



Regional Centre for  
Mapping of Resources  
for Development



# **SOIL MANAGEMENT ACTION PLAN FOR AL DAMAR IN THE RIVER NILE STATE OF SUDAN: 2024 - 2026**

Sustainability in Managing Soil Resources for Optimal  
Agricultural Productivity



**June 2024**

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## **ACKNOWLEDGEMENT**

The support and invaluable contributions provided by all stakeholders, especially the Technical Working Group based in Sudan, in the production of this soil management action plan is greatly appreciated. Special thanks are also extended to the Director General - RCMRD for the administrative and logistical support, as well as for guidance throughout the entire process.

**June 2024**



## SUMMARY

Soil is an essential of life, supporting the survival and socio-economic well-being of the inhabitants of Al Damar district in the River Nile State of Sudan. The support is mainly realized through small-scale agricultural activities, which are majorly confined on the banks of the Nile River. The increasing frequency of climatic extremes, particularly droughts, high-velocity wind storms, erratic rainfall, and floods has exposed the soils of the northern parts of Sudan to erosion by both wind and water. Anthropogenic factors, such as inappropriate land use practices have also accelerated the rates of soil erosion. The widespread soil degradation in the form of *inter alia* soil erosion, soil organic matter decline, salinity, sodicity and soil nutrients depletion underpins the low agricultural productivity and per capita income levels in the area. The ongoing soil degradation could also increase the vulnerability of communities in Al Damar to future climatic and economic shocks, culminating in human destitution, abandoned unproductive lands, conflicts and migration.

Restoring the degraded soils and averting further land degradation is an important investment in Al Damar's future soil health and security. This calls for concerted efforts towards Sustainable Land Management (SLM) involvements that will not only address the existing soil degradation issues, but also optimize productivity, incomes and livelihoods in a way that equitably meets the present needs of the communities, while conserving and advancing the various ecosystem services and functions offered by the soils.

This Soil Management Action Plan (SMAP) is a blueprint for Al Damar to enable the inhabitants manage their soil resources in a cost-effective, efficient and sustainable manner in order to attain the desired future of optimal productivity, food security, improved livelihoods and ecological resilience. The SMAP has been designed to provide a planning framework for systematic and coordinated SLM interventions for Al Damar. The Plan will create a context that optimizes utilization and management of soil resources, as well as secures the natural environment for sustainable socio-economic well-being. In addition, it will improve local planning by coordinating and guiding various SLM projects being implemented in Al Damar; hence, reducing wastage of scarce resources. Simply put, the Plan gives an overview of the current soil degradation issues, a

vision for the future and a framework of priority SLM actions, including the soil management goals and objectives, as well as the implementation mechanism.

Development of this SMAP involved consultations with various stakeholders and was guided by the principles of *inclusivity; sustainability; responsibility; efficiency; optimization; precaution; and ecological integrity*. Al Damar community was the lead stakeholder and was instrumental in (i) identifying the soil degradation issues of concern and remedial actions; and (ii) setting out the preliminary goals and indicators. A technical working group (TWG) was constituted to facilitate fora for engagement with these stakeholders and to collect relevant information for preparing the Plan. The whole process was facilitated by the Natural Resources General Directorate of the Ministry of Agriculture and Forests (NRGD) in Sudan with funding from the United Nations Climate Technology Centre and Network (CTCN) through the Regional Centre for Mapping of Resources for Development (RCMRD) under the project titled: " *Soil erosion evaluation using advanced laboratory measurement methods to support climate-resilient agriculture and food security* ".

Considering the major soil degradation issues identified in Al Damar, this SMAP prescribes five priority SLM action plans that aim to: (i) reduce soil erosion by wind and water; (ii) reduce salinity; (iii) reduce sodicity; (iv) improve soil fertility; and (v) increase soil organic matter levels. The SLM actions to address the soil degradation issues of concern in the area were evaluated and prioritized based on five indicators; namely, technical feasibility, social acceptability, environmental benefits, carbon benefits, biodiversity benefits and economic viability.

