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Final report: Land Degradation Neutrality Pilot Project

A project of the Ministry of Environment and Tourism

supported by the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)

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S. Hengari

simeon.hengari@wradac.org

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Abbreviations

BAU	Business-as-usual
CBA	Cost-benefit analysis
CIAT	International Centre for Tropical Agriculture
CICES	Common International Classification of Ecosystem Services
DLDD	Desertification, land degradation and drought
ELD	Economics of Land Degradation
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
HPC	High performance computing system
INDC	Intended Nationally Determined Contributions
IRLUP	Integrated Regional Land Use Plan
ISRIC	International Soil Reference and Information Centre
LD	Land Degradation
LDN	Land Degradation Neutrality
LDN-TSP	Land Degradation Neutrality Target Setting Programme (of the UNCCD)
MAWF	Ministry of Agriculture, Water and Forestry
MET	Ministry of Environment and Tourism
MLR	Ministry of Land Reform
NAP3	Third National Action Programme for Namibia to implement the UNCCD (2014-2024)
NDVI	Normalized Difference Vegetation Index
NDP5	National Development Plan
NILALEG	Namibia Integrated Landscape Approach for Enhancing Livelihoods and Environmental Governance to Eradicate Poverty (2018–2023)
NNF	Namibia Nature Foundation
NSA	Namibia Statistics Agency
NSI	Namibian Standards Institution
NUST	Namibia University of Science and Technology
SDG	United Nations Sustainable Development Goals
SEA	Strategic Environment Assessment
SEEA	UN System of Environmental-Economic Accounting
SLM	Sustainable Land Management
SOC	Soil organic carbon

SV-BoDeN	Sector Project on Soil Protection, Combating Desertification, Sustainable Land Management (of the GIZ)
UNAM	University of Namibia
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme

1. Executive Summary

The implementation of the Land Degradation Neutrality (LDN) pilot project in Namibia by the Ministry of Environment and Tourism (MET) has been accomplished through support from the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) Sector Project on Soil Protection, Combating Desertification, Sustainable Land Management (SV-BoDeN). The project was implemented from August 2015 to August 2018 in the selected project pilot sites of Otjozondjupa and Omusati region.

The objectives of GIZ support were:

- Supporting the MET to develop a nationally adapted monitoring approach for LDN
- Building the capacity of the MET and national experts to design and implement LDN assessments
- Mainstreaming the LDN-concept into the Integrated Regional Land Use Plan (IRLUP)
- Creating the necessary site-specific data baseline on core-indicators and testing additional indicators useful for monitoring of any LDN related interventions
- Understanding the challenges faced by a country like Namibia to rigorously and meaningfully monitor the United Nations Sustainable Development Goals (SDG) indicator "land degradation trends"
- Assessing the economic feasibility of land rehabilitation measures, especially with focus of de-bushing (as bush encroachment is one of the main land degradation types in the region) in close cooperation with GIZ project support to de-bushing
- Supporting up-scaling and out-scaling of experiences through national workshops and participation at international LDN related events

The major project outputs are:

- Establishment of locally applicable LDN assessment methodologies based on the United Nations Convention to Combat Desertification (UNCCD) recommendations
- Production of training material for technical training course on the LDN assessment methodology
- Training of MET staff and local experts from the University of Namibia (UNAM), the Namibia University of Science and Technology (NUST) and other institutions in LDN assessments
- Carrying out of LDN assessments in the Otjozondjupa and Omusati regions to create an information basis for land use plans, research and other actions related to land management
- Inclusion of the sustainable land management (SLM) recommendations for Otjozondjupa in the regional land use plan (IRLUP), based on the LDN assessment

- Provision of LDN assessment and SLM recommendations to the Ministry of Land Reform (MLR) and the Omusati Regional Council for inclusion in the IRLUP
- Facilitation of inter-ministerial meetings of the national Sustainable Land Management Committee (SLMC) in charge of the national LDN process
- Contribution to international knowledge exchange on best practices for LDN assessment
- Provisioning of guidance about the future of LDN in Namibia to the MET/United Nations Development Programme (UNDP) programme- the Namibia Integrated Landscape Approach for Enhancing Livelihoods and Environmental Governance to Eradicate Poverty (2018–2023) (NILALEG)
- Advising UNAM and NUST to improve the use of their technical infrastructure to enable the local analysis of LDN indicators

In summary, these outputs enabled Namibia to make substantial progress on its **Third National Action Programme to implement the UNCCD (2014-2024) (NAP3)**, particularly regarding Objective 3: "A functional Desertification, Land Degradation and Drought Monitoring System and supportive processes are in place by 2018 for Namibia to move towards land degradation neutrality". Beyond this, the pilot project demonstrated how data and maps from LDN assessments are not only relevant for monitoring purposes, but are also of high value to inform land use planning processes.

Capacities to assess, analyse and use LDN data for monitoring and land use planning have been developed. The MET and other Namibian stakeholders will be able to better advance the implementation of the national LDN targets and effective implementation of the NAP3. It is expected that upcoming LDN related projects (i.e. UNDP NILALEG) will build on the achievements of this LDN pilot project. An overview of the major actions completed during the project life cycle is given in Table 1.

Table 1: Major actions completed during the project life cycle.

Actions	Dates
Appraisal mission to Namibia by GIZ team for determining the support of the second phase of the UNCCD LDN programme in Namibia	22.06. – 26.06.2015
Selection of sub-national LDN assessment methodology to be used in Namibia	10.2015 – 02.2016
LDN assessment in Otjozondjupa region (field work training for local field teams)	03.2016 – 11.2016
Economics of Land Degradation assessment in Otjozondjupa region	03.2016 – 10.2016
1st training workshop of local LDN assessment experts	31.10. – 4.11.2016
2nd training workshop of local LDN assessment experts	05.07. – 09.07.2017
3rd training workshop of local LDN assessment experts	12.03. – 16.03.2018
LDN assessment in Omusati region	06.2017 – 07.2018
Final project workshop	11.07.2018

2. Introduction

2.1. Background on land degradation action in Namibia

Land degradation has been recognized as a major challenge in Namibia before and after independence. The Nature Conservation Ordinance of 1975 (replaced by the Nature Conservation Amendment Act of 1996) was one of the major laws used in Namibia to prevent various forms of land degradation before independence. Namibia launched the Green Plan in 1992 as a national framework for achieving sustainable development. The plan addressed desertification and land degradation and it identified actions to be taken by government, civil society organisations, the private sector and individuals to ensure sustainable development in Namibia. Today, the Green Plan of 1992 is used as the founding document for Namibia's Environmental Investment Fund, which was launched in 2012 with the aim of supporting and promoting investments in Namibia's environmental and natural resources. Fostered

The NAP3 is one of the latest national strategic documents being used to guide actions that will help prevent land degradation. The national LDN report of 2015 supports the NAP3 and provides specific LDN related targets to make Namibia land degradation neutral by 2030. The UNCCD supported LDN assessment of 2015 and current LDN programmes as well as the GIZ supported LDN pilot project have all supported the implementation of the NAP3 and the progress towards the achievement of LDN in Namibia. The new MET NILALEG programme, managed by the UNDP, will continue with the support for the implementation of various sub-projects aimed at achieving the national LDN targets.

National land degradation assessment in Namibia has been completed based on data developed and provided by the UNCCD. Revised data has recently been provided and was used to develop the National UNCCD report for Namibia. The Namibian government has been implementing several actions to improve the country´s economic development while ensuring the protection of its fragile environment. Different national land degradation management laws, policies and programmes are outlined in Section 2.5. A detailed list of all the laws enacted to protect the Namibian environment has been thoroughly reviewed before[1] and will not be presented in detail in this report.

The aim of Section 2 is to present an overview of national land degradation trends, the drivers of land degradation, LDN targets and the political vision/actions regarding land degradation management in Namibia. These topics will be covered in brief to lay the foundations/context in which the current GIZ supported LDN pilot project was implemented in Namibia.

2.2. Past and current land degradation trends in Namibia

The change in national land cover types from 2000 to 2010 are provided in Table 1 (data obtained from the UNCCD LDN program). The land cover types that experienced most change, according to this data, is grassland. However, although 7238 km^2 of grassland was lost during that period, 3,148 km^2 of

[1]Ministry of Environment and Tourism, 2010. A review of Natural Resource Management Policies, Namibia. Country Partnership Programme. Windhoek.

Desert Research Foundation, 2004. Namibia's third national report on the implementation of the United Nations Convention to Combat Desertification.;

Ruppel, O.C. and Ruppel-Schlichting, K. (eds). 2013. Ministry of Lands and Resettlement, 2009. Modelling Integrated Regional Land Use Planning. Pilot Region Karas. Windhoek.

"other land", 117.4 km2 Tree-covered area and 68.54 km2 Cropland was converted to grassland, therefore, the actual total loss of grassland during that period was approximately 4,090 km^2.

Table 2: Land cover changes [km^2] in Namibia between 2000 and 2010. Data from UNCCD.

Land cover types [km^2], 2000	Land cover types [km^2], 2010						
	Tree-covered areas	Grassland	Cropland	Wetland	Artificial surfaces	Other land	TOTAL loss (2000-2010)
Tree-covered areas	**74,565.3**	117.4	11.9	3.19	9.89	0	**- 142.38**
Grassland	3,239.31	**560,643.3**	2,803.45	0	57.44	1,138	**- 7,238.2**
Cropland	89.76	68.54	**20,026.29**	0	1.01	16.93	**- 176.24**
Wetland	61.53	0	0	**1,278.05**	0	0	**- 61.53**
Artificial surfaces	0	0	0	0	**663.22**	0	**0**
Other land	32.67	3,147.86	25.35	0	9.75	**14,9026.28**	**- 3,215.63**
TOTAL coverage 2010	**77,988.57**	**563,977.1**	**22,866.99**	**1,281.24**	**741.31**	**15,0181.21**	**10,833.98**

The change in vegetation health from 2000 to 2010 (Figure 1), measured as land productivity dynamics using the Normalized Difference Vegetation Index (NDVI), indicates different "pockets of stress" where land degradation in Namibia is severe. The two case study regions, Omusati and Otjozondjupa, showed different vegetation health changes from 2000 to 2010. The changes in vegetation health can be caused by different factors in each region.

Large areas in the southern Omusati region showed a stressed vegetation during the study period (2000 to 2010). It is probable that the stress distribution is likely the same up to today as a change analysis of vegetation health from 2000 to 2013 in the National LDN report of 2015[2] showed similar results. The stressed area is located in the Etosha National Park. The reason for this phenomenon could be due to a combination of factors such as climate, animal pressure and wild fires.

The stable and increasing vegetation health observed for the Otjozondjupa region is however to be seen in the context of the high bush encroachment that occurs in that region. The areas of high bush density appear to coincide with areas of high bush encroachment.

Namibia has generally poor soils with low soil organic carbon (Figure 2) that limit both agriculture and general vegetation growth. Increasing soil fertility is a difficult task that is best handled through a multidisciplinary approach. This would reduce cost, reduce the effective period needed to increase soil fertility and ensure maximum benefit to all land users. Cropland is concentrated in the northern areas (Figure 3), with commercial crop growth also done south east of the Etosha National Park in the "maize triangle". The high population density in these areas result in high livestock density, high soil

[2] Ministry of Environment and Tourism, 2015. Namibia – Land Degradation Neutrality National Report.

impact and vegetation use. The combination of poor soil fertility, salinity, high livestock impacts and vegetation use put pressure and limit the agriculture potential of these areas.

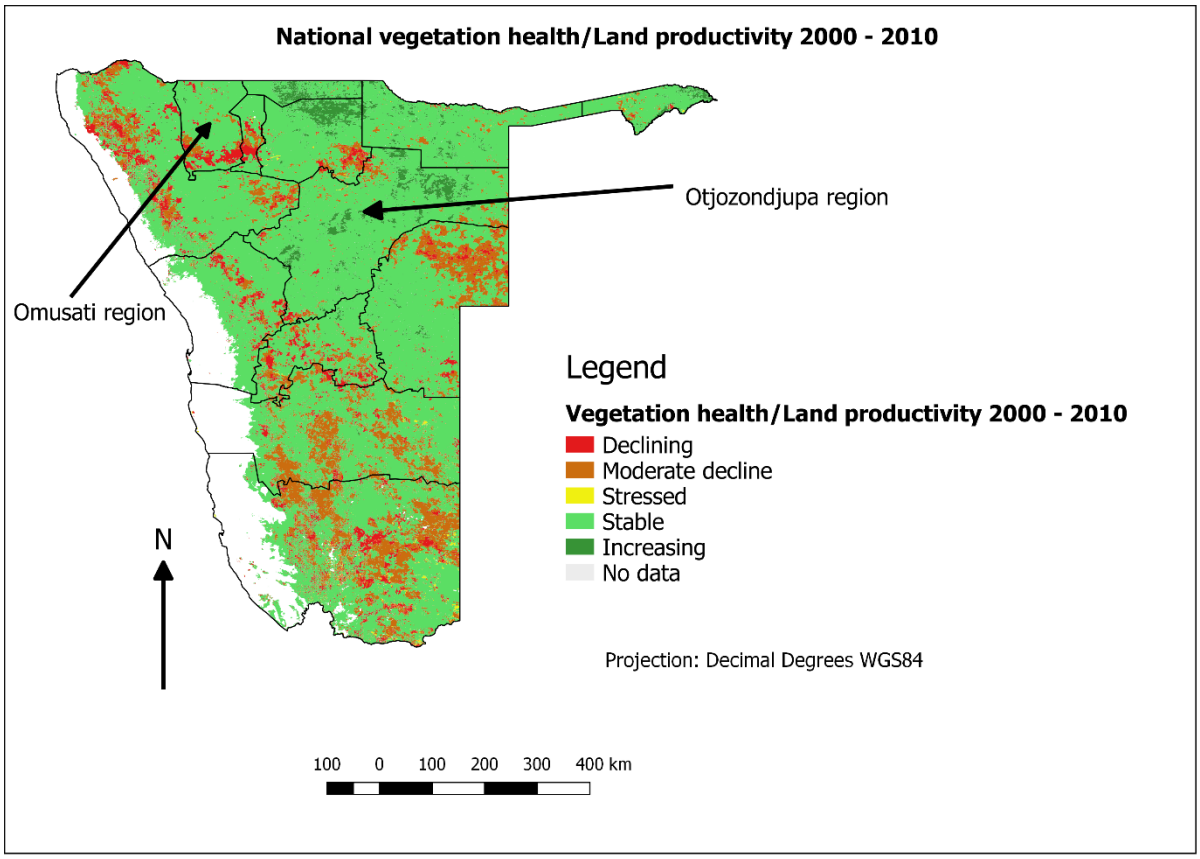


Figure 1. Change in land productivity in Namibia from 2000 to 2010. Data from the UNCCD.

