ZAMBEZI & KAVANGO EAST

RAPID SYSTEMATIC CONSERVATION PLAN

Priority conservation areas for the Zambezi & Kavango East

February 2022

WWF

Zambezi and Kavango East

RAPID SYSTEMATIC CONSERVATION PLAN

Priority conservation areas for an integrated conservation support plan for Zambezi and Kavango East Regions, Namibia

February 2022

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WWF

Executive Summary

The World Wildlife Fund Namibia (WWF) initiated this rapid systematic conservation plan (SCP) or conservation prioritization plan for the Zambezi and Kavango East Regions of Namibia. The area forms part of the Kavango Zambezi (KAZA) Transfrontier Conservation Area (TFCA). It is a priority conservation landscape given that it supports critical wildlife corridors linking Namibia to its neighbouring TFCA countries, Angola, Botswana, Zambia and Zimbabwe. The wildlife economy is an important socio-economic driver in this region and therefore the need for more detailed spatial planning was identified in order to promote a more sustainable, inclusive and coordinated development vision.

The SCP analyses comprised 149 distinct biodiversity features, including:

- Terrestrial ecosystems (vegetation types).
- Protected areas and conservation areas.
- Species distribution data (point form and satellite tracking).
- Expert identified priority areas.
- Areas that support ecological processes; constituting wildlife dispersal areas (corridors) and species movement patterns, flood risk areas and freshwater ecosystems (rivers and wetlands).
- Landcover areas of the Zambezi-Kavango East Regions which are in the best ecological condition.

In selecting priority conservation areas, the SCP methodology always attempts to be spatially efficient by meeting conservation targets in as small an area as possible, while avoiding conflict with other land users, at the lowest possible cost for other sectors. In total, 11 socio-economic cost features were used. Considering these criteria, the following competing land use sectors and activities were therefore avoided, as far as reasonably possible:

- Mining, settlement (villages), buildings, transport, deforestation, cattle density, competing land rights, irrigation and zoning, areas under mining applications and proposed agricultural areas.

The MARXAN analysis was run for **seven conservation scenarios** for the Zambezi and Kavango East Region's planning domain. The targets were set as follows:

- **Baseline:** Generally, targets of 30% were used with higher targets for high conservation value habitat types, special features (e.g. wetlands), special process areas (e.g. floodplains) and expert mapped features (e.g. wildlife dispersal areas).
- **Low Target Scenario:** Half of baseline targets (above).
- **Landscape Connectivity One Scenario:** Higher conservation targets for connectivity features (e.g. wildlife corridors and rivers).
- **Landscape Connectivity Two Scenario:** Moderately higher targets for connectivity features.
- **No Zone Scenario:** A target scenario that does not lock in existing conservancy conservation zones.
- **No Fixed Corridors Scenario:** A target scenario that does not lock in pre-identified wildlife corridors.
- **Outside Protected Areas (PAs) Scenario:** Targets for this version are similar to the baseline, but the contributions of existing PAs are excluded. This effectively means the planning and target setting is done outside of PAs.

After consideration in a review workshop, the **baseline target scenario 1** was used for both Zambezi and Kavango East (Figure 1).

A review of the wildlife corridors in Zambezi identified higher and lower priority corridors. The analysis showed that some existing corridors may be impractical to implement and may have lower value. The high value corridors were incorporated into the final set of Conservation Priority Areas (Figure 2).