All the relevant stakeholders will be actively involved in collaborative implementation of this Plan, which will be initiated and coordinated by NRGD. The stakeholders and partners will play an important role in communicating the set out priority SLM actions. In addition, monitoring will be done continuously to assess the Plan's progress towards success and to ensure that the intended SLM actions are implemented in a timely manner in order to achieve the set management objectives. A monitoring and evaluation tool with verifiable indicators and a time schedule will be prepared to guide the regular monitoring and evaluation process.



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## **LIST OF ABBREVIATIONS**

GIS	Geographical information systems
HCENR	Higher council for environment and natural resources
NRGD	Natural resources general directorate of the ministry of agriculture and forests
RNS	River Nile State
RSSA	Remote sensing and seismology authority
SDG	Sustainable development goal
SLM	Sustainable land management
SMAP	Soil management action plan
TWG	Technical working group



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## 1.0 INTRODUCTION

### 1.1 Background

Soil is an integral part of Al Damar's landscape in the River Nile State of Sudan, supporting the survival and socio-economic well-being of its inhabitants. The support is mainly realized through small-scale agricultural activities, which are majorly confined on the banks of the Nile River. The increasing frequency of climatic extremes, particularly droughts, high-velocity wind storms, erratic rainfall, and floods has exposed the soils of the northern parts of Sudan to erosion by both wind and water. Anthropogenic factors, such as inappropriate land use practices have also accelerated the rates of soil erosion. The widespread soil degradation in the form of *inter alia* soil erosion, soil organic matter decline, salinity, sodicity and soil nutrients depletion underpins the low agricultural productivity and per capita income levels in the area. The ongoing soil degradation could also increase the vulnerability of communities in Al Damar to future climatic and economic shocks, culminating in human destitution, abandoned unproductive lands, conflicts and migration.

Restoring the degraded soils and averting further land degradation is an important investment in Al Damar's future soil health and security. This calls for concerted efforts towards Sustainable Land Management (SLM) involvements that will not only address the existing soil degradation issues, but also optimize productivity, incomes and livelihoods in a way that equitably meets the present needs of the communities, while conserving and advancing the various ecosystem services and functions offered by the soils.

This Soil Management Action Plan (SMAP) is a blueprint for Al Damar to enable the inhabitants manage their soil resources in a cost-effective, efficient and sustainable manner in order to attain the desired future of optimal productivity, food security, improved livelihoods and ecological resilience. It gives an overview of the current soil degradation issues, a vision for the future and a framework of SLM interventions, including the soil management goals and objectives, as well as the implementation mechanism. The SMAP is anchored on output 3.4.1 of the African Fertilizer and Soil Health action plan 2023 - 2033, which aims at promoting integrated soil and water conservation, planning, and management across agricultural landscapes, as well as on Sustainable Development Goal 15 (SDG 15), which focuses on sustainable

management of forests, combating desertification, reversing land degradation and halting biodiversity loss.

## **1.2 Purpose**

Overall, this SMAP provides direction towards the desired future by listing the actions that NRGD and partners have agreed to take to protect and better manage Al Damar's soils. It is designed to provide a planning framework for systematic and coordinated SLM interventions for Al Damar. The Plan will create a context that optimizes management of soil resources, as well as secures the natural environment for sustainable socio-economic well-being of the community. In addition, this SMAP will improve local planning by coordinating and guiding various SLM projects being implemented within Al Damar in order to reduce wastage of the scarce resources.

## **1.3 Vision**

The actions proposed in this Plan envisage *healthier soils for enhanced agricultural productivity, food security, livelihoods, ecological resilience and other functions that soils perform.*