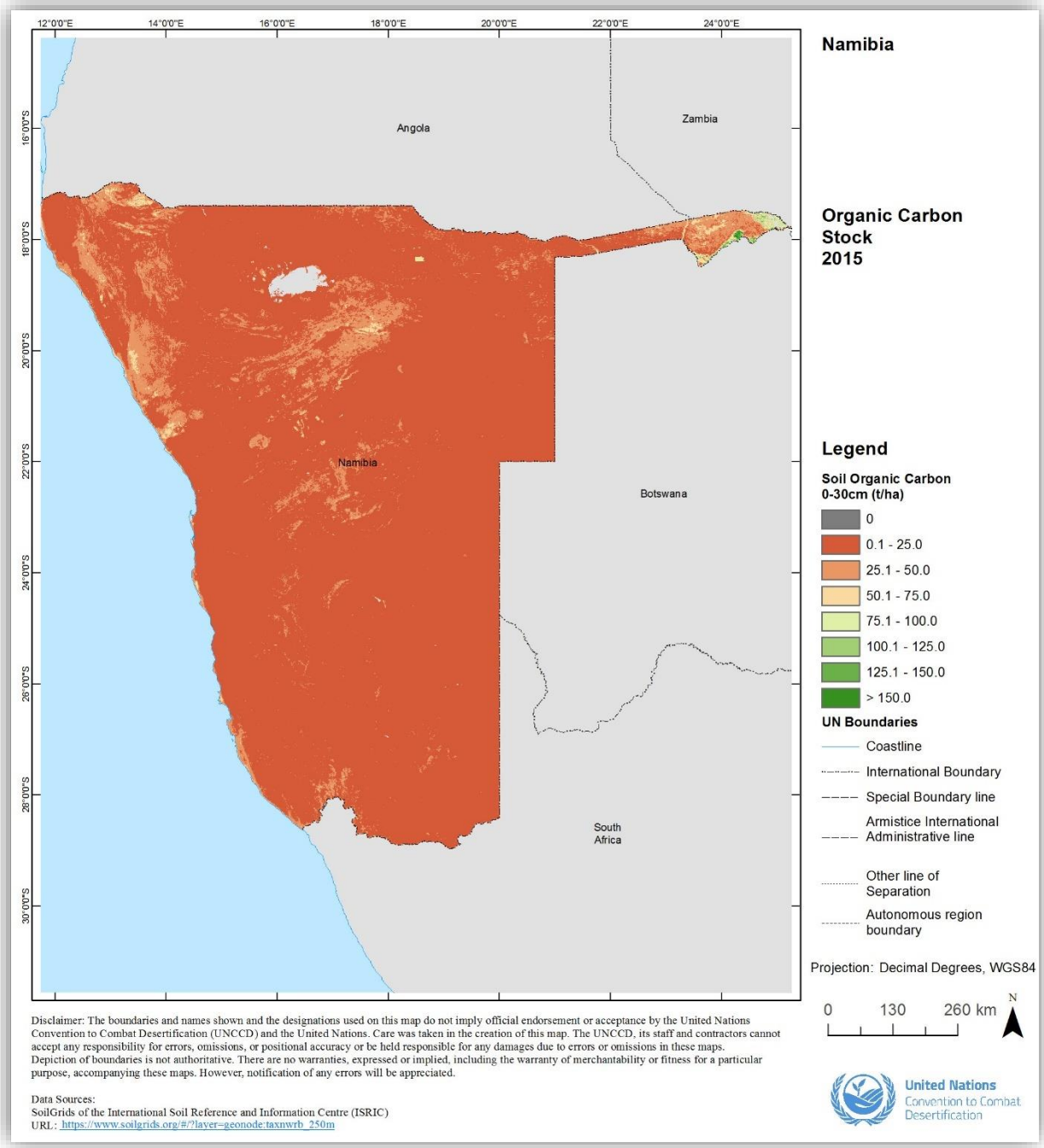


Figure 2. Soil organic carbon in Namibia. Data from the UNCCD.

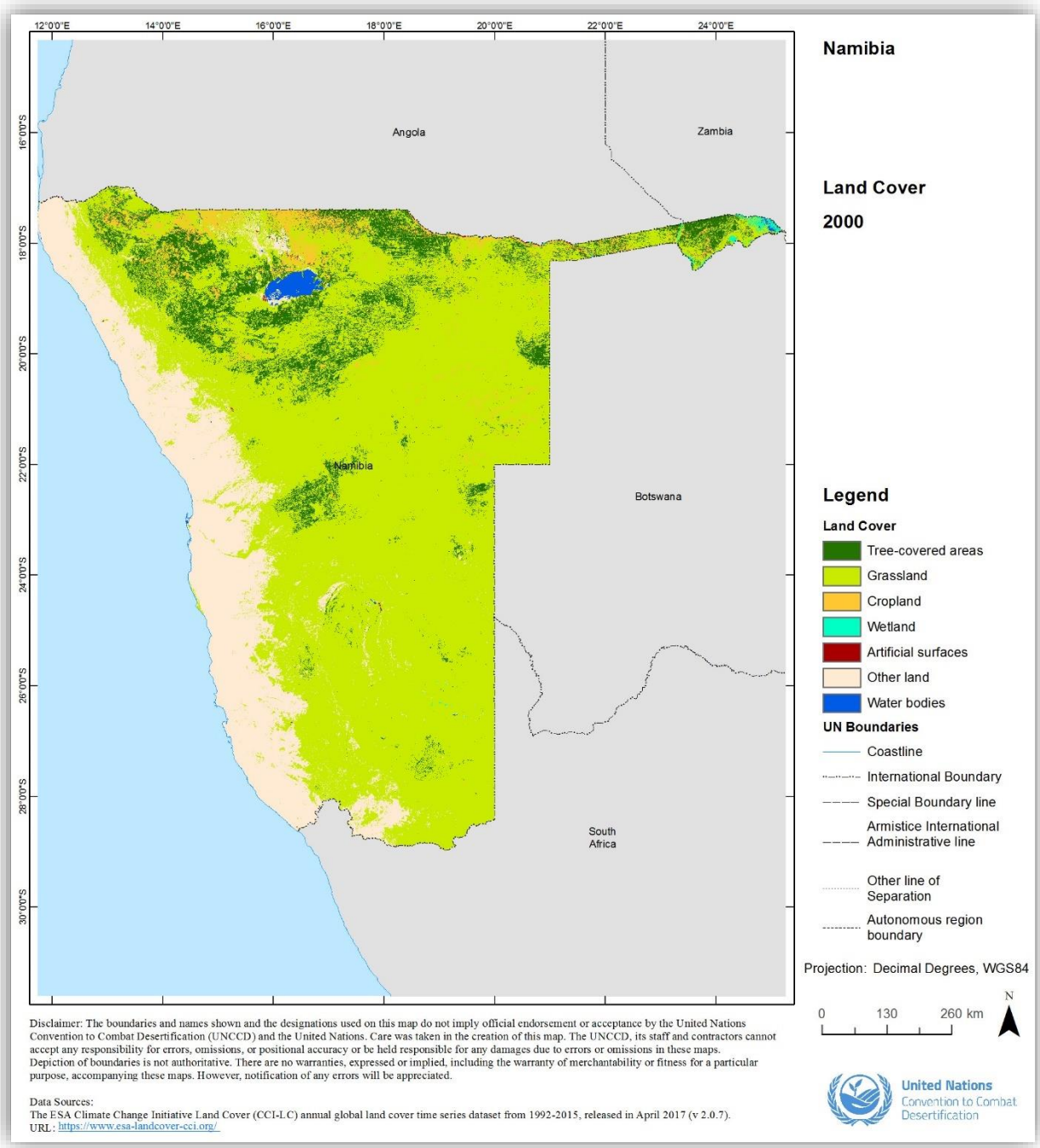


Figure 3. Land cover types in Namibia, 2000. Data from the UNCCD.

2.3. Land degradation drivers

Namibia faces a number of **social and economic conditions** that will make achieving and maintain LDN in the country in the near future a big challenge:

- The population will continue to increase and put pressure on the limited natural resources
- Poverty levels and income inequality remain stubbornly high despite the government's efforts to reduce them

- The unequal distribution/ownership of land remains politically challenging to resolve
- Climate change will possibly cause an increase in mean maximum temperatures and therefore an increase in the already high evaporation rate, while rainfall will potentially become more erratic and rainfall intensities will increase which will increase top soil erosion and reduce land productivity
- Cross sector collaborations are still slow, although they are improving
- There is lack of local expertise, especially for long term scientific monitoring of the factors causing land degradation
- Communal farmers still lack the appropriate collaterals to access affordable financial mechanisms and they lack the economic knowhow to become profitable over the long term
- High number of these communal farmers (with financial support from the urban dwellers) continue to rely on cultural knowledge for their farming practices that include keeping large numbers of livestock even in the face of ever decreasing grazing land which continue to degrade the land further
- The current poor condition of the national economy and the impact of the political and related economic changes in the Republic of South Africa will keep pressure on financial resources allocated to environment management actions

The **three major drivers of land degradation** in Namibia are:

- Poor soil conditions and rainfall levels
- Unsustainable (local culture-based) farming practices (contributing to i.e. overgrazing)
- Poverty (people with limited access to basic needs such as energy, housing and food)

The increasing population, especially in the lower income segment of the population, contributes to increasing poverty levels and unsustainable land use in rural areas. Efforts to attain and maintain LDN should therefore aim to resolve the problems posed by these major factors.

Many factors contribute to the observed land degradation in Namibia and in Otjozondjupa region in particular. In 2014, the national SLMC members were asked to rank the factors contributing to land degradation in Namibia according to their perceived level of importance as depicted in Figure 4. The data in the figure can be summarised as follows:

Factors with a high contribution to land degradation (ranked from high to low level of contribution)

1. Overgrazing
2. Poverty
3. Poor soil conditions and rainfall level
4. Poor cross-sector collaboration between land management agencies

5. Increasing population
6. Lack of appropriate technologies for SLM
7. Unsustainable water usage
8. Pollution

It is also likely that all the factors with perceived high contribution to land degradation at the national level play a role in the observed land degradation in Omusati and Otjozondjupa region. The exclusion of fires from rangelands is a major contributor to the current bush encroachment problem observed in the region. However, of the high land degradation contributing factors listed above, pollution may play a much lower role than the other factors in the region.

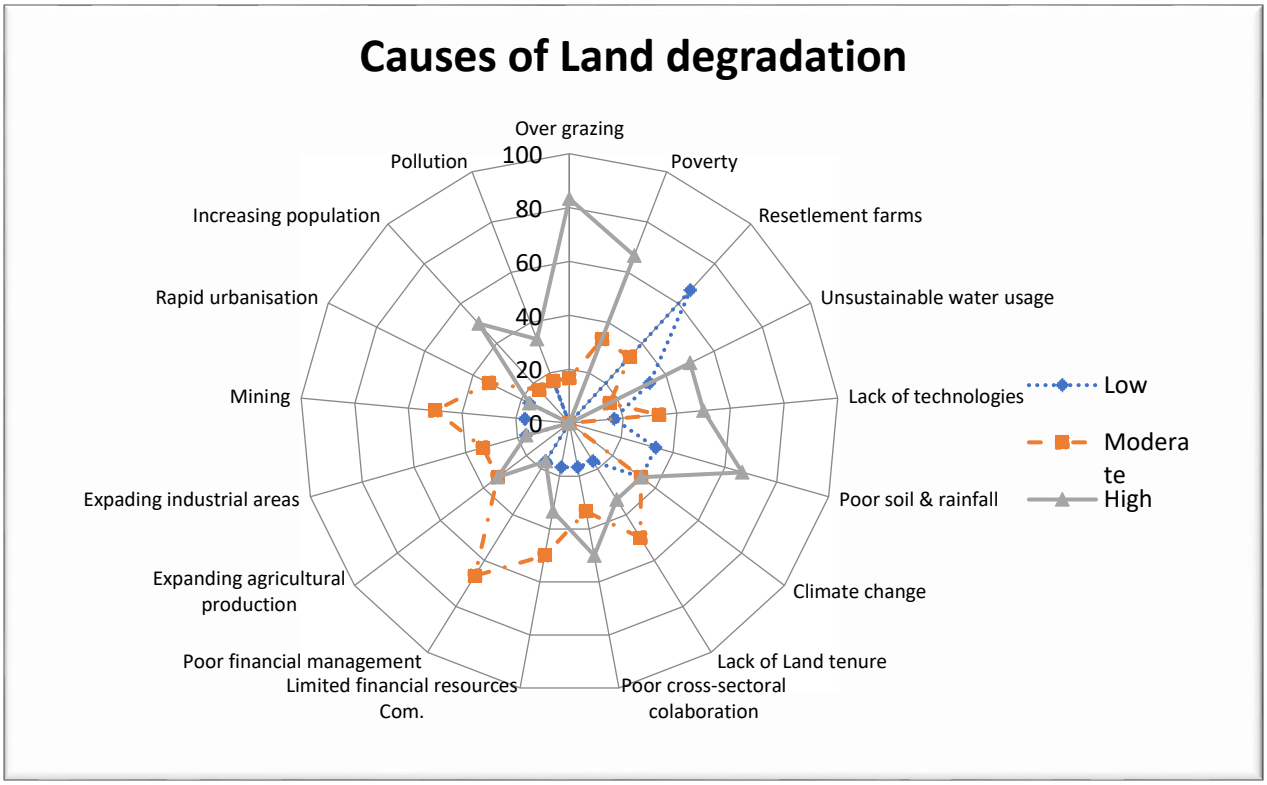


Figure 4. Factors that contribute to land degradation in Namibia, ranked by the national SLMC members in 2014. National Land Degradation Report 2015[2].

2.4. Land Degradation Neutrality Target Setting and implementation in Namibia

The LDN concept was endorsed at the 12th Session of the Conference of the Parties to the UNCCD, held in Ankara, Turkey in 2015. Land Degradation Neutrality was defined as the "*state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within the specified temporal and spatial scales*".

The UNCCD uses **three basic indicators for the assessment of land degradation** (with each country adding locally important indicators):

1. **Land cover/use change**
2. **Land productivity dynamics change per land cover class (using net primary productivity data)**
3. **Soil organic carbon (SOC) change**

Bush encroachment was added as a 4th LDN indicator in Namibia because of the large areas affected by this land degradation factor.

The implementation of the LDN concept of the UNCCD is aligned towards the achievement of the SDG Goal 15 "*to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss*". The UNCCD aim to help specifically member countries for achieving SDG Target 15.3, which is: "*By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world*". The UNCCD launched LDN Target Setting Programme (LDN-TSP) was launched in 2015 for participating member countries to set voluntary LDN targets.