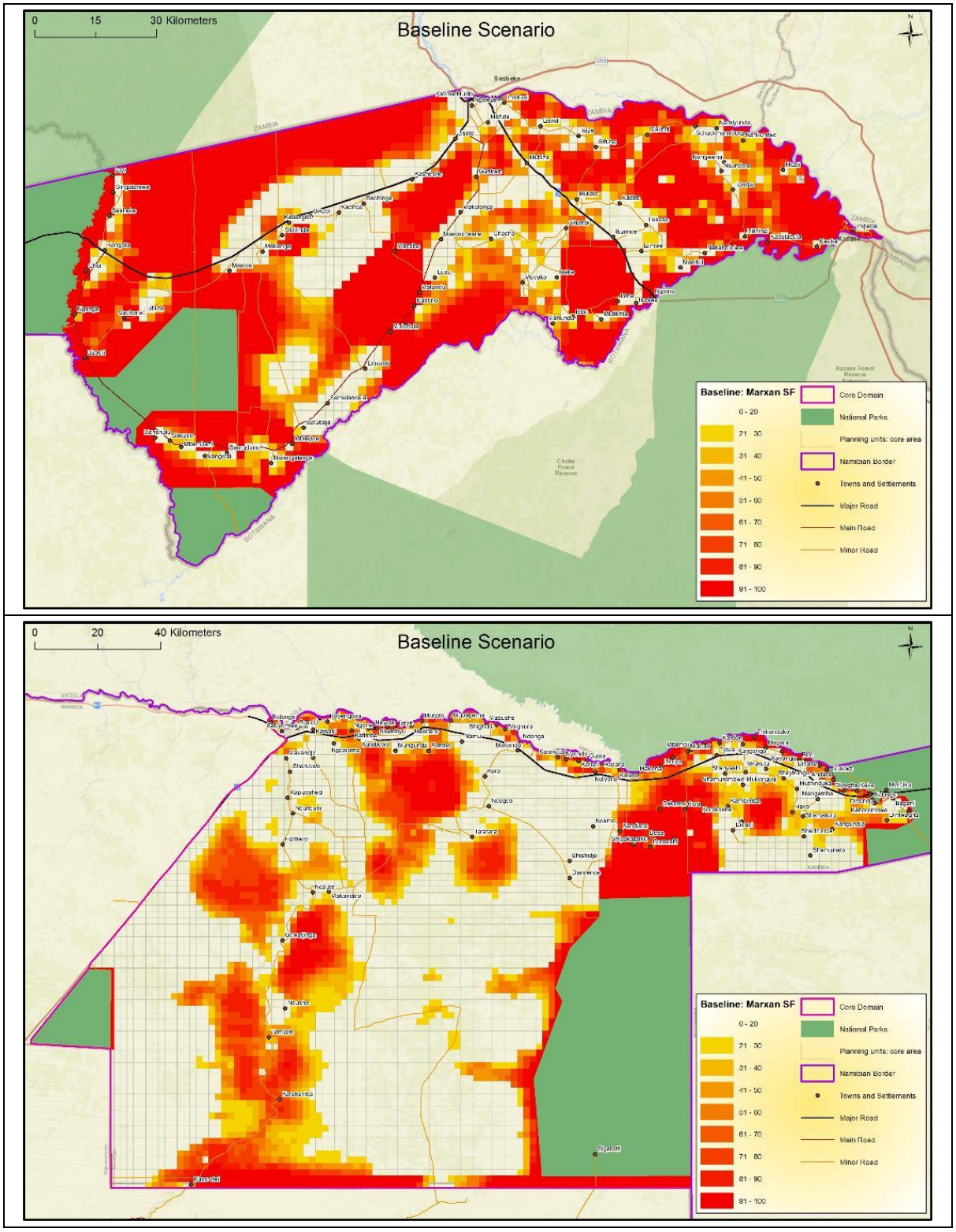


Figure 1. The MARXAN irreplaceability maps representative of the baseline scenario 1 for the Zambezi Region (Top) and Kavango East Region (Bottom), Namibia.

The rapid systematic conservation plan (SCP) identified two Conservation Priority Area categories for the Zambezi-Kavango East Regions that require conservation action by WWF (Figure 2), namely:

- **Highest Conservation Priority Areas:** These areas are highlighted as the most important for immediate conservation actions. They are generally less fragmented and have overall higher irreplaceability values. These areas are most important for overall landscape linkages, and loss of these areas would result in a significant decrease in landscape connectivity. They were identified as the most important conservation areas in the expert workshop.
- **Additional Conservation Priority Areas:** These are additional areas of conservation importance; but may be of lower significance. They are often slightly more fragmented and have lower irreplaceability values. In some cases, these areas are less connected with the rest of the priority areas network (i.e. they are important, but the remainder of the network is not dependent on them). Alternatively, these were areas identified in the expert workshop as possibly having significant implementation constraints.

The **"Highest Conservation Priority Areas"** represent 30.9% (or 1 397 556 ha) of the Zambezi-Kavango East SCP planning domain, which measures 4 523 176 ha (Table 1). Approximately 6.4% (or 287 980 ha) encompasses the "**Additional Conservation Priority Areas"**. National Parks account for 25.6% (or 1 158 395 ha) and areas outside of the conservation priorities are 37.1% (or 1 679 245 ha) of the total landscape.