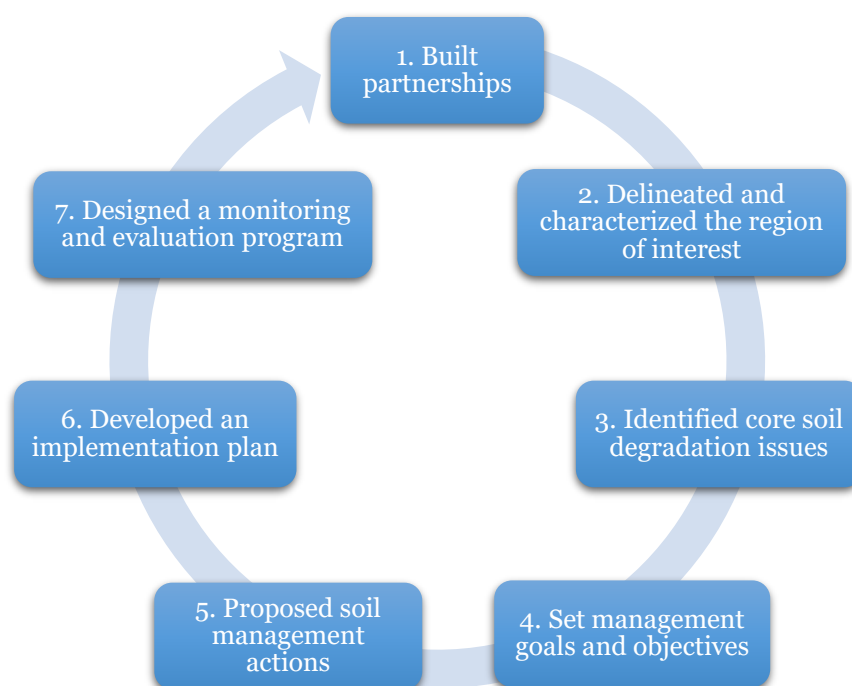
## **1.4 Guiding principles**

Development of the SMAP was guided by the principles of *inclusivity; sustainability; responsibility; efficiency; optimization; precaution; and ecological integrity.* The same principles will govern the implementation of the priority SLM actions identified to tackle the key soil degradation issues.

## **1.5 Preparatory process**

The soil management action planning was a structured effort to identify the major soil degradation issues and set out the remedial actions to be taken to protect, restore and sustainably utilize Al Damar's soils. A technical working group (TWG) consisting of 11 experts from six institutions played an important role in spearheading this effort. The institutions include: Natural Resources General Directorate of Ministry of Agriculture and Natural Resources (NRGD); Higher Council for Environment and Natural Resources (HCENR); Dry land centre of Agriculture Research Cooperation; Remote Sensing and Seismology

Authority (RSSA); Institute for Desertification Studies University of Khartoum; and River Nile state (farmer representative, agricultural research station, land use department and Rahjhi private soil laboratory). The TWG not only identified an agreed path forward for Al Damar's soil, but also provided high level technical advice and input on the drafting of the soil action plan. Figure 1 illustrates the steps followed to develop the SMAP.



**Figure 1:** Steps to delivery of the soil management action plan

## 1.6 Stakeholder participation

The Plan was drawn in consultation with pertinent stakeholders (i.e., local communities, experts and other interest groups) in order to encourage ownership and support. Thus, the first step was to identify the key stakeholders who make and implement decisions, who are affected by the decisions, who can assist or impede implementation of the decisions, who can contribute resources and assistance to the SMAP effort and who are working on similar programs. The TWG engaged with these stakeholders to facilitate fora for:

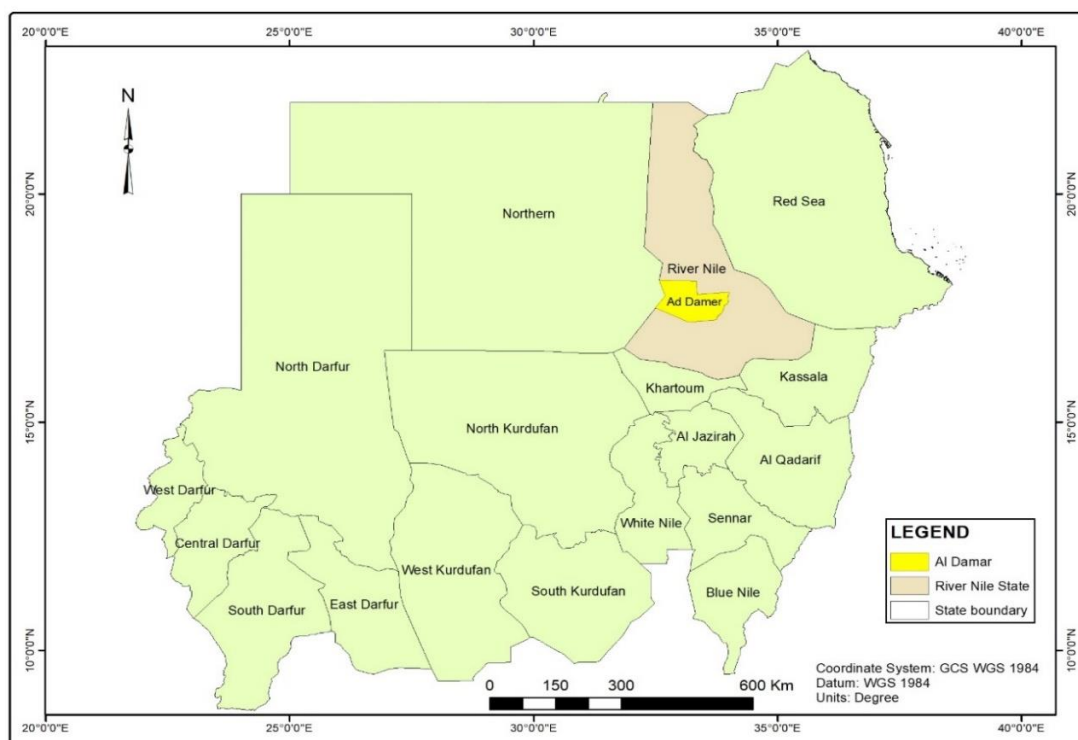
- a) Delineating and characterizing the region of interest;
- b) Identifying the key soil degradation issues;
- c) Setting the preliminary goals and indicators; and
- d) Developing the soil management action plan

Different aspects of the SMAP were also presented to stakeholders to seek feedback on the proposed priority actions for improving the draft Plan.

Effective and continued collaboration between all stakeholders and partners will be crucial to the action plan's success. The stakeholders in close collaboration with partners will have an important role in communicating the priority actions.

## 2.0 DESCRIPTION OF AL DAMAR

### 2.1 Geographical location and biophysical environment



**Figure 2:** Location of Al Damar District in the River Nile State, Sudan

Al Damar (Ad Damer, Ed Damer) District of the River Nile State (RNS) lies between Latitudes  $17^{\circ} 11' 9.6''$  and  $18^{\circ} 6' 46.8''$  N, and Longitudes  $32^{\circ} 28' 12''$  and  $33^{\circ} 59' 45.6''$  E, at an altitude of 1,158 feet (353 m) above sea level (Figure 2). It covers an area of 10,866 km<sup>2</sup>, which is dominated by Aridisols (i.e., dry soils with CaCO<sub>3</sub> accumulations), semi-desert vegetation (i.e., scrubs and grasslands) and semi-arid climatic conditions. The mean annual rainfall is about 56 mm, most of which is received between July and September, relative humidity is less than 40 percent, and temperatures are as high as 43°C between April and June, and as low as 14°C in January. In addition, the shortwave solar

radiation is as high as 659 calorie  $\text{cm}^{-2}$  in May, while the mean maximum wind speed is about 17.6  $\text{km}^{-\text{hr}}$ . Owing to these extreme climatic conditions, agricultural activities are majorly confined on the banks of the Nile River.