Namibia has been involved in the implementation of the LDN-TSP since its inception in 2015. With support from the UNCCD LDN/TPS programme, Namibia has developed its national LDN targets in 2015[2]. **The national LDN targets are**:

- **Reforest and increase** the **productivity of 13.8 km²** (1,380 ha) **of forests** that have been converted into croplands or shrubs, grasslands and sparse vegetation by 2040
- **Improve** the **productivity of** the **414.3 km²** (41,430 ha) **forest** area currently showing early signs of decline and having declining productivity by 2030
- **Improve** the **productivity of 104013 km²** (10.4 M ha) of **shrubs, grasslands and sparsely vegetated areas** currently showing signs of declining productivity by 2040
- **Improve** the **productivity of 14849 km²** (1.5 M ha) of **cropland** by 2035
- Reduce bush encroachment on 18880 km² (1.9 M ha) by 2040
- **Maintain** the **current SOC levels** beyond 2040: forests at 17 t/ha; shrubs, grasslands, sparsely vegetated land, cropland each at 14 t/ha; wetlands at 16 t/ha

The implementation of actions that will contribute towards the achievement of these targets remains challenging. The targets shall be achieved through the collective actions of all land management related stakeholders. The stakeholders who are part of the SLM committee report their actions annually as a contribution to the national UNCCD report. However, there is a need to further mainstream the achievement of these targets through specific policy interventions.

In addition to the national LDN targets, according to the **Intended Nationally Determined Contributions** (INDC) of the Republic of Namibia to the United Nations Framework Convention on Climate Change (2015), **Namibia** aims **to reduce** its **greenhouse gas emissions by 89 %** (**20,000 Gf CO_2-equivalent**) by the year 2030. The Agriculture, Forestry and Other Land Use **(AFOLU) sector will contribute** to **92 % to the INDC** through the achievement of the following sector-based targets:

1. Reduce deforestation rate by 75 %
2. Reforestation of 20,000 ha per year
3. Restore 15 M ha of grassland
4. Reduce removal of wood by 50 %
5. Afforest 5,000 ha per year
6. Plant 5,000 ha of arboriculture per year
7. Fatten 100,000 cattle heads in feedlots
8. Increase soil carbon

The achievement of the national LDN targets will therefore also directly contribute to Namibia's INDC.

As part of the effort to achieve LDN, Namibia identified **seven land degradation hotspots** to be **target for** exclusive **restoration actions** in the near future (Namibia- National LDN Report 2015). The Otjozondjupa and Omusati regions were identified as part of these hotspots. This is because of the occurrence of bush encroachment that reduces the economic viability of cattle farming in Otjozondjupa region and the high cattle densities in cattle post/grazing areas in Omusati region, causing vegetation and soil degradation. It was therefore decided to start activities under the LDN pilot project in this region. The GIZ-supported project produced land degradation assessment products, conducted an Economics of Land Degradation (ELD) assessment and provided land degradation related policy inputs for the development of the Otjozondjupa IRLUP.

Namibia is currently part of the new UNCCD LDN implementation programmes and will therefore continue to obtain support from the UNCCD for the implementation of LDN work in the country. The UNCCD support relies on each country´s specific request for support with implementing transformative land degradation management related projects in identified areas.

2.5. Political vision for land degradation management in Namibia

Historic national strategies to prevent land degradation in Namibia include the following:

- The Green Plan of 1992
- Sustainable Animal and Rangeland Development Programme (SARDEP)
- Northern Regions Livestock Development Programme (Nolidep)
- Namibia's Programme to Combat Desertification (Napcod)

- Country Pilot Partnership (CPP) on SLM

These are the **current actions** at the National level **that** explicitly **address land degradation**:

- NAP3
- LDN assessments and integration into regional land use plans, MET, with support from GIZ.
- Comprehensive Conservation Agriculture Programme, Ministry of Agriculture, Water and Forestry (MAWF)
- National Rangeland Management Strategy and Action Plan, MAWF
- NILALEG, MET and UNDP
- Bush encroachment management, MAWF
- Bush Control and Biomass Utilization Project, GIZ and MAWF

There is potential to permanently integrate land degradation management into land use planning, as it was tested by the current LDN project. The inclusion of LDN related assessments in the Strategic Environment Assessment (SEA) guidelines, could enable this process. This can then result in the development of land management recommendations for actions to prevent land degradation at the regional level, and at the intersection between the local and the national level.

3. Implementation of the GIZ supported Land Degradation Neutrality project

3.1. Introduction

The GIZ supported LDN pilot project in Namibia was spearheaded by the MET, with support from various local stakeholders. The support from the GIZ to Namibia´s LDN actions started in 2015, during the implementation of the LDN-TSP pilot programme to develop LDN targets. In June 2015, the GIZ team conducted an appraisal mission to determine the focus of the support of the second phase of the UNCCD LDN programme in Namibia. During this mission, the need for an integration of the next LDN phase into present policy and planning processes was identified to create synergies and for harmonizing ongoing national and regional activities. The integrated regional land use planning process, that was carried out at the time for Otjozondjupa region, was identified by the SLM committee as a suitable vehicle to transfer the LDN concept from the global policy level to the regional and more practical scale. The integrative, intersectoral and participatory character of the IRLUP was considered as appropriate to mainstream the LDN approach.

The national LDN report of 2015 identified the need to address bush encroachment, one of the most severe land degradation types in Namibia. Bush encroachment reduces the productivity of the farms and thus causes major economic losses that can reach up to a 100 % decline in rangeland productivity. Within the region of Otjozondjupa, bush encroachment is the predominant type of land degradation. Presently, more than 30 M ha are affected in the high productivity parts of this region. It was therefore agreed that within this region, assessments and analysis should mainly focus on bush encroachment and feasible approaches to combat associated phenomena.

3.2. Project aims and objectives

The GIZ supported LDN project, coordinated by the SV-BoDeN, had the overarching objective to **go beyond LDN-target setting and to integrate LDN in a cross-sectoral and implementation-oriented policy process.** This included, for example, mainstreaming the LDN-concept into the IRLUP, providing local LDN monitoring capacity building to meet long term monitoring challenges, and analyzing land degradation rehabilitation in collaboration with GIZ supported projects.

The objectives of GIZ support were:

- Supporting the MET to develop a nationally adapted monitoring approach for LDN
- Building the capacity of the MET and national experts to design and implement LDN assessments
- Mainstreaming the LDN-concept into the IRLUPs
- Creating the necessary site-specific data baseline on core-indicators and testing additional indicators useful for monitoring of any LDN related interventions.
- Understanding the challenges faced by a country like Namibia to rigorously and meaningfully monitor the SDG-indicator "land degradation trends"
- Assessing the economic feasibility of land rehabilitation measures, especially with focus on de-bushing in close cooperation with GIZ project support to de-bushing
- Supporting up-scaling and out-scaling of experiences made through national workshops and participation at international LDN related events

3.3. Project implementation

During the development of the national LDN targets and the national LDN report (2015), the SLM Committee identified seven land degradation hotspots in the country. The national LDN report (2015) recommended that actions should be taken to help reduce and prevent further land degradation in these hotspots.

At the inception meeting of the GIZ supported LDN project it was agreed to integrate LDN implementation activities with the development of the Integrated Regional Land Use Plans that were being coordinated by the MLR.

Several factors played a role in the **selection of the two land degradation hotspots as pilot sites** of the GIZ supported LDN project. The selection of **Otjozondjupa region** as the first pilot site for the project was based on three criteria:

1) It was one of the identified land degradation hotspot area in the National LDN report (2015), having bush encroachment problems all over the region;

2) The GIZ bush control project is being implemented in the region. Hence, it could benefit from the new LDN project implementation. The de-bushing project was to benefit both from the LDN

assessment exercise and the ELD assessment of the economic feasibility of bush encroachment land management practices and related implications.

3) The Ministry of Land Reform was planning to develop a new regional land use plan for Otjozondjupa region.

The selection of **Omusati region,** as the second pilot site for the GIZ supported LDN project, was based on two criteria:

1) It had a land degradation hotspot area, representing land degradation caused by overgrazing

2) it was one of the next regions were the Ministry of Land Reform was planning to develop a new regional land use plan.

The first phase of the project received direct technical assistance from the International Centre for Tropical Agriculture (CIAT) and the International Soil Reference and Information Centre (ISRIC) after their LDN assessment methodology was selected as the preferred one. The project work focused on the first pilot site, the Otjozondjupa region. This involved completion of the initial establishment steps of the LDN assessment method and:

- Training of local field teams for data collection
- Soil sample analysis by the MAWF soil lab
- LDN data analysis and interpretation
- Theoretical training of local LDN assessment technical experts
- Testing of the LDN assessment methodology through the production of mapping products and their interpretation
- Production of SLM guidelines to tackle the observed land degradation issues as indicated by the LDN assessment results
- Development of an LDN baseline report submitted to the Otjozondjupa regional council; submission of the LDN baseline report to the MLR
- Inclusion of LDN data and data interpretation conclusions and SLM management guidelines in the Otjozondjupa IRLUP

The second phase project implementation was carried out directly by the MET with support from local stakeholders. CIAT and ISRIC acted as advisors to the process and provided the continuous training of the local LDN data analysis experts. The project work of the second phase focused on the second pilot site, the Omusati region. The project actions included:

- Theoretical training on LDN data analysis
- Practical training on LDN data analysis and interpretation via the direct analysis of the Omusati LDN assessment data by the trained local experts
- Compilation of training material for the LDN assessment technical training course and the LDN assessment methodology
- Production of SLM guidelines to tackle the observed land degradation issues in Omusati region as indicated by the LDN assessment results
- Development of an LDN baseline report submitted to the Omusati regional council
- Submission of the LDN baseline report to the MLR for inclusion in the Omusati IRLUP

The coordinated actions between the MET and the local supporting stakeholders made the completion of the tasks in phase one and two possible. The established collaborations and lessons learned should help the MET to continue its LDN implementation work.

3.4. Project achievements and lessons learned

The project outputs provide Namibia with a base to continue effectively with the LDN achievement and maintenance process in the future. The outputs contributed to the implementation of the NAP3, specifically to the following Outcomes of the NAP3 implementation matrix:

NAP3 Outcome 1: By 2018 information on the risks Namibia faces and the need to combat desertification at a national scale is produced, made easily accessible and actually used by policy makers, land managers, research and educational institutions.

- NAP3 Output 1.1. Policy advocacy papers on Sustainable Land Management (SLM) produced and publicized by Technical Committee on SLM
    - **LDN pilot project output: SLM recommendations (as advocacy papers), based on the LDN baseline assessments, shared with the Regional councils of Otjozondjupa and Omusati regions and the Ministry of lands, while also being included in the IRLUPs of these regions**
- NAP3 Output 1.3. Reports on the management, rehabilitation and recovery of land degradation focal areas
    - **LDN pilot project output: SLM recommendations, based on the LDN baseline assessments, produced for Otjozondjupa and Omusati regions**

NAP3 Outcome 2: Policy and institutional frameworks are effectively implemented and strengthened to address desertification, land degradation and drought by 2024

- Output 2.3. Local level governance structures linked to sustainable land management further strengthened and empowered – such as conservancy committees, community forests, communal land boards, basin management committees, water point associations, livestock marketing committees etc.
    - **LDN pilot project output: A proposal was made and tested to intergrate LDN into regional land use plans. This would provide more detailed information for local governing structures to effectively help prevent, reduce and reverse the adverse land degradation in their respective areas.**

NAP3 Outcome 3: Outcome 3: A functional DLDD Monitoring System in place by 2018 and supportive processes are in place by 2018 for Namibia to move towards land degradation neutrality

- NAP3 Output 3.1. A proposed institutional collaborative structure to collect data and information on degradation processes in Namibia (Soil Organic Carbon, Trend in Land Use/Cover and Trend in Land Productivity) including other relevant indicators
    - **LDN pilot project output: LDN data collection collaboration achieved between MET, UNAM, MAWF and NUST**
- NAP3 Output 3.4. Publication of and access to data on trends in land degradation in thematic areas (forest cover, bush encroachment, range conditions, droughts, floods) – and interpretation of the trends in actionable terms
    - **LDN pilot project output: Soil Organic Carbon data for Otjozondjupa region and the data collection process published in scientific journals**

NAP3 Outcome 6: Research on aspects of sustainable land management and climate change science in support of adaptation and mitigation are mainstreamed in research and tertiary educational institutions and extension services by 2020.

- Output 6.1.4. Training modules on climate change and SLM issues developed for inclusion into the curricula of tertiary institutions and other educational programs in Namibia.
    - **LDN pilot project output: A training module draft on SLM issues, specifically LDN indicators, was developed and promoted for inclusion in UNAM Geography department programmes**
- Output 6.2. Institutional partnerships for research and training launched or strengthened
    - **LDN pilot project output: Collaboration for research and training on LDN strengthened between MET, UNAM, MAWF and NUST**

The project achieved the following general outputs based on the project objectives:

- Establishment of locally applicable LDN assessment methodologies based on the UNCCD recommendations
- Production of training material for technical training course on the LDN assessment methodology
- Trainings with MET staff and local experts (from UNAM, NUST and other institutions) in designing and implementing LDN assessments
- Carrying out of comprehensive LDN assessments in the Otjozondjupa and Omusati regions to create an information basis for land use plans, research and other land management related actions
- Inclusion of the SLM recommendations for Otjozondjupa in the regional land use plan, based on the LDN assessment
- The GIZ Support to Bush encroachment project in Namibia is now working on efforts to improve soil management in project areas, in part because of the SLM recommendations from the LDN project
- Provision of LDN assessment and SLM recommendations to the MLR and the Omusati Regional Council for inclusion in the regional land use plan
- Facilitation of inter-ministerial meetings of the SLM committee in charge of the national LDN process
- Contribution to international knowledge exchange on best practices for LDN assessment
- Provisioning of guidance to the MET/UNDP NILALEG programme for continued support of LDN actions in Namibia
- Advising UNAM and NUST to improve the use of their technical infrastructure to enable the local analysis of LDN indicators

The project LDN assessment output, maps and SLM recommendations, were utilised in regional land use plans and further provided information for local and international researchers on LDN (see Annexure 9.2). The established LDN assessment capacity should allow Namibia to develop more LDN assessment products, to ensure continuous LDN monitoring and effective land management. Completing the integration of LDN into the IRLUP development will ensure greater stakeholder participation in working towards achieving and maintaining LDN in Namibia.

The next sections of the report will focus on the technical results from the Otjozondjupa and Omusati region LDN assessment work, a discussion of the proposed LDN assessment methodology and a critical analysis of the project implementation methodology. Finally, the last section is a look at how Namibia can build best on the current momentum to implement future LDN actions in order to achieve a sustainable LDN status in future.

4. Land Degradation Neutrality assessment in Otjozondjupa region

4.1. Introduction to land degradation assessment in Otjozondjupa region

The implementation of the LDN project was initiated in Otjozondjupa region as the first pilot site. The work was coordinated through the MET with support from MAWF, GIZ and the CIAT as a consulting agency. The project workflow for Otjozondjupa region is presented in Annexure 9.3, while the detailed LDN baseline report is presented in Annexure 9.4.