Table 1. Summary table of planning unit categories, with Conservation Priority Areas, for the Zambezi-Kavango East SCP recommended baseline scenario 1.

Spatial Planning Category	Extent (ha)	Percent of Domain (%)
Recommended Baseline Scenario 1 – Zambezi-Kavango East Regions		
National Parks	1 158 395	25.6%
Highest Conservation Priority Areas	1 397 556	30.9%
Additional Conservation Priority Areas	287 980	6.4%
Other (outside the above conservation priority areas)	1 679 245	37.1%
Total Area of Planning Domain	**4 523 176**	**100.0%**

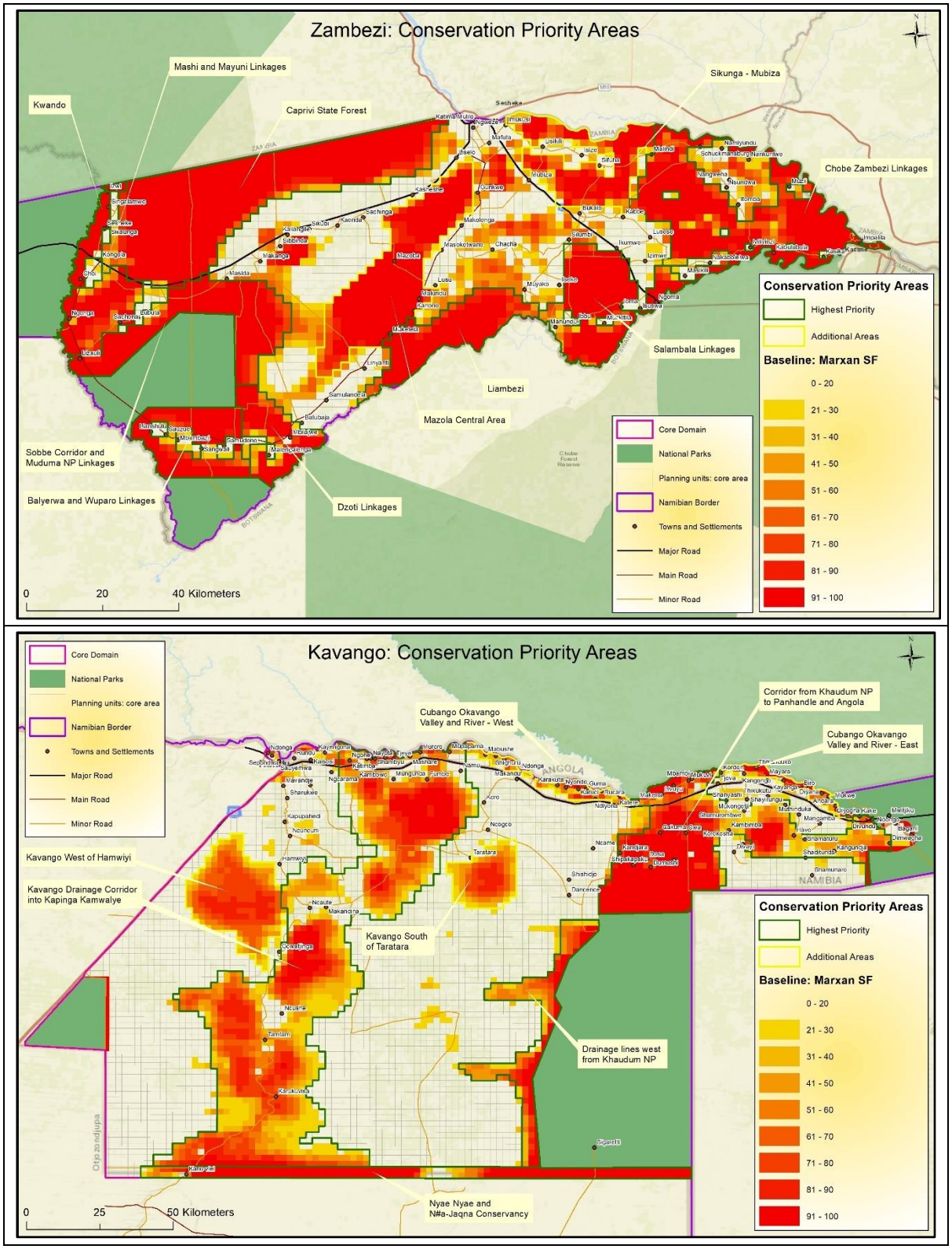


Figure 2: Priority conservation areas for action by WWF Namibia in the Zambezi (Top) and Kavango East (Bottom) Regions of Namibia.