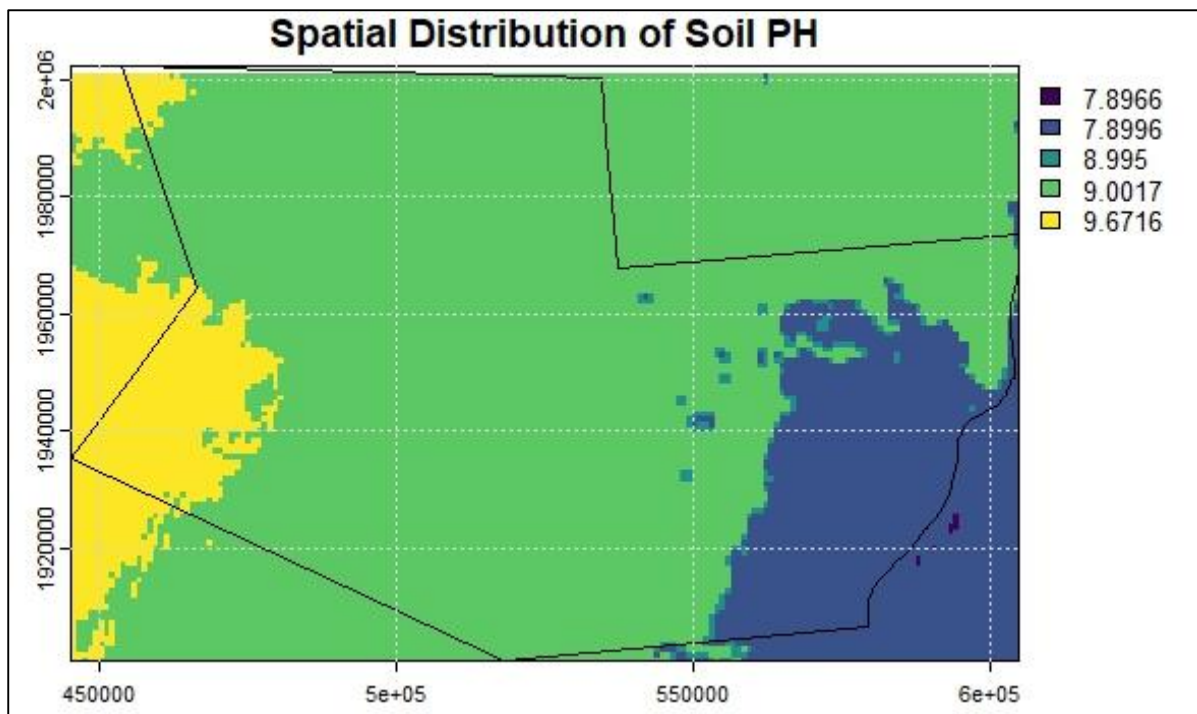
In terms of physiography, the landform of Al Damar is characterized by flat to slightly undulating desert plains, rising from 100 to 600 feet above sea level, with *wadis*, sand dunes, and low ridges and hills appearing in some parts.

