenhouse management, and water conservation techniques. Partner with local vocational institutions to integrate water management and agriculture curricula, building long-term technical capacity.

Environmental and Social Safeguards

Conduct a full Environmental and Social Impact Assessment (ESIA) before construction, focusing on biodiversity preservation and community livelihoods. Implement riparian vegetation restoration along the Juba River banks to stabilize soil and enhance ecosystem resilience. Engage women and vulnerable groups in decision-making forums to ensure equitable access to resources and benefits.



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