Contents

Executive Summary iii
List of Figures viii
List of Tables x
Acronyms and Abbreviations xii
Introduction 1
Planning Objectives 1
Specific planning objectives 1
Planning Approach 2
Planning Domain 2
Systematic conservation planning concept 3
Planning units 4
Data collection and integration 5
MARXAN analysis 6
Target setting 10
Spatial Biodiversity Data 14
Ecosystem Types 14
Protected Areas 17
Key Species Data – Tracking and Survey Data 22
Additional Species Distribution Data – Point Data 25
Ecological Processes – Wildlife Dispersal Areas (WDA) and Broad International Corridors 26
Ecological Processes – Zambezi Wildlife Corridors 27
Ecological Processes – Rivers and Wetlands 28
Ecological Processes – Zambezi Flood Process Areas or Flood Risk Areas 29
Expert Mapped Features – Opportunities and Constraints 30
Ecological Condition Features 39
Opportunities: Conservancies, Conservation Zones and Communal Forests 42
Cost Surface: Socio-economic and land use cost features 45
Cost surface approach and components 45
MARXAN Cost Layer 57
Spatial Scenarios 59
Scenarios 59
Recommended Scenarios 63
Spatial Priorities Results 65
Overall Priorities 65

Priorities – Whole Region 67
Conservation Priority Areas – Zambezi Region 67
Corridor Review - Zambezi Region 71
Corridor Results 71
Conservation Priority Areas – Kavango East Region 74
Alignment opportunities between Community Based Natural Resource Management (CBNRM) and Spatial Priorities 77
Results of the assessment 77
Main priorities for Community Based Natural Resource Management (CBNRM) highlighted for the Zambezi Region 78
Main priorities for Community Based Natural Resource Management (CBNRM) for the Kavango East Region 78
Conclusion 80
References 80

List of Figures

Figure 1. The MARXAN irreplaceability maps representative of the baseline scenario 1 for the Zambezi Region (Top) and Kavango East Region (Bottom), Namibia iv
Figure 2: Priority conservation areas for action by WWF Namibia in the Zambezi (Top) and Kavango East (Bottom) Regions of Namibia. vi
Figure 3: Map of the planning domain, which incorporates the Zambezi Region, to the east, and Kavango East Region, to the west. 3
Figure 4: Systematic Conservation Planning process summary. 4
Figure 5: Summary of the Overall Project Planning Approach. 4
Figure 6: Map showing the 2x2-km planning units used for the assessment. These units were used for data collection, data integration and for the conservation planning analyses. 5
Figure 7: Additional details on data review and dataset building stages of the planning process. 6
Figure 8: Summary of the Systematic Conservation Planning (SCP) process applied in this project. Note that although some sections are shown as separate processes to aid understanding of the approach, in the actual SCP process they are part of a single optimization. 7
Figure 9: The broad-scale vegetation map (2002) for the Zambezi-Kavango East regions (Top) and a fine-scale Zambezi Vegetation Map (1996) (Bottom) for the Zambezi Region and the eastern portion of Kavango East, Namibia. 14
Figure 10: Map showing Protected Areas (i.e. formal conservation areas such as National Parks) and Conservation Areas (e.g. conservancies and community forests) in the Zambezi and Kavango East Region of Namibia and across the neighbouring KAZA TFCA countries. Note that the PA labels are given in Table 7 and Table 8. 17
Figure 11: GPS collar tracking of top predator and iconic species, African Wild Dog, Buffalo, Hyena, Lion, Elephant and Zebra (2010 – 2019) for the Kavango East - Zambezi Regions, with additional MEFT aerial survey data for Elephant (2013, 2015 & 2019). 24