### 3.0 OVERARCHING SOIL DEGRADATION ISSUES

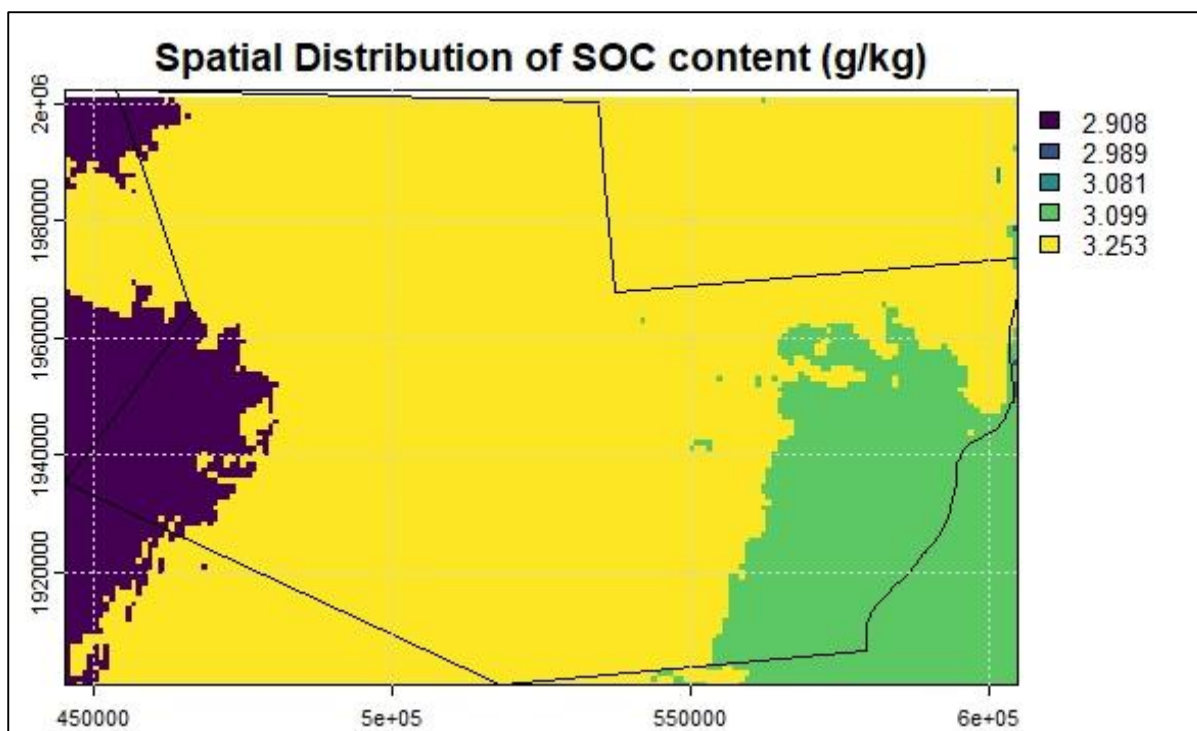
The existing soil degradation problems in Al Damar were identified through reconnaissance survey, stakeholder meetings, literature reviews and geospatial analytical methods. Biophysical information (e.g., land use, climate, soils and landforms) was compiled and technically analysed to determine the baseline land use conditions and critical issues. Reconnaissance survey was conducted to gather primary soil degradation data (Figure 3). Geographic information systems (GIS) was useful in organizing, manipulating and mapping of the collected information, the output thematic maps (e.g., soil erosion risk map) of which were used to inform stakeholders and partners (Figure 4, 5 & 6). Existing literature helped to identify gaps, opportunities and priorities for targeting SLM practices across the landscape. Lastly, stakeholder meetings were crucial in determining the soil degradation issues, remedial actions and constraints to soil conservation. Table 1 presents the general findings from biophysical information analysis, literature reviews and stakeholder consultations.



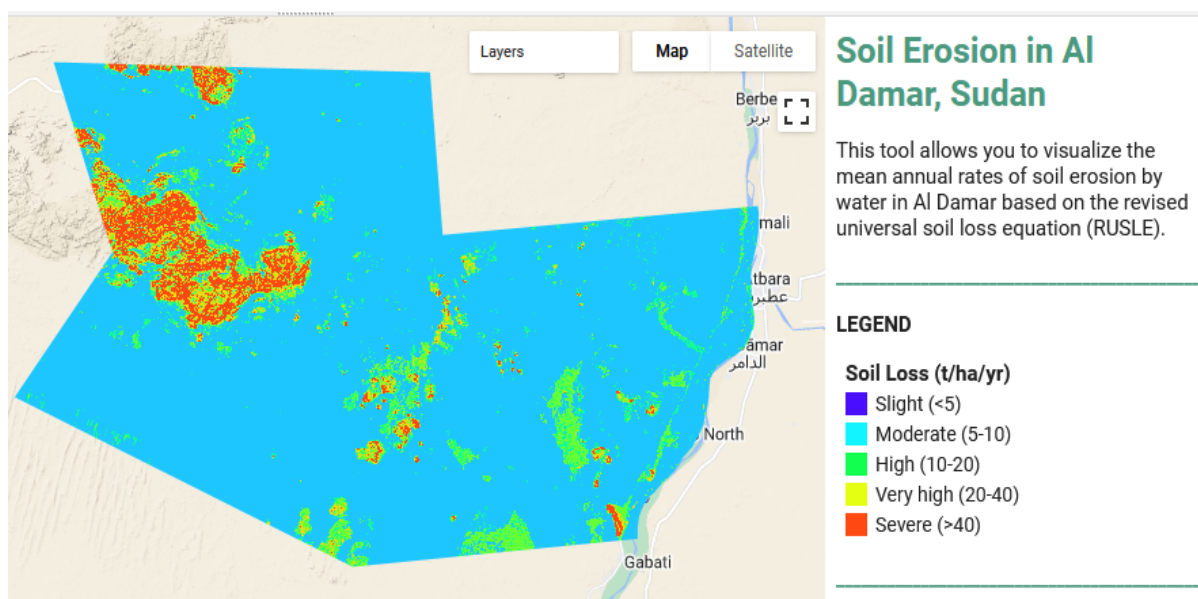
**Figure 3:** Pictorial representation of some of the soil degradation issues in Al Damar District in the River Nile State, Sudan