The **objectives of the LDN project work implementation in Otjozondjupa region** were:

- Training of local land degradation experts to conduct field data collection for LDN indicators assessment
- Land degradation assessment based on the indicators: land use/cover, NDVI change, SOC and bush density
- ELD assessment
- Develop a land degradation assessment protocol for the four LDN indicators, based on the CIAT & ISRIC methodology
- Interpretation of the LDN assessments results by CIAT
- Present practical cases (approaches) on how to address observed land degradation in order to obtain LDN in Otjozondjupa region

The implementation of the LDN project provided important information to the MLR for the development of the IRLUP for Otjozondjupa region. The data showed high levels of bush encroachment (Figure 5), as expected, and provided the latest data to this major problem for the Otjozondjupa region. The soil health was for the first time depicted through the SOC data, showing that the region has very low SOC levels.

4.2. Results of the Land degradation assessment in Otjozondjupa region

The project implementation in the Otjozondjupa region pilot site produced the following **outputs**:

- Baseline data and maps for the assessment of bush densities, land cover, soil organic compounds and general NDVI assessment (data reproduced from the Otjozondjupa LDN Baseline report, Annexure 9.4, unless otherwise stated)
- SLM recommendations that built on the baseline data and interviews of affected stakeholders from the region
- A study on the ELD in relation to bush encroachment in the region
- Training of local field and data analysis experts

The LDN indicators analysed to produce the maps and related SLM recommendations were land use/cover, vegetation health (land productivity) as NDVI, SOC and bush encroachment. The bush density levels are presented in Figure 5, showing the bush density distribution pattern in the region.

The results showed that the high bush encroachment problem in the region reached up to more than 6000 bushes/ha. The bush density data, especially the indication of high bush seedling areas was included as resource data in the Otjozondjupa IRLUP. Related SLM recommendation and the recommendations from the ELD assessment were also included in the IRLUP. This information helped shape conclusions drawn in the IRLUP.

In Figure 6, the 10-years NDVI change (data produced by the UNCCD) is presented to show the possible correlation between the high bush density areas and especially areas with increasing NDVI level increase during the study period. The seasonal NDVI changes from 2005 to 2015 are depicted in Figure 7, showing the general NDVI levels during each season. The top soil (0 – 30cm) soil organic carbon levels are presented in Figure 8, while the general land use land cover (2000 and 2016) are presented in Figure 9, 10 and Table 2. Bush encroachment development from 2000 to 2016 in the south-central part of the region is presented in Figure 11. The current land use patterns in the region a presented in Figure 12.

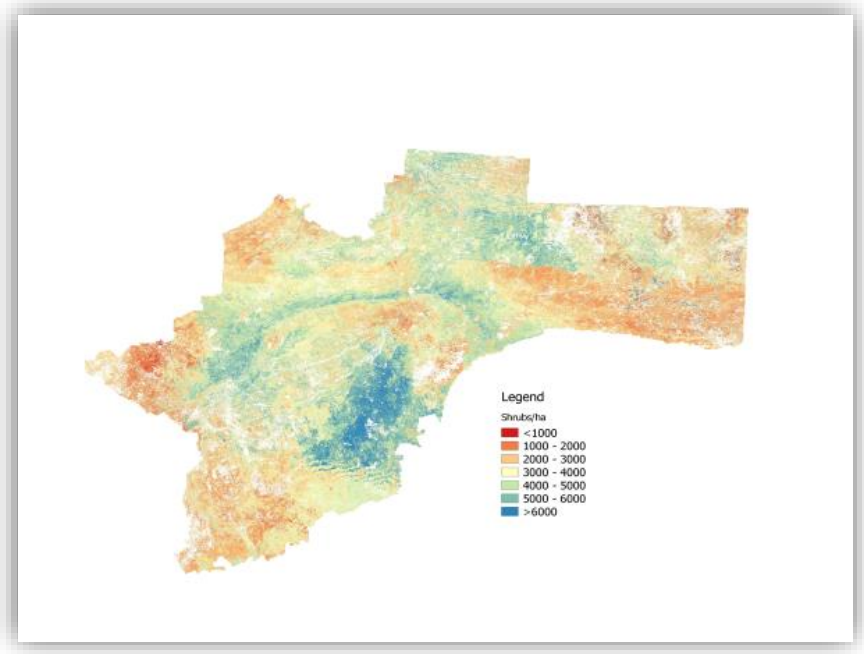


Figure 5: Bush encroached areas in Otjozondjupa, CIAT land degradation Assessment report for Otjozondjupa.

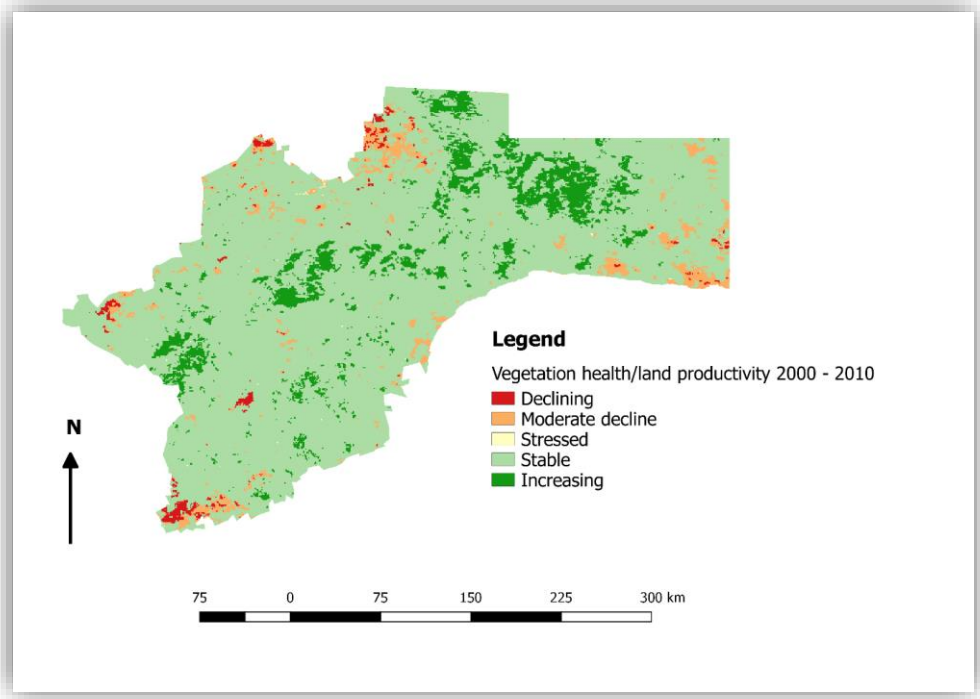


Figure 6: Vegetation health change from 2000 to 2010, Otjozondjupa. NDVI data from the UNCCD.

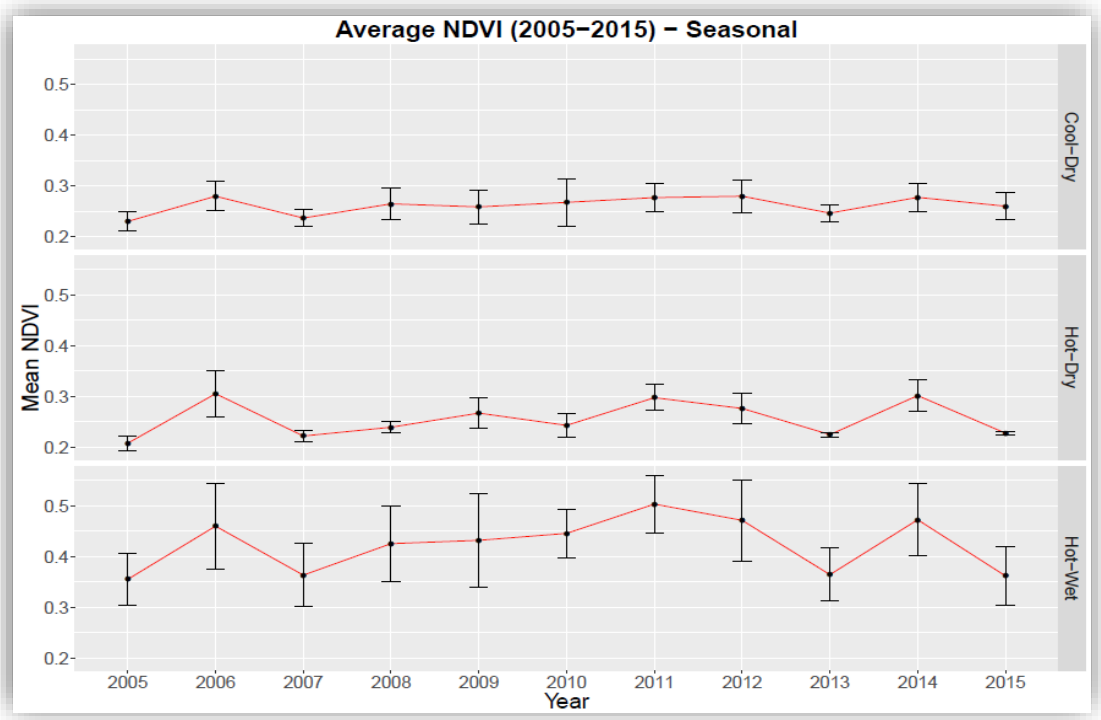


Figure 7: Annual mean NDVI variability by season, CIAT land degradation Assessment report for Otjozondjupa.

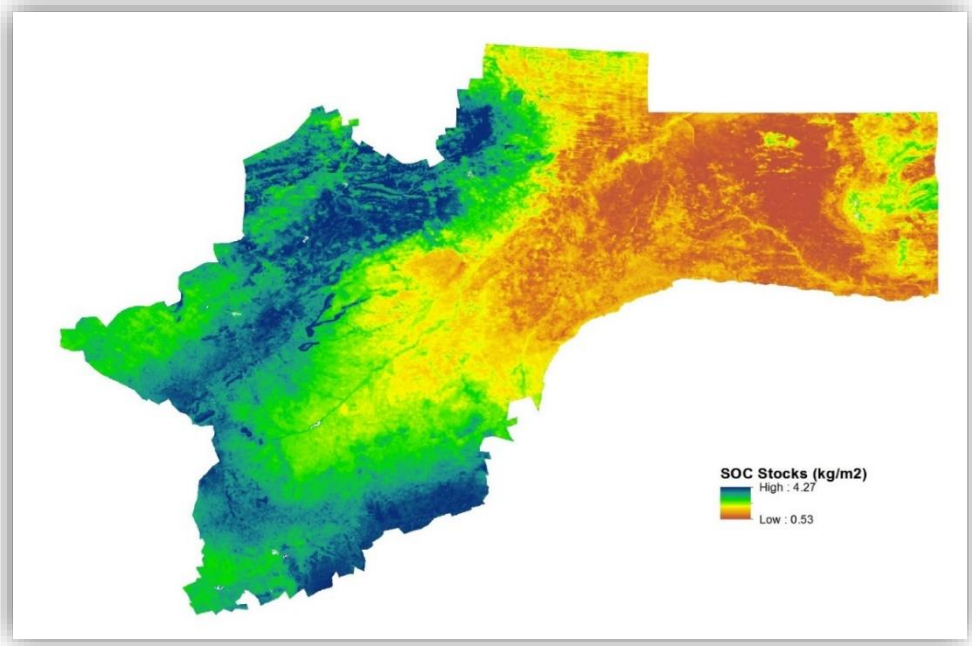


Figure 8: Top soil (0-30 cm) SOC stock map for Otjozondjupa. Total SOC stock is 2,835 tons (CIAT land degradation Assessment report for Otjozondjupa).

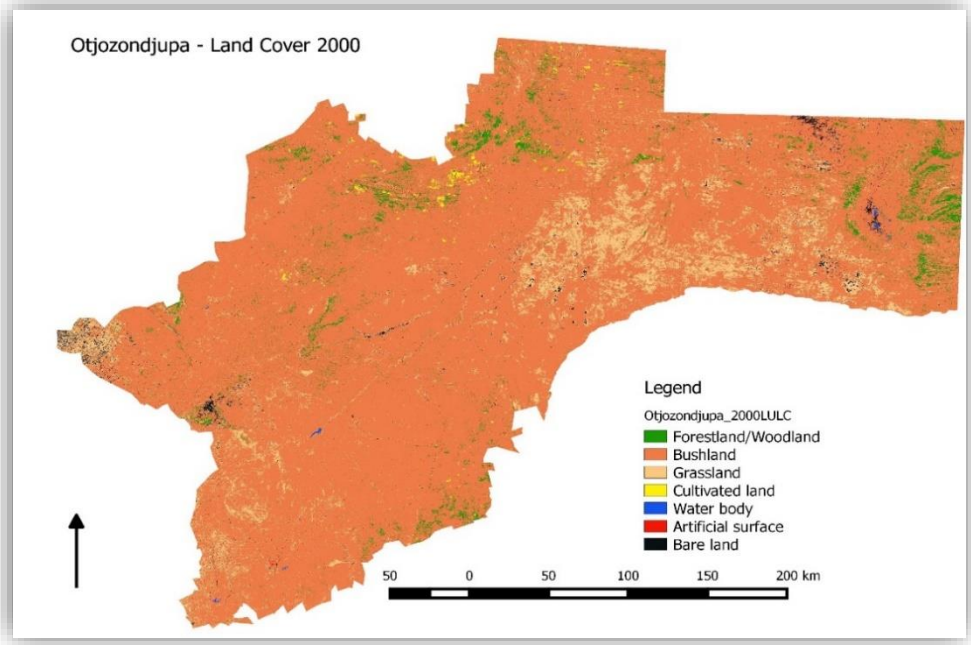


Figure 9: Otjozondjupa Land Cover 2000, CIAT land degradation Assessment report for Otjozondjupa.

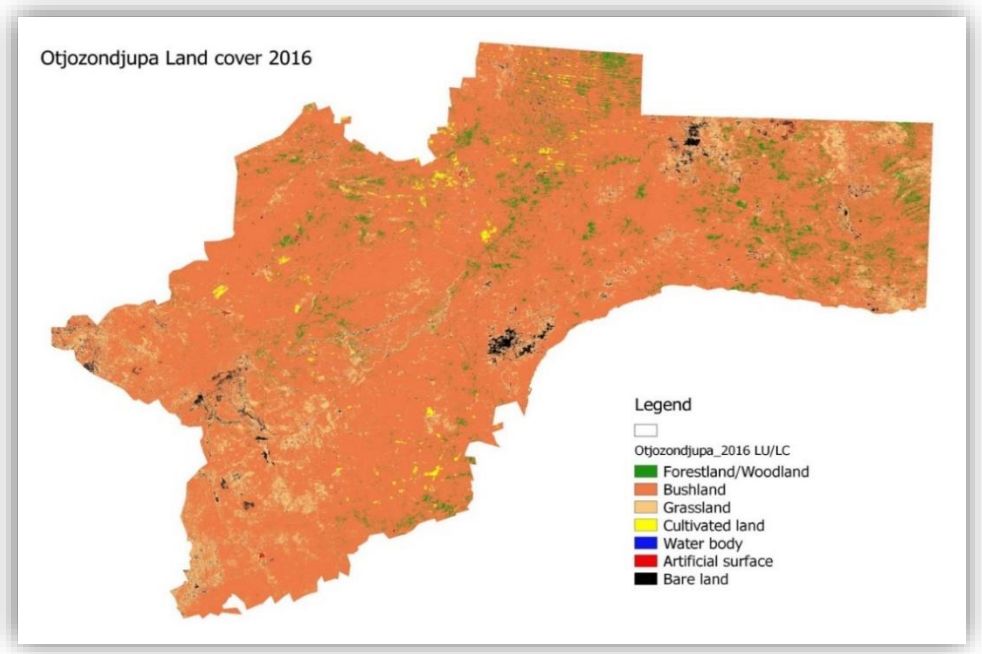


Figure 10: Otjozondjupa Land Cover 2016, CIAT land degradation Assessment report for Otjozondjupa.