Figure 12. Map showing additional mammal species distribution records in point form. (Note: The map shows records for all species, but each species was separately included in the MARXAN analysis). . 25
Figure 13: Map of the three KAZA TFCA wildlife dispersal areas that overlap the planning domain. The identified broad international corridors are also shown. 26
Figure 14: Local level wildlife corridors have been mapped at a fine scale (Ministry of Lands and Resettlement, 2015; WWF, 2020), referred to as the WWF Wildlife Corridors and the Zambezi Land Use Plan Wildlife Corridors. 27
Figure 15: Ecological (hydrological) process areas represented by rivers and wetlands (Note: This map is a slightly generalized version of freshwater resources and is for illustrative purposes only). 28
Figure 16: Zambezi flood risk areas. 29
Figure 17: An example of expert mapped features (Top) with the associated metadata form (Bottom) provided during the expert mapping workshop. 30
Figure 18: Expert mapped biodiversity features by John Mendelsohn, which includes a range of terrestrial and aquatic vegetation habitats / ecosystem types. 36
Figure 19: Expert mapped biodiversity features by Lise Hansen, which includes wildlife migration routes for lion, spotted hyaena, wild dog, cheetah and leopard; and Linyati Swamp, a priority wetland. 36
Figure 20: Expert mapped features by Carol Murphy and Janine Sharpe, which includes wildlife migration routes, emerging community forests and important fish breeding grounds. 37
Figure 21: Expert mapped features by Pauline Lindeque, Aldrin Mwilima, Bargrey Kapelwa and Dominic Muema, which includes priority areas for wildlife movement, wildfire control, socio-economic opportunities and emerging conservancies. 37
Figure 22: Expert mapped features by Britta Hackenberg, which includes priority areas for ten emerging fish reserves and two potential corridors. 38
Figure 23: The Zambezi Region's ecological condition layer derived from the 2005 KAZA TFCA landcover map (Schultz et al., 2018). 39
Figure 24: Forest clearance during 1996, 2019 and 2021 in the Zambezi Region, which contributes to interpreting ecological condition or land cover (Schultz, M., 2017). 39
Figure 25: The Kavango East Region's ecological condition layer derived from the 2005 KAZA TFCA landcover map (Schultz et al., 2018). 40
Figure 26: Namibia's Zambezi Region conservancies, conservancy conservation zones, communal forests and the proposed Caprivi / Zambezi State Forest Reserve. 42
Figure 27: Namibia's Kavango East Region conservancies, conservancy conservation zones and communal forests. 42
Figure 28: The socio-economic cost layers for the Zambezi Region: Buildings, dwellings, population density, landcover, transport, deforestation, villages, cattle density, competing rights, irrigation zoning and mining & prospecting rights. 52
Figure 29: The socio-economic cost layers for Kavango East: Buildings, dwellings, population density, landcover and mining & prospecting rights. 54
Figure 30: The overall cost surface layer used in the MARXAN analysis for the Zambezi Region (Top) and the Kavango East Region (Bottom). 57
Figure 31: MARXAN Selection Frequency for the seven conservation planning scenarios derived for the Zambezi-Kavango East rapid systematic conservation plan. 63
Figure 32: MARXAN Selection Frequency for the recommended baseline scenario 1 derived for the Zambezi-Kavango East rapid systematic conservation plan. 64

Figure 33: Expert workshop prioritization of initial MARXAN results for Kavango East (with expert views categorised as 'Priority', 'Not a Priority', 'Corridor', 'Possible' and 'Not Realistic'). 66
Figure 34: Expert workshop prioritization of initial MARXAN results for Zambezi (with expert views categorised as 'Priority', 'Not a Priority', 'Corridor', 'Possible' and 'Not Realistic'). 67
Figure 35: Descriptive map depicting the Zambezi-Kavango East rapid Systematic Conservation Planning (SCP) Conservation Priority Areas for the recommended baseline scenario 1 in the Zambezi Region. 69
Figure 36: Results of the workshop expert evaluation of corridors. Corridors were split into priority sections ("Priority"), areas that are not a priority ("Not a Priority") and sections that were not considered to be realistic ("Not Realistic"). 72
Figure 37: Map showing corridors in relation to the identified "Highest Conservation Priority Areas", "Additional Conservation Priority Areas" and the MARXAN selection frequency. For clarity, only the priority areas which are relevant for corridors are annotated. 72
Figure 38: Evaluation of the existing corridor network for Zambezi. The costs (from the MARXAN cost surface) and benefits (irreplaceability and priority areas) for planning units within the corridors were evaluated. Planning units were divided into four categories of various combinations of high or low costs and benefits. Conservation Priority Areas with specific importance (based on this analysis) are annotated. 73
Figure 39. Descriptive map depicting the Zambezi-Kavango East rapid Systematic Conservation Planning (SCP) Conservation Priority Areas for the recommended baseline scenario in the Kavango East Region. 75
Figure 40: CBNRM alignment opportunities with the baseline scenario's MARXAN selection frequency values in the Zambezi Region, Namibia. 79
Figure 41: CBNRM alignment opportunities with the baseline scenario's MARXAN selection frequency values in the Kavango East Region, Namibia. 79