**Figure 4:** Spatial distribution of soil pH in Al Damar



**Figure 5:** Spatial distribution of SOC ( $\text{g kg}^{-1}$ ) in Al Damar



**Figure 6:** Annual rates of soil erosion by water in Al Damar

**Table 1:** Summary of the soil degradation issues

Land resource	Degradation issues
1. Agricultural soils	<ul style="list-style-type: none"> <li>▪ Erosion by water;</li> <li>▪ Erosion by wind;</li> <li>▪ Nutrient depletion (low P and N);</li> <li>▪ Organic matter decline;</li> <li>▪ Sodicity;</li> <li>▪ Salinity;</li> <li>▪ Alkalinity</li> </ul>

#### 4.0 SOIL MANAGEMENT GOAL AND OBJECTIVES

In view of the foregoing soil degradation issues, the management goal is to *execute SLM actions that promote sustainable agriculture, while safeguarding ecological integrity* in Al Damar district. Specifically, the proposed SLM actions aim at:

- a. Reducing soil erosion by water and wind
- b. Reducing salinity
- c. Reducing sodicity
- d. Reducing soil nutrient depletion; that is, increasing soil P and N levels
- e. Increasing soil organic matter levels.

## 5.0 PRIORITY SOIL MANAGEMENT ACTIONS

The Plan sets out five (5) priority actions for tackling the key soil degradation issues (Table 1), as well as for managing and improving Al Damar's soils. The actions were selected based on five qualities; namely, technical feasibility, social acceptability, environmental benefits, carbon benefits, biodiversity benefits and economic viability (Annex 1).

### **Action 1: Reducing soil erosion by water and wind**

Specific activities under this action include:

- Planting trees (local drought-tolerant tree species, e.g., Neem, Palm and Damas) as shelterbelts or windbreaks
- Contour farming
- Mulching
- Establishing physical soil conservation structures e.g., terraces and check dams
- Strip farming
- Planting cover crops
- Intercropping
- Water harvesting during the rainy season

### **Action 2: Reducing salinity**

Specific activities under this action include:

- Planting salt-tolerant crops and plant species
- Scheduling irrigation, or implementing efficient irrigation practices, such as drip irrigation to avoid over-irrigation, which can increase salt accumulation
- Applying excess water to leach salts below the root zone and promote drainage, flushing out accumulated salts from the root zone (soil washing).
- Implementing crop rotation and diversification (to break the cycle of salt accumulation)

### **Action 3: Reducing sodicity**

Specific activities under this action include:

- Liming if the soil pH is below 5

- Applying a mix of lime (calcium carbonate) and gypsum (calcium sulphate) if the soil pH (CaCl<sub>2</sub>) is in the 5 to 6.5 range
- Applying calcium-containing fertilizers
- Planting crops and plant species that are tolerant to sodicity

#### **Action 4: Reducing soil nutrient depletion**

Specific activities under this action include:

- Applying appropriate inorganic and organic fertilizers after soil testing

#### **Action 5: Increasing soil organic matter levels**

Specific activities under this action include:

- Incorporating soil amendments and organic matter, such as compost, mulch, organic manure and biochar

## **6.0 IMPLEMENTATION MATRIX**

The successful implementation of these actions will require a collaborative approach to be coordinated by NRGD. Table 2 presents the major soil degradation issues, proposed SLM actions, time line for implementation of the remedial action(s) and the responsible party.