Table 3: Change in land cover class from 2000 to 2016.

Land use/cover class	% area (2000)	% area (2016)
Forestland/Woodland	3.3	4.6
Bushland	85.6	82.4
Grassland	9.8	10.8
Cultivated land	0.3	0.7
Water body/Wetland	0.1	0.01
Artificial surface	0.01	0.03
Bare land	0.9	1.4

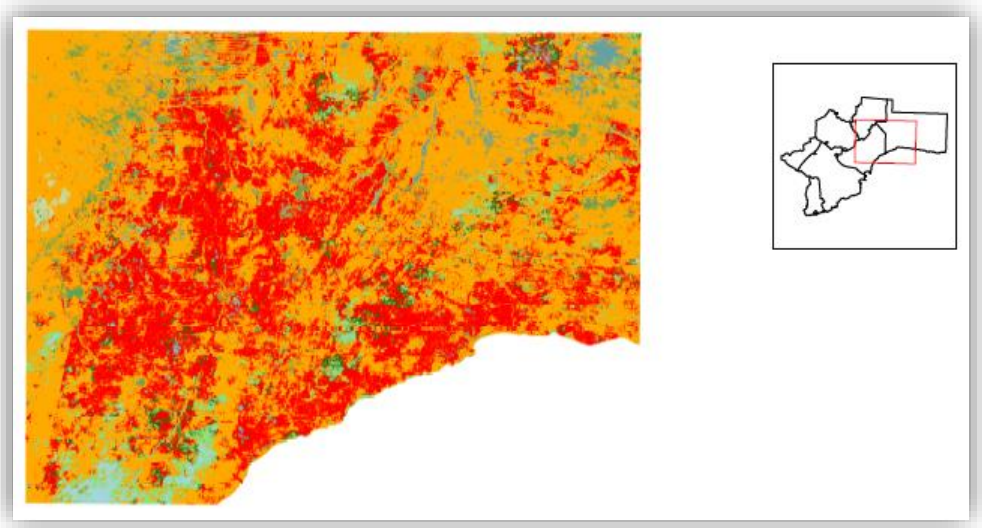


Figure 11: Conversion of grassland to bushland represented by red coloured areas on map, representing bush encroachment development between 2000 and 2016.

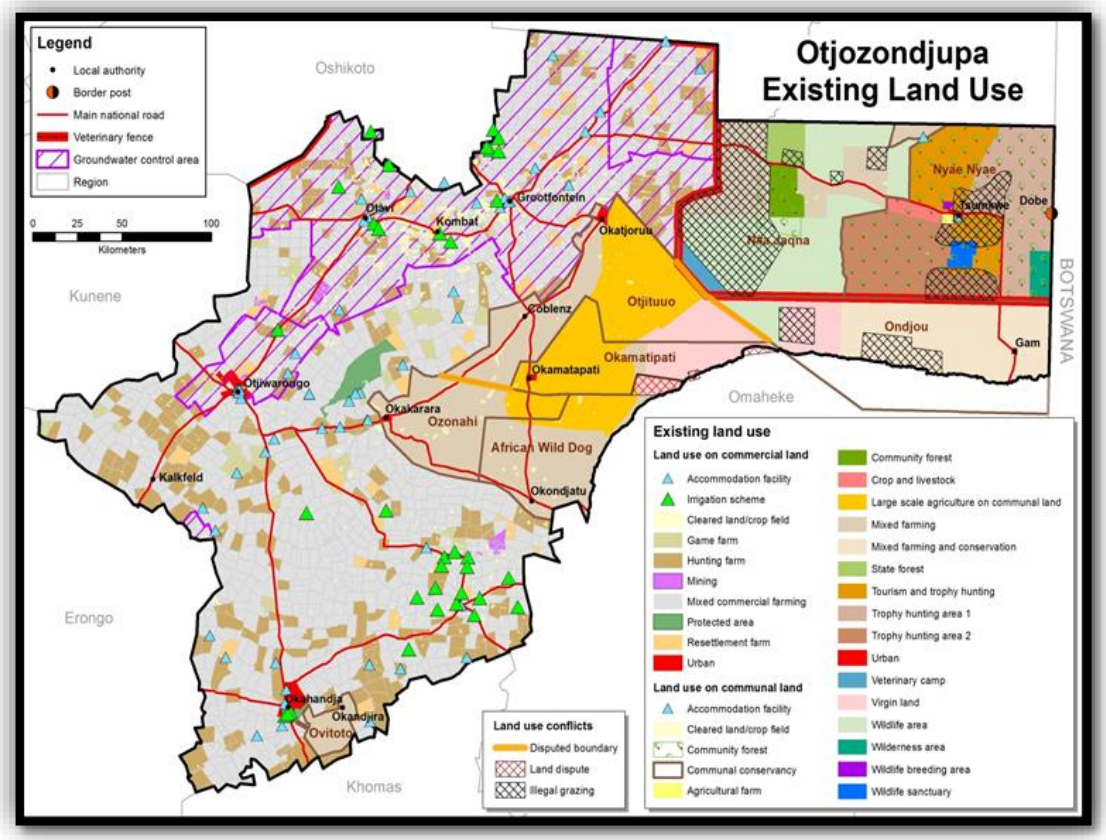


Figure 12: Current land use in the Otjozondjupa region (from a draft Otjozondjupa IRLUP, apologies for the poor image quality)

4.3. Conclusion from the land degradation assessment in Otjozondjupa region

The **land degradation assessment** (Figure 5) **confirms the high bush encroachment problem** in **Otjozondjupa region**, with high bush density reaching more than 6000 bushes/ha. The bush density level is highest in the central part of the region, especially in the south-central part. It should also be noted that in relation to the NDVI change data (2000 – 2010) in Figure 6, there are areas having an increase in NDVI that have high bush densities. This shows for the first time that increasing NDVI values in Otjozondjupa region could be an indication of increasing bush density as suggested in the national LDN report of 2015.

The seasonal NDVI values (from 2005 to 2015) generally **remained constant during each season** (Figure 7), with the hot-wet season having the highest NDVI values. There was a high NDVI value in the hot-wet season of 2011, likely due to higher average rainfall during that season compared to the other years (see the Otjozondjupa baseline report).

Soil organic carbon levels (Figure 8) in the region are **lowest in the central and eastern part** of the region. The communal lands in the region (Figure 12) are all located in the area with the lowest SOC. It is therefore possible that the combination of high livestock densities, as practiced in communal areas, un-effective or no land management concepts and deep sandy soils, that are low in SOC content creates a condition that will worsen land degradation in this part of the region now and in the long term.

4.4. Economics of land degradation assessment in Otjozondjupa region

The following summary is taken from the ELD assessment report for Otjozondjupa that was conducted by the Namibia Nature Foundation (NNF) for the LDN project. The full ELD report is available in Annexure 9.5. In summary, the **ELD assessment estimated that game farming would economically benefit best from de-bushing actions followed by mixed use** (game & cattle) **and then cattle farming** as least**, while potential economic and environmental risks exist**.

Bush encroachment is "*the invasion and/or thickening of aggressive undesired woody species resulting in an imbalance of the grass:bush ratio, a decrease in biodiversity, and a decrease in carrying capacity"* (De Klerk 2004)[3]. It affects around 45 million hectares of Namibia's land area (SAIEA 2016)[4]. In Otjozondjupa, Namibia's fourth biggest region at more than 10.5 million hectares, bush encroachment reportedly affects the majority of the land area (Hengari 2016)[5]. Overgrazing is thought to be a key driver of bush encroachment, but the displacement of browsers by livestock, the suppression of high

[3] De Klerk, JN (2004). *Bush Encroachment in Namibia*. Prepared for the Ministry of Environment and Tourism, Windhoek.

[4] Southern African Institute for Environmental Assessment (2016). *Strategic Environmental Assessment of Large-scale Bush Thinning and Value Addition Activities in Namibia*. SAIEA, Windhoek.

[5] Hengari, S (2016). *Recommendations on Sustainable Land Management Practices based on assessment of land degradation and currently implemented sustainable land management practices in the Otjozondjupa region of Namibia*. Land Degradation Neutrality, unpublished.

intensity fires due to cattle farming, rainfall and its variability, and increased atmospheric CO_2 concentrations are also contributors (Joubert and Zimmerman 2002)[6].

Bush encroachment has negative impacts on some of Otjozondjupa's key ecosystem services, such as livestock production, groundwater recharge, and tourism, as well as biodiversity. This has given rise to calls for a comprehensive programme of de-bushing, to reduce bush encroachment and try to reverse some of these negative effects. De-bushing also offers economic opportunities for the utilisation of woody biomass via charcoal, firewood, and animal feed production, power and electricity generation, and other products.

The ELD report builds on the framework developed by the NNF in the national assessment of the ELD related to bush encroachment. Furthermore, it estimated the financial costs involved in unlocking the ecosystem service benefits and some of the wider economic impacts to build a business case for de-bushing.

The ELD report delineated and assessed the state of bush encroachment in Otjozondjupa, identified ecosystem services impacted by bush encroachment, and evaluated how flows and stocks of these services would likely change under a programme of de-bushing. The benefits and costs for key sectors and services, namely cattle production, groundwater recharge and supply, wildlife viewing, hunting and game products, carbon sequestration, and value addition industries were estimated. Furthermore, the wider economic benefits generated by additional jobs and income in these sectors were estimated. Cost-benefit analysis was then used to estimate the net benefit of de-bushing by sector and the overall net benefit, when compared with a business-as-usual (BAU) scenario of no de-bushing. The ELD study followed the methodology of the ELD Initiative.

The delineation of bush encroachment was based on new data collected by the GIZ supported LDN pilot project in 2016. According to this data, bush encroachment is present across the majority of Otjozondjupa region, affecting multiple ecosystems and land uses, but particularly commercial and communal agriculture and tourism (both consumptive and non-consumptive). This makes it a complex problem, as impacts can vary depending on the immediate environment (e.g. types of soil, other vegetation, wildlife), how the land is used (e.g. cattle farming, tourism), and how many people depend on the land. Furthermore, the appropriate method, range, and scope of de-bushing activities are also dependent on the local context.

To identify the ecosystem services affected by bush encroachment (and de-bushing), the ELD report adopted the Common International Classification of Ecosystem Services (CICES) in order to remain consistent with the draft Inventory of Ecosystem Services in Namibia (2015) and the UN System of Environmental-Economic Accounting (SEEA). The CICES classification recognises three broad categories of services: provisioning, regulation and maintenance, and cultural. Given data and research constraints, we were unable to quantify the likely impacts of de-bushing on the majority of services. However, there is reason to believe that many of these services would be positively affected by de-bushing, which suggests that there is upside risk to our estimates of net benefits.

[6] Joubert, DF and Zimmermann, I (2002). *The potential impacts of wood harvesting of bush thickening species on biodiversity and ecological processes*. Proceedings of the First National Forestry Research Workshop held on 12 and 13 March 2002 in Windhoek, Namibia, Ministry of Environment and Tourism, Forestry Publication 9:67-78.

Some key assumptions underpin the estimation of benefits and costs for each sector and ecosystem services under a scenario of de-bushing. It was assumed that 60 % of the bush-encroached area in Otjozondjupa could be targeted for de-bushing, and that 5 % of the targeted area could be de-bushed per annum. We also assumed that the density of the identified dominant encroacher species would be reduced by 90 %, leaving non-encroacher species untouched. This would result in an overall reduction in bush density across the region of 38.5 %. Another assumption made was that bush encroachment would remain constant without a widespread programme of de-bushing. In reality though, bush encroachment is thought to be increasing by around 3.5 % per annum.

The impacts of de-bushing on key sectors and ecosystem services were then estimated, along with the direct costs of de-bushing operations and the wider economic impacts, using real prices (base year 2015). It was estimated that de-bushing could generate a net benefit for livestock production, groundwater recharge, wildlife viewing, and hunting and game products, as well as charcoal, firewood, and animal feed production, and power and electricity generation. Furthermore, wider economic (and social) benefits would arise from the additional jobs and household income. However, it would result in net costs for de-bushing operations, additional emissions from livestock, and loss of SOC.

Cost-benefit analysis was then used to estimate the potential net benefit of a programme of de-bushing, compared with the BAU scenario of no de-bushing, over a 25-year horizon. Annual costs and benefits were discounted by a real rate of 6 % per annum. In the central case, the total net benefit was estimated at N$4.9 billion (2015 prices, discounted) over 25 years. Total cost is estimated at N$20.3 billion. Total benefit is estimated at N$25.1 billion and includes benefits for the wider economy of N$5.3 billion.

Scenario analysis indicated that the net benefit could range from -N$2.9 billion under a worst-case scenario to N$10.6 billion under a best-case scenario. The worst-case scenario is significantly impacted by the use of the social cost of carbon to value the net change in carbon emissions/sequestration. It also assumes that meat prices would decline further, although it is thought that prices are currently bottomed out, and that de-bushing costs would be 20 % higher. We believe that this worst-case scenario is highly unlikely. The net benefit in the central case is also observed at varying discount rates. At a discount rate of 12 %, the net benefit is estimated at N$1.3 billion, but this is an extremely high discount rate in the Namibian context. At a more realistic rate of 4 %, the net benefit is estimated at N$7.3 billion.

De-bushing was treated as an isolated cost in the cost-benefit-analysis (CBA) but we looked at a number of business cases to evaluate their industry net benefit and social net benefit when the sector-specific cost of de-bushing and economic multipliers are included. Of the value addition industries, animal feed, charcoal production, and electricity generation all have estimated positive industry and social net benefits. Although the social net benefit for charcoal production was estimated to be positive, the industry net benefit was estimated to be negative. More efficient technology, and therefore lower demand for biomass, would close this gap somewhat. In terms of farming, game farms were estimated to generate the largest net benefit under three different payment options for de-bushing the land, followed by mixed use farms, and cattle farms.

Overall, the results suggested that the net benefit of a comprehensive de-bushing programme in Otjozondjupa would be significantly positive and make a considerable contribution to Otjozondjupa and Namibia’s economy and social welfare. This model for Otjozondjupa could also be expanded to

the other bush-encroached areas of Namibia. Furthermore, as we believe that many of the unquantified ecosystem services would be positively affected by de-bushing, it is reasonable to expect that there is upside risk to our estimates.