List of Tables

Table 1. Summary table of planning unit categories, with Conservation Priority Areas, for the Zambezi-Kavango East SCP recommended baseline scenario 1. v
Table 2: MARXAN was run for seven conservation planning targets or scenarios. 9
Table 3. The MARXAN planning units were split into four spatial planning categories, which includes the two Conservation Priority Areas, for the recommended scenario. 9
Table 4: Targets used for the spatial prioritization. 10
Table 5. Broad-scale vegetation types of the Zambezi-Kavango East Regions, Namibia (Ministry of Environment and Tourism, 2002). 15
Table 6. Fine-scale terrestrial ecosystems of the Zambezi-Kavango East Regions (1996), Namibia (Mendelsohn and Roberts, 1996). 15
Table 7: Formal Protected Areas in the Zambezi and Kavango East Region of Namibia and across the neighbouring KAZA TFCA countries. 18
Table 8: Conservation Areas in the Zambezi and Kavango East Region of Namibia and across the neighbouring KAZA TFCA countries. 19
Table 9. List of additional mammal species distribution data 25
Table 10: Expert mapped data provided by the experts, with feature number, name and additional information. 31

Table 11: KAZA TFCA landcover data (2005), showing percentage values for 'Natural' versus 'Not Natural'. 41
Table 12: The Zambezi WWF Forest clearance data combined for the periods 1996, 2019 and 2021 (hectares and percentage values). 41
Table 13: Registered (existing) conservancies and emerging conservancies in the Zambezi and Kavango East Regions, with hectare (ha) statistics. 43
Table 14. Elements incorporated into the cost surface for Zambezi and Kavango East Regions. 45
Table 15: Summary table of planning unit categories, with Conservation Priority Areas, for the Zambezi-Kavango East SCP recommended baseline scenario 1. 67
Table 16**:** Summary table of planning unit categories and Conservation Priority Areas for the Zambezi Region's recommended baseline scenario 1. 68
Table 17: Summary of Zambezi Region's Conservation Priority Area descriptions identified in the SCP with the extent (ha) and proportion of the planning domain (%) for the recommended baseline scenario. 70
Table 18: Summary table of Conservation Priority Areas for the Kavango East Region. 74
Table 19: Summary of Kavango East Region's Conservation Priority Area descriptions identified in the SCP with the extent (ha) and proportion of the planning domain (%) for the recommended baseline scenario. 76

Acronyms and Abbreviations

BLM	Boundary Length modifier
CBD	Convention on Biological Diversity
COP	Conference of the Parties
FR	Forest Reserve
HWC	Human Wildlife Conflict
IUCN	International Union for Conservation of Nature
KAZA TFCA	Kavango Zambezi Transfrontier Conservation Area
MLR	Ministry of Lands and Resettlement (Namibia)
MET	Ministry of Environment and Tourism (Namibia)
MEFT	Ministry of Environment, Forestry and Tourism (Namibia)
NBA	National Biodiversity Assessment
NGOs	Non-Governmental Organizations
NMU	Nelson Mandela University
NP	National Park
PA	Protected Area
PACA	Protected Area and Conservation Areas
RILUP	Regional Integrated Land Use Plan
SCP	Systematic Conservation Planning
SPF	Species Penalty Factor
WDAs	Wildlife Dispersal Areas
WWF	World Wildlife Fund (Namibia)

Introduction

This document reports on the results of a rapid systematic conservation plan (or conservation prioritization plan) for the Zambezi and Kavango East Regions, an area situated in the north-eastern corner of Namibia. The area forms part of the Kavango Zambezi (KAZA) Transfrontier Conservation Area (TFCA), which extends across parts of Angola, Botswana, Namibia, Zambia and Zimbabwe.