**Table 2:** Implementation matrix for the proposed SLM practices

<b>LAND DEGRADATION ISSUE</b>	<b>PROPOSED SLM ACTION</b>	<b>RESOURCES REQUIRED</b>	<b>ESTIMATED COST (USD)</b>	<b>RESPONSIBLE</b>	<b>TIME FRAME</b>
Soil erosion by water and wind	<p><i>Action 1:</i> <i>Reducing soil erosion by water and wind</i></p> <ul style="list-style-type: none"> <li>▪ Planting trees (local drought-tolerant tree species, e.g., Neem, Palm and Damas) as shelterbelts or windbreaks</li> <li>▪ Contour farming</li> </ul>			Ministry of Agriculture and Forestry	2024 - 2026

LAND DEGRADATION ISSUE	PROPOSED SLM ACTION	RESOURCES REQUIRED	ESTIMATED COST (USD)	RESPONSIBLE	TIME FRAME
	<ul style="list-style-type: none"> <li>▪ Mulching</li> <li>▪ Establishing physical soil conservation structures e.g., terraces and check dams</li> <li>▪ Strip farming</li> <li>▪ Planting cover crops</li> <li>▪ Intercropping</li> <li>▪ Water harvesting during the rainy season</li> </ul>				
Salinity	<p><i>Action 2: Reducing salinity</i></p> <ul style="list-style-type: none"> <li>▪ Planting salt-tolerant crops and plant species</li> <li>▪ Scheduling irrigation, or implementing efficient irrigation practices, such as drip irrigation to avoid over-irrigation, which can increase salt accumulation</li> <li>▪ Applying excess water to leach salts below the root zone and promote drainage, flushing out accumulated salts from the root zone (soil washing)</li> </ul>			Agricultural Research Corporation	2024 - 2026

LAND DEGRADATION ISSUE	PROPOSED SLM ACTION	RESOURCES REQUIRED	ESTIMATED COST (USD)	RESPONSIBLE	TIME FRAME
	<ul style="list-style-type: none"> <li>▪ Implementing crop rotation and diversification (to break the cycle of salt accumulation)</li> </ul>				
Sodicity	<p><i>Action 3: Reducing sodicity</i></p> <ul style="list-style-type: none"> <li>▪ Liming if the soil pH is below 5</li> <li>▪ Applying a mix of lime (calcium carbonate) and gypsum (calcium sulphate) if the soil pH (CaCl<sub>2</sub>) is in the 5 to 6.5 range</li> <li>▪ Applying calcium-containing fertilizers</li> <li>▪ Planting crops and plant species that are tolerant to sodicity</li> </ul>			Agricultural Research Corporation	2024 - 2026
Soil nutrient depletion (low P & N)	<p><i>Action 4: Reducing soil nutrient depletion</i></p> <ul style="list-style-type: none"> <li>▪ Applying appropriate inorganic and organic fertilizer after soil testing</li> </ul>			Ministry of Agriculture and Forestry	2024 - 2026
Decline in soil organic matter	<p><i>Action 5: Increasing soil organic matter levels</i></p>			NRGD	2024 - 2026

LAND DEGRADATION ISSUE	PROPOSED SLM ACTION	RESOURCES REQUIRED	ESTIMATED COST (USD)	RESPONSIBLE	TIME FRAME
	<ul style="list-style-type: none"> <li>▪ Incorporating soil amendments and organic matter, such as compost, mulch, organic manure and biochar</li> </ul>				

## 7.0 MONITORING AND EVALUATION

Monitoring will be done continuously to measure the degree of success of the Plan and to ensure that the intended actions are implemented in a timely manner in order to achieve the set management objectives. A monitoring tool with verifiable indicators and a time schedule will be prepared to guide the regular monitoring process by relevant parties. Evaluation will also be undertaken to assess the progress and achievements in implementation of the planned SLM actions. The evaluation will also help to address the constraints encountered in the process.