A comprehensive de-bushing programme deserves support from the private sector, which stands to reap returns in the long run, and the public sector, given the social, environmental, and wider economic benefits. In addition, it is in the interest of Namibians in Otjozondjupa and across the country, as well as the global community, to support an initiative that would also improve biodiversity and other unquantified ecosystem services. We also recommend further research focussing on the effects of de-bushing on ecosystem services that are currently unquantifiable or uncertain, the environmental impacts of de-bushing, and potential mitigation measures.

4.5. Integration of Land Degradation Neutrality data in the Otjozondjupa region land use plan

The LDN project was implemented in Otjozondjupa region during the development of the regional land use plan process. Meetings were periodically held between the LDN project team members, the IRLUP consulting team and the responsible MET and MLR representatives. At the end of the land degradation assessment, a number of policy recommendations and actions were provided to the IRLUP development team and they were included in the Otjozondjupa region IRLUP. The recommendations listed below were made based on land degradation assessment results and stakeholder consultations.

A. **De-bushing Policy recommendations**:

1. De-bushing of bush encroached land must be done to improve grazing land
2. The biomass produced from the first (1st) de-bushing action can be used to produce wood-based products for sale (charcoal, fire wood, electricity production etc.)
3. The production of wood-based products from de-bushing must only be done one time when the land is de-bushed for the first time
4. The biomass from any land being de-bushed for the second time (2nd) or more must be returned to the soil of the land being de-bushed to improve soil organic carbon content
5. No wood-based products must be produced from biomass harvested from a land that has been de-bushed before. No permit must therefore be issued for such actions.
6. The land owner/user can decide in what form the biomass will be returned to the soil, but more than 90% of the de-bushing biomass must remain on the land from the second de-bushing action onward.
7. The use of bush to fodder to return bush biomass to the soil must be managed in such a manner that animal movement allow the spreading of the animal droppings over the entire land/farm (not just in specific areas where the animals prefer going, e.g. flat lying areas and water points)

B. Objectives of the recommendations:

1. To encourage land owners/users to implement effective after-care actions that will prevent regrowth of invader bushes
2. To ensure that SOC and plant nutrients in soils of grazing land are not depleted through the continuous removal of woody biomass from grazing land
3. To prevent land degradation and desertification in Namibia

In addition to the SLM recommendations in the regional land use plan, a map product showing areas having high conversion of grassland to bush areas (Figure 11) was also included. Other map products such as the SOC maps were included in earlier versions of the plan but later excluded from the final plan.

5. Land Degradation Neutrality assessment in Omusati region

5.1. Introduction to land degradation assessment in Omusati region

The implementation of the LDN project, after the completion in Otjozondjupa, was extended to LDN assessment in Omusati region as the second pilot site, selected as per the criteria outlined in Section 3. The work was also coordinated by the MET with support from MAWF, UNAM, NUST, GIZ and CIAT & ISRIC as a consulting agency. The Omusati assessment was carried out with less external support in order to further strengthen national and local capacities that were developed during the first phase of the pilot project. The project workflow for Omusati region is presented in Annexure 9.6 while the Omusati LDN baseline report is available in Annexure 9.7 and a technical implementation report by CIAT in Annexure 9.8.

The **objectives of the LDN project work in Omusati region** were:

- Training of local land degradation experts to interpret LDN indicators assessment data and develop output maps
- Land degradation assessment based on the indicators: land use/cover, NDVI change, SOC and bush density
- Refine the land degradation assessment protocol for the four LDN indicators, based on the CIAT & ISRIC methodology
- Interpretation of the LDN assessments by local trained experts
- Present practical cases (approaches) on how to address the identified land degradation in order to achieve LDN in Omusati region
- Propose LDN targets for Omusati region using the results of the land degradation assessment

The Omusati region **land degradation assessment showed three major land degradation aspects**:

- The region in general has very low SOC levels (< 0.3 %), with exception of the far north-western areas
- The vegetation health (NDVI), although remaining generally constant over 15 years, is showing gradual decline
- The vegetation health of the Etosha National Park is showing alarming decline

The project implementation in Omusati region produced the following **major outputs**:

- Baseline data for the assessment of soil organic compounds and general NDVI assessment
- A SLM recommendation that builds on the baseline data
- Local teams were trained in technical and data analysis and can likely continue with the work independently, if sufficient finance is available
- A land degradation assessment protocol/methodology
- Content data for a technical training course of the land degradation methodology

Actions are needed in the region to improve the observed land degradation aspects. The SOC levels need to be increased while the observed decline of vegetation health should be halted and reversed where possible.

5.2. Results of the land degradation assessment in Omusati region

The data presented here are from the Omusati Baseline report (Annexure 9.7), unless otherwise stated. The top soil (0 – 30 cm) SOC levels are presented in Figure 13. The monthly vegetation health (NDVI) from 2005 to 2015 is presented in Figure 14, while the spatial distribution of the change in vegetation health from 2000 to 2010 is showed in Figure 15.

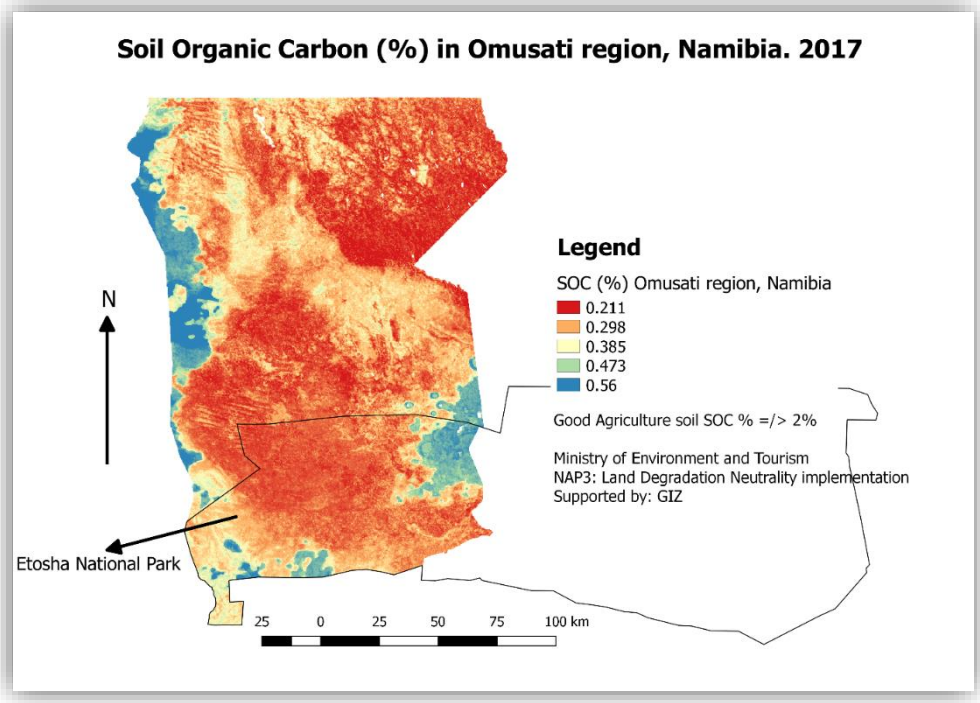


Figure 13: Soil Organic Carbon concentration [%] distribution in Omusati region, 0 -30 cm, 2017.

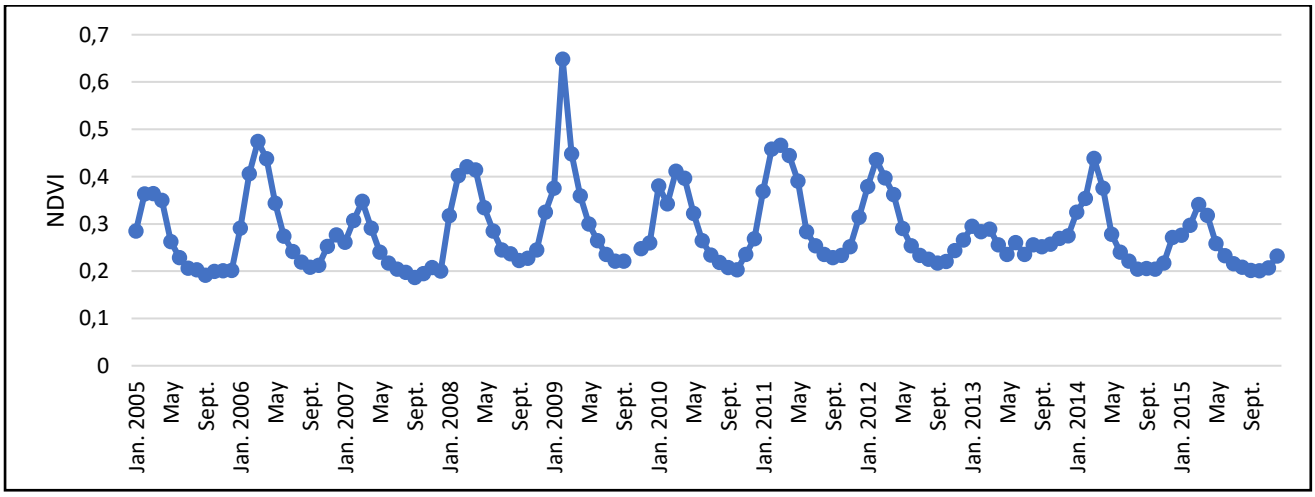


Figure 14. Monthly NDVI (vegetation health index) values from January 2005 to December 2015.

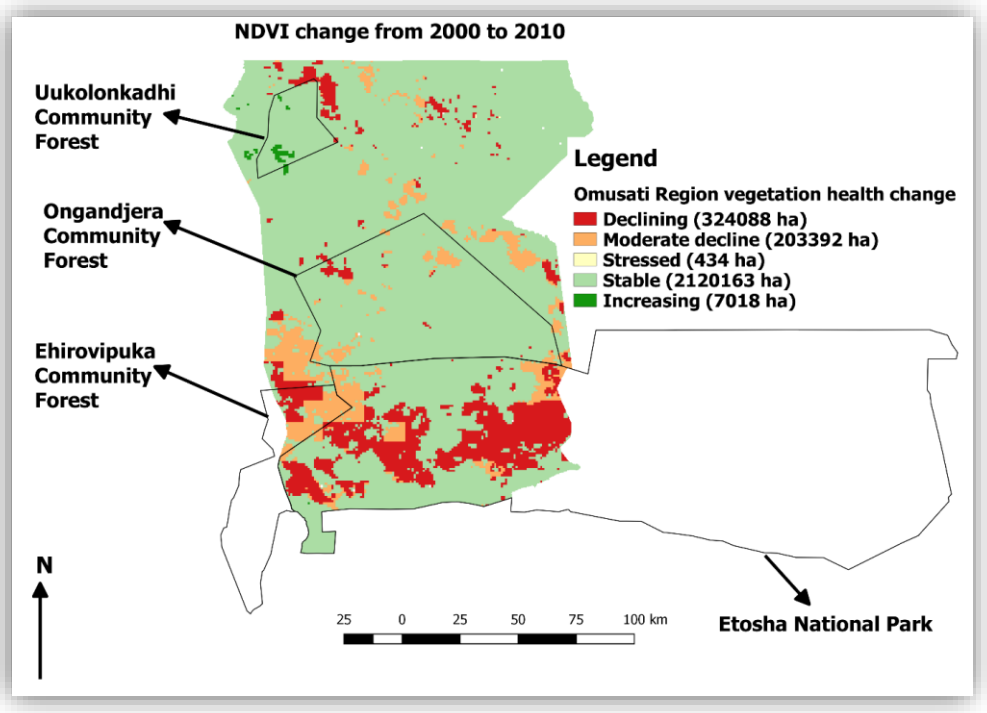


Figure 15.: Vegetation health change from 2000 to 2010, Omusati region. NDVI data from the UNCCD.

5.3. Conclusion from the land degradation assessment in Omusati region

The vegetation in the southern and northern parts of the region is experiencing stress and its vitality is decreasing. This is indicated by the reduced NDVI range from 2000 to 2010 (Figure 15). Fire data over the same period was not correlated to the areas that showed decreasing vegetation health. However, fire, especially repeated fires in the same area, can have a negative impact on long-term vegetation health. Similarly, animal movement patterns in Etosha National Park, located in the southern part of the region, also did not show a correlation to the observed decrease in vegetation health. The following conclusions can therefore be drawn:

- The change in vegetation health could be due to a combination of livestock and wildlife pressure, fires (anthropogenic and wild fires) actions and weather pattern changes
- Wildlife pressure and fires may have major impacts on vegetation health in the Etosha National Park, while livestock pressure and fires have impacts in the central north, eastern and south-eastern parts of Omusati region
- Urgent action is needed to improve the vegetation health in the southern part of Omusati region, as well as at the various hotspots in the central north and the south-east

Soil organic carbon levels in the region are very low, with the best potential especially for crop production being in the north western and western parts of the region, with a small area in the south eastern part of which most is located in the Etosha National Park. The following conclusion can be drawn from the soil organic carbon data:

- Best crop production potential for the region therefore is in the north-west part of the region and in the south-east
- Increasing soil organic carbon content should be a major goal for actions implemented to increase crop production in especially the highly populated north and north central part of the region
- It will be futile to increase fertilizer application in the soils with poor SOC levels as the soils will not have the capacity to absorb and hold these nutrients

5.4. Integration of Land Degradation Neutrality data in the Omusati region land use plan

One of the major outputs of the land degradation assessment are the recommended SLM practices that should be included in the subsequent regional land use plan for the Omusati region. Therefore, the recommendations below were forwarded to the MLR with the expectation that they will be included in the regional land use plan being developed for Omusati region. Continued support will be offered to the consultants responsible for the development of the regional land use plan to ensure the inclusion of the land degradation data and the SLM recommendations in the land use plan.

Urgent actions are needed for improving the soil conditions of the Omusati region to rise crop-farming outputs and to prevent further deterioration of vegetation health in specific hotspots. The following SLM practices recommendations were suggested for the region, based on the observed land degradation data:

- Soil management by farmers in the region should be done in a manner that can help increasing SOC levels:
    - Avoidance of burning crop residues left on the field after harvest
    - The crop residue left on the field after harvest should be turned/buried into the soil
    - Animal manure of the animal grazing on field after harvest should also be turned/buried into the soil
    - Minimum tillage should be practiced on crop fields to help preserve the soil biota/soil organisms. Conservation agriculture practices should be implemented or intensified where they have been introduced already
    - Erosion of topsoil should be minimized or prevented (prevent wind and water erosion)
- The photosynthetic capacity of the vegetation in the identified “vegetation health” hotspots mentioned in Section 5.3 should be improved:
    - The loss of vegetation in the hotspot areas should be minimized or prevented
    - Alternative energy and construction material should be provided to communities depending heavily on plant material to meet these demands
    - Actions should be taken to balance the ratio of available vegetation to wild life numbers in the Etosha National Park, especially in relation to the possible continuous decrease in rainfall expected due to climate change
    - Actions should be taken to reduce increasing soil salinity due to high volume use of saline ground water:

        - Reducing the evaporation of irrigation water from fields by covering soil with plant material
        - Reducing or preventing the use of saline water in irrigation
    - The total number of livestock kept in the region by farmers should be reduced to levels below the potential carrying capacity of the rangelands

The implementation of these actions and many others already implemented on a local scale or that can be copied from elsewhere in the world, can help alleviate the identified land degradation problems.

6. Land Degradation Neutrality monitoring approach in Namibia

6.1. Technical course for Land Degradation Neutrality assessment

A number of workshops were conducted as part of the project implementation to train local experts in land degradation assessment based on the four LDN indicators: land use/cover, bush density, NDVI (land productivity) and SOC. The list of trained local land degradation assessment experts is provided in Annexure 9.9. The information from these training workshops have been combined to produce material for the first LDN assessment technical course. The course content can be viewed at this link:

https://www.dropbox.com/sh/ph7ct3wyqy9322y/AACqlKT3Sa_wecm5jKXCeDIpa?dl=0

The current course structure is:

1. Essentials of R
2. Basic Geostatistics
3. Regression Modelling
4. Data Preparation – Covariates for SOC
5. Map Validation
6. SOC Mapping
7. NDVI Mapping
8. LUC Mapping
9. Bush Density Mapping
10. Boarders files
11. Errors
12. Setting up field sampling points
13. Field work preparation
14. Software installation
15. GitHub
16. Steps – Methodology for completing an LDN assessment

The course uses data from the Omusati and Otjozondjupa region land degradation assessments as examples. However, the course will need to be further refined to provide the information in a more structured pattern. Lecturers from UNAM who were part of the LDN assessment training can present

the course. Support for refining the technical course to develop it into a registered course at local universities can possibly be provided by the NILALEG project of the MET, coordinated by the UNDP.

The LDN assessment uses the open source R programming language. As the applied method has a high computing space requirement, the assessment can be best conducted using high volume computing capacity data bases or the High-Performance Computing system (HPC). The HPC can be provided by UNAM and NUST. The use of open source software for the LDN assessment was recommended by the National Statics Agency. This ensures that the assessment can be replicated by anyone in Namibia and that the data can be easily made accessible to everyone. This also solved the problem of using software that require expensive annual licence renewals that cannot be supported by budgets of local agencies and government ministries.

6.2. Land Degradation Neutrality assessment methodology and costs

LDN assessment methodology

The applied methodology used to conduct the land degradation assessment in Otjozondjupa and Omusati region can now be used for similar assessments in other regions of the country. The assessment can equally utilized at district or municipal levels to conduct land degradation assessment.

The first combined draft of the methodology can be viewed at the link below or in Annexure 9.10:

https://www.dropbox.com/sh/wkx8ts7nz7trh7r/AAAHIMFE7EMrnWWpPfxzDu5ka?dl=0

The structure of the methodology is:

- Chapter 1: Introduction
- Chapter 2: Stratified random sampling: Allocating the field sampling points
- Chapter 3: Field data collection plan
- Chapter 4: Field guide for GPS waypoint collection using Etrex 10 and processing GPS data using DNRGPS
- Chapter 5: Soil and bush encroachment sampling procedure
- Chapter 6: List of equipment used for the field work
- Chapter 7: Land use land cover classification manual
- Chapter 8: Bush density mapping manual
- Chapter 9: NDVI time series assessment manual
- Chapter 10: Soil organic carbon
- Chapter 11: List of covariates used to model soil organic carbon

The methodology, just like the technical course, will also require refinement, although it can already be applied for assessing LDN all over Namibia. The methodology and the LDN technical course need to be discussed and agreed upon with the NSA and the Namibian Standards Institution (NSI). The LDN assessment methodology is coordinated by the MET and any changes should be endorsed by the ministry.

The methodology is based on these concepts:

1. Using the soil laboratory of the MAWF as a standard to conduct the SOC assessment and other soil nutrient assessments
2. Evaluation of the MAWF soil laboratory SOC analysis quality through a private soil laboratory
3. Local communities should help with the data collection in the field, while they should be remunerated with an acceptable fee for their effort
4. Support and blessings of the local political management structures for conducting the land degradation assessment

LDN assessment costs

The cost of the LDN related land degradation assessment is estimated to be N$ 20/km^2, excluding the purchase of field data collection material and fieldwork vehicles. It is assumed that most consulting agencies possess these items already. However, a list of the needed items is provided and the budget can be updated. The detailed budget is provided in Annexure 9.11. The cost estimation should consider the ease of access to the sampling sites. Areas with very sandy or clay soils will have lower accessibility and the cost could increase by more than 10 %, especially after rain for the clay soils. The field assessment should therefore always be completed before the rain season starts.

7. Strength, weakness, opportunity and threats of the project implementation methodology

The LDN project was implemented using the following concept directives:

- Engaging the national SLM committee at different critical project implementation stages
- Engaging any relevant stakeholders who may not be part of the SLM committee but who can assist with the smooth implementation of the project (See Annexure 9.12)
- Linking the LDN project work to relevant local GIZ supported projects
- Direct the implementation of land degradation assessment results and recommendation through inclusion in the IRLUP being coordinated by the MLR
- Conducting the project work with clear consultation of local political offices in the pilot areas
- Conducting the land degradation assessment only for LDN indicators identified by the UNCCD, with addition of bush encroachment as a Namibian specific indicator

- Use of technologies and software that can easily be acquired and used by local stakeholders to assess land degradation in future
- Use of local expertise for support to the project: using the local soil lab for soil assessment
- Training of local experts to conduct future LDN related land degradation assessments

The project implementation had support from many stakeholders while it also faced a number of challenges. Current and future threats can derail the good work started by the project, while a number of opportunities exist to upscale and continue the project work in future. Many of the strength, weaknesses, opportunities and threats to the project work and to its implementation concept are presented in this section. A summary of the strength, weakness, opportunity and threat (SWOT) analysis of the project is presented in Table 5.

7.1. Strengths of the Land Degradation Neutrality implementation process

- The concept was focused on the local technical capacity of the implementing agencies

  The project implementation concept was focused on using the local technical capacity of the implementing agencies. This was done so that much of future LDN related land degradation assessments elated activities/work can be done locally. This should reduce the dependency on external agencies, speeds up the LDN land degradation assessment process and hopefully reduce costs. Local agencies can also help to improve and refine the LDN land degradation assessment process in future.

- The concept was linked to a regional land use management strategy of MLR, ensuring a clear link to other cross sectoral land management strategies

  Linking the project implementation to the process of regional land use plans for regions coordinated by the MLR allows a greater footprint for the LDN implementation. More sectors that will help with the achievement of the national LDN targets can be reached. This should introduce the LDN concept and national targets to stakeholders beyond those who are normally related to the actions implemented by the MET.

- The staff members of the MET and the Directorate of Forestry supported the implementation of the project concept

  The direct local coordination of project work by MET and staff members of the Directorate of Forestry ensured local ownership of the work, while support was provided by the general project coordinator and the technical support agencies. The direct involvement of ministry staff members ensured the planning, execution and completion of the second land degradation assessment in Omusati region could be done locally without involvement of any external parties apart from general supervision support.

- The concept had support from the national SLMC

  The SLM committee was involved from beginning to end and its members offered support and guidance to the work. This also helped improving the local shared knowledge on the LDN process and should ease future LDN related discussions in the committee.

- Support from GIZ through CIAT made it possible to achieve most of the project objectives

  The initial selection to use the CIAT methodology for land degradation assessment, as it focused on knowledge transfer, proved to be useful if not successful all together. The other land degradation assessment methodology that was considered at the project inception phase focused on external expert knowledge and technology. This would have made future LDN assessments in Namibia constantly dependent on these external parties. Through choosing the CIAT methodology local experts have been trained, a basic LDN land degradation assessment methodology has been developed and content for a technical course was produced so that more local experts can be trained to expand the knowledge base of the methodology. The LDN assessment methodology and the technical training course will however need to be refined soon to improve their implementation potential.

- There is a possibility to integrate LDN implementation in the IRLUP process through the SEA guidelines

  One of the more specific aspect is to integrate LDN related land degradation assessment in the current SEA guidelines. The SEA is part of the process to develop IRLUPs and as such, the inclusion of LDN assessment will ensure the performance of LDN related land degradation assessments during the development of each IRLUP. This will also ensure that the any other land related project that requires a SEA completion will include LDN related land degradation assessments. The implementation of the national LDN targets can then expand much further and beyond the capacity of what the MET is able to achieve.

7.2. Weaknesses of the Land Degradation Neutrality implementation process

- Although the implementation of the NAP3 is a national priority, there is no clear legal linkage between the NAP3 and the IRLUP process

  One cornerstone of the project concept is the integration of LDN into the IRLUP development process. The current legal document, approved by parliament, for LDN implementation in the country is the NAP3. The national LDN report of 2015 provides clear LDN targets that should help the achievement of LDN in Namibia as wished for by the NAP3. However, there is currently no legal instrument (i.e. national policy) that links the NAP3 to the IRLUP process.

  Implementing LDN through the IRLUP process will require extra budget allocations to the MLR for conducting the LDN assessments. Therefore, it is vital that a clear legal agreement or process is established, either through existing legal documents or through the production of new documents. This should ensure the justification for future additional budget allocations by the MLR and its supporting agencies for the LDN-IRLUP integration.

- There is also no direct legal instrument for the practical implementation of the NAP3

  The NAP3 has a framework plan for its implementation, and its aim is to achieve LDN in Namibia. However, there are no legally binding guidelines for LDN related land degradation assessments that can help identifying clear actions for the implementation on the ground.

This is why the integration of LDN land degradation assessment as part of the SEA is crucial for the achievement of LDN in Namibia.

- The MET is under-staffed for LDN implementation with its own resources

  The major role of MET in LDN work is to be a national regulator of the different processes that lead or contribute towards the achievement of the national LDN targets that lead towards Namibia becoming land degradation neutral and maintaining this status. The MET does not have the staff capacity to carryout LDN land degradation assessments. This refers to the number of people, the expertise and the technology required for conducting the assessments and completing the data analysis and interpretations. However, the establishment of the LDN assessment methodology and the technical training course provide tools that MET can use to help guide the process while other stakeholders are implementing it. The inclusion of LDN in the SEA guidelines will help complete the needed set of tools for MET to become the regulator of LDN assessments and for it to guide the implementation of LDN work all over the country.

- The Directorate of Forestry, responsible for mapping of national natural resources, is also under staffed and has limited hardware and software resources

  There is a need to expand the capacity of LDN assessment to the private sector through the LDN assessment technical course that can be offered by UNAM, as the governmental agencies that could be tasked to complete the work will not have the capacity to do so in the long term. Due to the higher number of experts from the private sector that can be trained in LDN asessment, the MLR will be able to advertise confidently the completion of a revised SEA that includes LDN assessments. Increasing LDN assessment capacity can be achieved through the revision and finalisation of the current LDN methodology, the technical training course and the inclusion of LDN assessment in the SEA guidelines.

- Most potential LDN assessing organisations use conventional technology and software. Adoption of R programming and using the UNAM HPC system should be a pre-condition to access SEA contracts for keeping the information publicly accessible

  The MLR should make a precondition in the tender process to accept only SEA contracting companies that are willing to use R programming language and to conduct the assessment using the HPC system of UNAM or NUST. This is important to keep all the LDN data publicly available to comply with the condition set by the NSA on using open source software and open availability of national data.

7.3. Opportunities for the Land Degradation Neutrality implementation process

- LDN assessment can be included in revised SEA guidelines

  The LDN land degradation assessment guidelines, based on the established methodology, can now be added to the SEA. This work can be done internally by the MET without much operational costs. However, the work should be done in a manner that ensures that private sector agencies normally implementing the SEA guidelines can easily follow the LDN assessment guidelines. The completion of the technical training course is therefore vital for the implementation of the revised SEA.

- There is a current willingness of land management agencies and the private sector to include LDN in their strategies

  Various land management agencies are willing to integrate LDN assessment results in their actions, as observed from discussions with various stakeholders and looking at how the LDN assessment results and their recommendations have been received to date. The MET should use the momentum to obtain extra funding for its budget, to complete the needed actions of including LDN in the SEA and to provide logistical support to UNAM to formally finalise the technical LDN assessment course.

- The NILALEG project coordinated by the UNDP has potential to assist with LDN implementation

  The MET´s logistical support to UNAM will be the coordination of the support from NILALEG for the development of the technical course. UNAM and UNDP already have a memorandum of understanding (MoU) to coordinate their work and this can be explored to direct NILALEG funding for the establishment of the technical course and even a proposed LDN research centre at UNAM.

- The use of open source software and the availability of the HPC system at UNAM and NUST make an upscaling of the regional LDN assessment exercise to the whole country possible

  The cost of LDN land degradation assessment is now reduced by the use of open source software like R programming language and Quantum GIS (QGIS), plus the availability of the HPC system at UNAM and NUST for data processing on R-studio. The only major cost related to LDN assessments will be the field data collection. However, the data published by the LDN project has shown and proven that reliable mapping can be produced with a minimum set of data sampling points.

- The LDN assessment methodology and the training workshop data can be developed into a technical training course that can be presented at the two participating national universities

  The basic data for developing the technical course have been produced by the LDN project. This information can be refined into a nationally approved technical course that can be offered by UNAM and NUST to participating private sector agencies. The capacity provided by this course could be implemented as a pre-condition for organisations to obtain SEA completion contracts of IRLUP development.

- Required five to ten-year renewal of IRLUPs provides an opportunity for automatic LDN monitoring if included in the SEA

  According to the MLR guidelines for IRLUPs development, these plans should be revised every five to ten years. If LDN is integrated into the SEA guidelines, it will automatically provide opportunity for continuous long term LDN monitoring through future SEA implementation in land use planning work.

7.4. Threats to the Land Degradation Neutrality implementation process

- The implementation of the IRLUP by the regional governments could be limited, reducing the potential to achieve the NAP3 objectives and limit LDN implementation

  The regional land use plan is only a guiding document for the regions in the allocation of their resources. It is not a binding document through which all actions should be implemented. The regional governments are regulators of actions implemented by different private and public agencies in the regions. They are not the main implementers of land management related environment altering actions that can cause land degradation. Therefore, it is possible that the implementation of the LDN prevention/management recommendations made through the IRLUPs may not be followed by the land owners.

  However, data provided through a continuous monitoring of LDN indicators can serve as a reminder to all stakeholders of the achievements and dangers related to land degradation as it might show direct negative impacts on the land owner´s operational viability in the short and long term.

- Trained personnel from the different participating organisations could move to other positions, making them unavailable for future assistance with LDN assessments

  The currently trained staff members from the different agencies that were involved in the project might not be available in the future. However, the establishment of the current LDN assessment methodology and the development of the technical training course should counter this and provide a long-term sustainability of the results of the project.

- LDN implementation coordinated by the MET will potentially face major challenges after the support from GIZ comes to an end

  The MET has limited resources, financial and staffing capacity, and could face problems in effectively taking the current completed work forward with some low-level external support. Therefore, the completion of GIZ support to LDN work in the country could potentially jeopardise the current project achievements.

  However, this can be mitigated through local support such as can be obtained from the NILALEG project. Never the less, there continues to be a need for a central party that will continue to carry the LDN agenda forward between the current potential local LDN implementing agencies.

- IRLUP renewal may not require major SEA assessment

  There is a possibility that future IRLUP renewals may not require major SEA assessments as a potential cost reduction mechanism. It is therefore important that the MET agrees in advance with the MLR to ensure that all future IRLUP renewals retain a component to conduct LDN land degradation assessment to act as long term LDN monitoring.

Table 5: SWOT analysis of the project implementation concept

	Positive Factors	**Negative Factors**
Internal **Factors**	**STRENGTHS** - The concept was focused on the local technical capacity of the implementing agencies - The concept was linked to a regional land management strategy of MLR, ensuring a clear link to other cross sectoral land management strategies - The staff members of the MET and the Directorate of Forestry supported the implementation of the project concept - The concept had support from the national SLM committee - Support from GIZ through CIAT made it possible to achieve most of the project objectives - There is a possibility to integrate LDN implementation through the SEA guidelines	**WEAKNESSES** - Although the implementation of the NAP3 is a national priority, there is no clear legal linkage between the NAP3 and the IRLUP process - There is no direct legal instrument (e.g. LD/LDN guidelines) for the implementation of the NAP3 - The MET is under staffed for the LDN implementation with its own resources - The Directorate of Forestry, responsible for mapping of national natural resources, is also under staffed and has limited hardware and software resources - Most potential LDN assessing organisations use conventional technology and software. Adoption of R programming and using the UNAM HPC system should be a pre-condition to access SEA contracts for keeping the information publicly accessible
	Positive Factors	**Negative Factors**
External Factors	**OPPORTUNITIES** - LDN assessment guidelines can be included in revised SEA guidelines - There is a current willingness of land management agencies and the private sector to include LDN in their strategies - The NILALEG project coordinated by the UNDP has potential to assist with LDN implementation - The use of open source software and the availability of the HPC system at UNAM and NUST make an upscaling of the regional LDN assessment exercise to the whole country possible - The LDN assessment methodology and the training workshop data can be developed into a technical training course that can be presented at the two participating national universities - Required five to ten-year renewals of IRLUPs provides an opportunity for automatic LDN monitoring if included in the SEA	**THREATS** -The implementation of the IRLUP by the regional governments could be limited, reducing the potential to achieve the NAP3 objectives and limit LDN implementation -Trained personnel from the different participating organisations could move to other positions, making them unavailable for future assistance with LDN assessments -LDN implementation coordinated by the MET will potentially face major challenges after the support from GIZ comes to an end -IRLUP renewal may not require major SEA assessment

8. The future of Land Degradation Neutrality implementation in Namibia

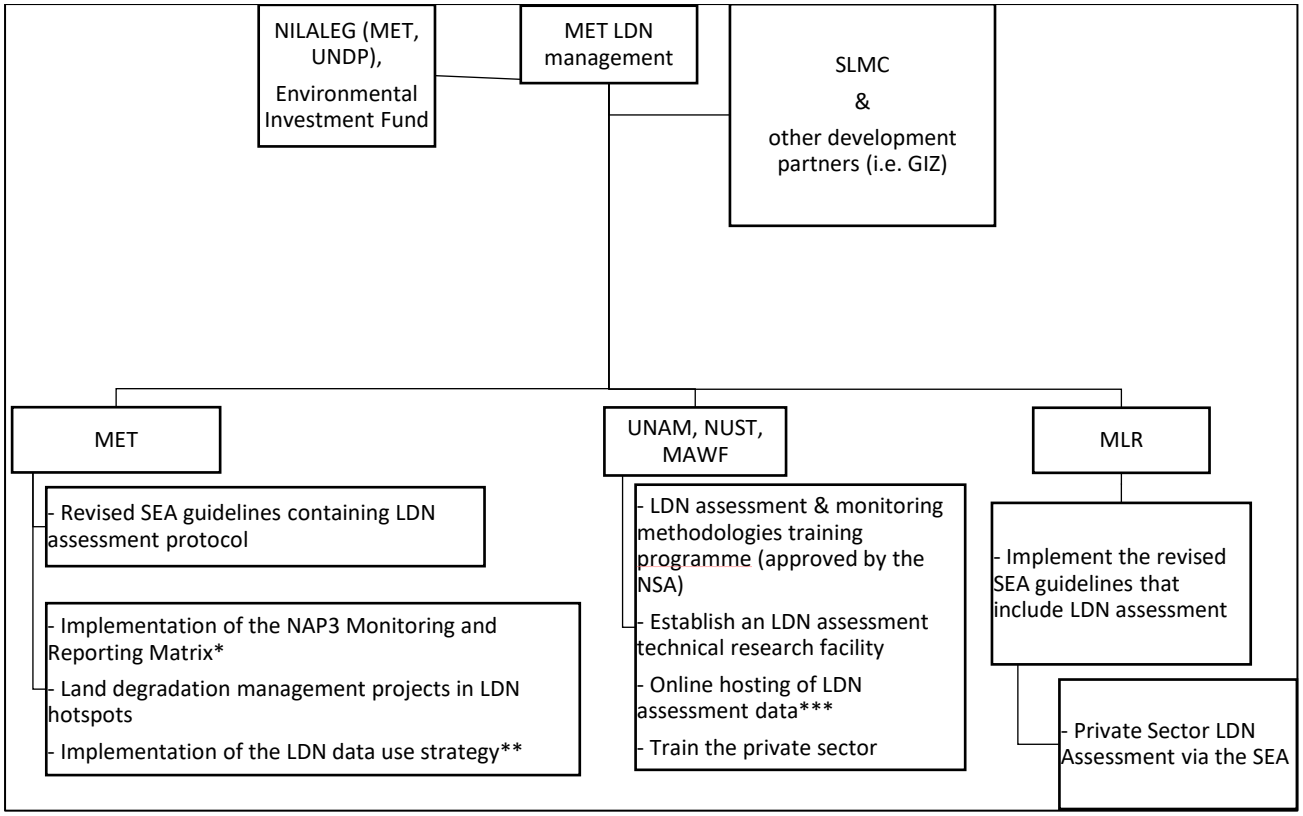
8.1. Introduction

The integration of LDN into land management policies in Namibia, as part of a potential long term LDN implementation concept, was already discussed at the SLM committee meeting on 19th February 2015. The meeting was the inception workshop of the UNCCD LDN pilot phase in Namibia. The inclusion of LDN in land management was also discussed at the SLM committee meeting on 6th May 2015, which was the final workshop for the UNCCD LDN pilot phase. It was agreed at this workshop that the collaboration between the MET and the MLR for the integration of LDN into land management should be increased. The development of the GIZ supported "Pilot project for the establishment of a baseline for land degradation in the Otjozondjupa Region" in March 2016 was concluded based on the recommendation from the UNCCD LDN pilot phase work. It recommended the inclusion of LDN in land management planning as a prospective mechanism for long term LDN achievement in Namibia.

The GIZ LDN project was therefore partly structured around the provision of land degradation assessment data to the IRLUP work, specifically in Otjozondjupa as implemented by the MLR, and later extended to Omusati region. The work done in Otjozondjupa provided a case study to discuss the general concept to be used for the inclusion of land degradation assessment and recommendations, using the three indicators of the UNCCD LDN concept, as part of the development of IRLUPs. This concept was discussed at a technical meeting of the SLM committee meetings (3rd and 4th November 2016 respectively). It was therefore agreed that in future, land degradation assessment products should be provided at specific times to the IRLUP unit of the MLR for their inclusion in the IRLUPs. It was also agreed that a long-term concept should be developed for the standardisation of land degradation assessment based on the three UNCCD LDN indicators and bush encroachment.

8.2. Land Degradation Neutrality implementation concept

Based on all the above-mentioned discussions, LDN work carried out in pilot sites and in support of the NAP3 and the national LDN report of 2015, a potential structure for future LDN implementation processes was developed. The future multisector organisation of LDN implementation in Namibia is indicated in Figure 16. The process will be managed and coordinated by the MET with financial support from NILALEG, the Environmental Investment Fund and supervision by the SLM committee.



*Annexure 9.1; **Annexure 9.13; ***Annexure 9.14

Figure 16: Multisector organisation for LDN implementation in Namibia.

The aims of this implementation concept are:

- Revise the current SEA guidelines to include LDN assessment

  This will allow LDN assessment to become an integral part of the SEA assessment and to be included in all future IRLUPs and their reviews.

- Establish an LDN assessment training programme at UNAM, with support from NILALEG

  The material for the training programme and the basic structure of the programme has been developed by the LDN project (see Section 6.1). This can potentially already be used in a course by the lecturers from UNAM who were part of the LDN training workshops and helped developed some of the mapping products. However, for a formal wider application of the programme, the material should be refined and the course officially registered with the Namibian Qualification Authority (NQA), the NSA and the NSI.

- Establish a long-term monitoring LDN technical facility at UNAM, with support from NILALEG

  Establishing a long term LDN monitoring technical facility at UNAM will help centralise LDN monitoring in the country and provide a platform for LDN related research and data collection. This was suggested by participants from UNAM who are interested in working

with NILALEG to develop this facility, while setting up a national LDN monitoring system is also one of the core operational objectives of NILALEG.

- Provide continuous training to the private sector in LDN assessment through the established technical training programme

  The implementation of the revised SEA containing LDN assessments can only be practically provided if there are enough local experts trained in applying the established LDN land degradation assessment methodology. Therefore, continuous training and research on LDN assessment should be provided by UNAM and NUST based on the agreed/approved technical training programme.

- The MLR implements the revised SEA guidelines during the development and revision of IRLUPs

  The MLR should provide budget allocation for the SEA completion of IRLUPs that make provision for LDN assessments once the SEA guidelines are revised to contain LDN assessments.

- The MET, through the support of partner institutions, implements projects that help tackle the identified courses of land degradation all over Namibia

  The LDN implementation, in addition to integration into the IRLUPs, should still be achieved through targeted projects in all the different LDN hotspots that have been identified and those to be observed in future LDN assessments. The MET should continue to develop projects that will carry out this work with support from partner institutions and development agencies.

- The MET spearheads the identification and implementation of land degradation management projects in the currently and future identified LDN hotspots all over Namibia

  Action is required for specific targeted interventions to stop, prevent and reverse land degradation in land degradation hotspots that were already identified and in those that will be identified in future.

- The MET implements the NAP3 Monitoring and Reporting Matrix (Annexure 9.1)

  The implementation of actions outlined in the matrix is crucial for the achievement of the objectives set out in the NAP3. The achievement of LDN in Namibia is also supported by the matrix.

The more detailed steps that the MET can take to implement LDN in Namibia are presented in Figure 17. These steps can be incorporated in any new LDN project to ensure continuity with the current and past related work.

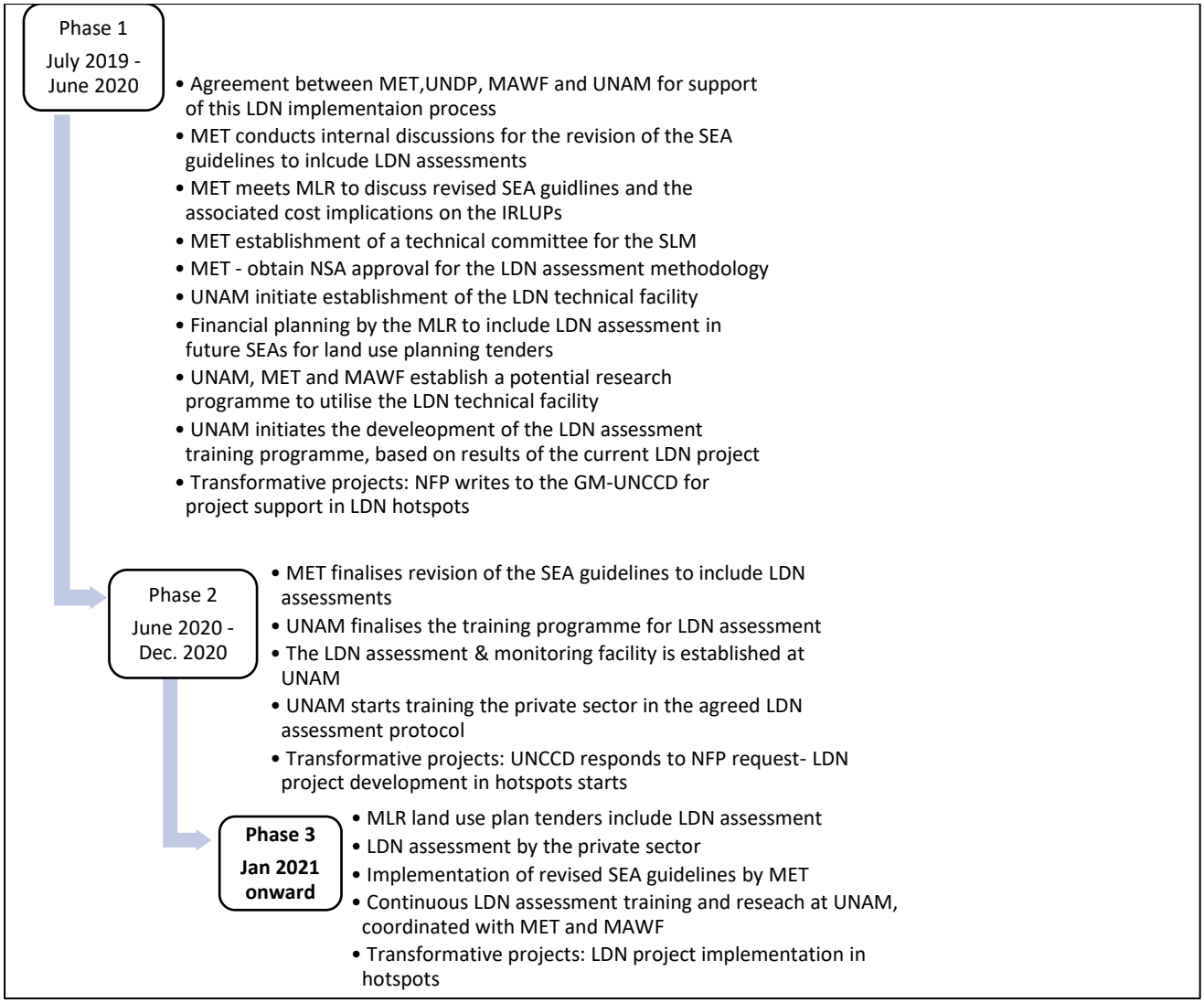


Figure 17: Potential steps for the LDN implementation process