The KAZA TFCA is the largest of its kind globally and a priority conservation landscape to the World Wildlife Fund (WWF). Several other NGOs and international development agencies are also active in the region (e.g. Peace Parks Foundation, The Nature Conservancy). Namibia's Kavango East and Zambezi Regions (formerly Caprivi Strip) are a critical landscape for the movement of wildlife, the course of large north to south flowing rivers; and the overall ecological sustainability of the KAZA TFCA. The Namibian section of the KAZA TFCA is essentially a key ecological linkage between the 'wildlife abundant' Botswana (to the south) and the 'wildlife impoverished' Angola and Zambia (to the north and north-east).

Since the wildlife economy is the basis for socio-economic development in the region; and to the KAZA as a whole, sustainable development is vital. The Integrated Regional Land Use Plan for the Zambezi Region (Ministry of Lands and Resettlement, 2015) however seems to have had little influence over development in Zambezi. Consequently, WWF recognized the need to develop a rapid systematic conservation plan for the Zambezi Region and the Kavango East Region. This exercise would also provide a pilot for use in the planned Kwando River strategic environmental assessment (SEA). The plan is also aimed at coordinating the various conservation activities and organizations to achieve the best socio-ecological-economic outcome in the Namibian section of the KAZA TFCA.

Planning Objectives

Specific planning objectives

The purpose of the Zambezi and Kavango East Rapid Systematic Conservation Plan is to:

"Support rational decisions by WWF on priority conservation areas for an integrated conservation support plan for Zambezi and Kavango East Regions, including confirmation of priority corridors and specification of particular areas which need to be strategically held down for conservation in the long term".

The plan will support WWF in the following manner:

- Inform internal decision making.
- Guide current project development.
- Contribute to future zoning exercises in Zambezi and Kavango East.
- Contribute to broader inclusive basin-wide planning processes, as part of the Dreamfund Project.
- Demonstrate what can be achieved using a systematic conservation planning approach.
- Inform a more comprehensive proposal to facilitate regional integrated planning and development in the Zambezi Region and Kavango East areas of Namibia.

Specific Scope of Work to achieve the planning objectives:

a. Compile existing data on the socio-biodiversity-political-development layers of the planning domain (Zambezi/ Kavango East); and compile regional context data for the adjacent areas.

b. Build additional value-added analyses of available biodiversity data (e.g. animal tracking and/or alternative connectivity approaches), subject to access to information sourced via WWF.
c. Identify conservation goals for the planning domain, applying systematic conservation planning tools.
d. Build a systemic conservation plan using MARXAN.
e. Identify spatial priorities for conservation actions (including additional conservation areas):
    i. Review existing conservation areas; and include an explicit summary of the contribution/ value of each of the reserves in terms of contributing to set goals.
    ii. Identify priority/focus areas for alignment of Community Based Natural Resource Management (CBNRM) and other conservation activities.
    iii. Confirm key corridor / linkage areas for landscape connectivity.
    iv. Identify where conservation actions could be undertaken in a way that has minimal social or economic costs.
    v. Help support the development of spatial scenarios for the vision/scenario development process.
f. Virtual workshops:
    i. A stakeholder workshop held in June 2021.
    ii. A spatial product and landscape scenarios workshop in November 2021.
    iii. Ongoing engagements with a smaller WWF technical team.

Planning Approach

Planning Domain

Critical components of a systematic conservation plan's planning domain include identifying and mapping (i) the extent and distribution of biodiversity; (ii) the ecosystem processes that sustain biodiversity; and (iii) human activities that impact on and threaten it.

The core planning domain or footprint is the Zambezi Region and most of the Kavango East Region of Namibia (Figure 3). It includes the area formerly known as the Caprivi Strip, which constitutes the Zambezi Region and the very eastern portion of Kavango East. This area is the focus for conservation prioritization and detailed spatial data.

The study expands the conservation context area to include the remainder of Kavango East, portions of south-east Angola, north-west Botswana and south-western Zambia (Figure 3). This provides a broader planning context, which needs to be taken into consideration when building a systematic conservation plan (e.g. major socio-economic patterns, such as population density and land use, ecological process priorities, protected area linkages and landscape connectivity should be aligned).

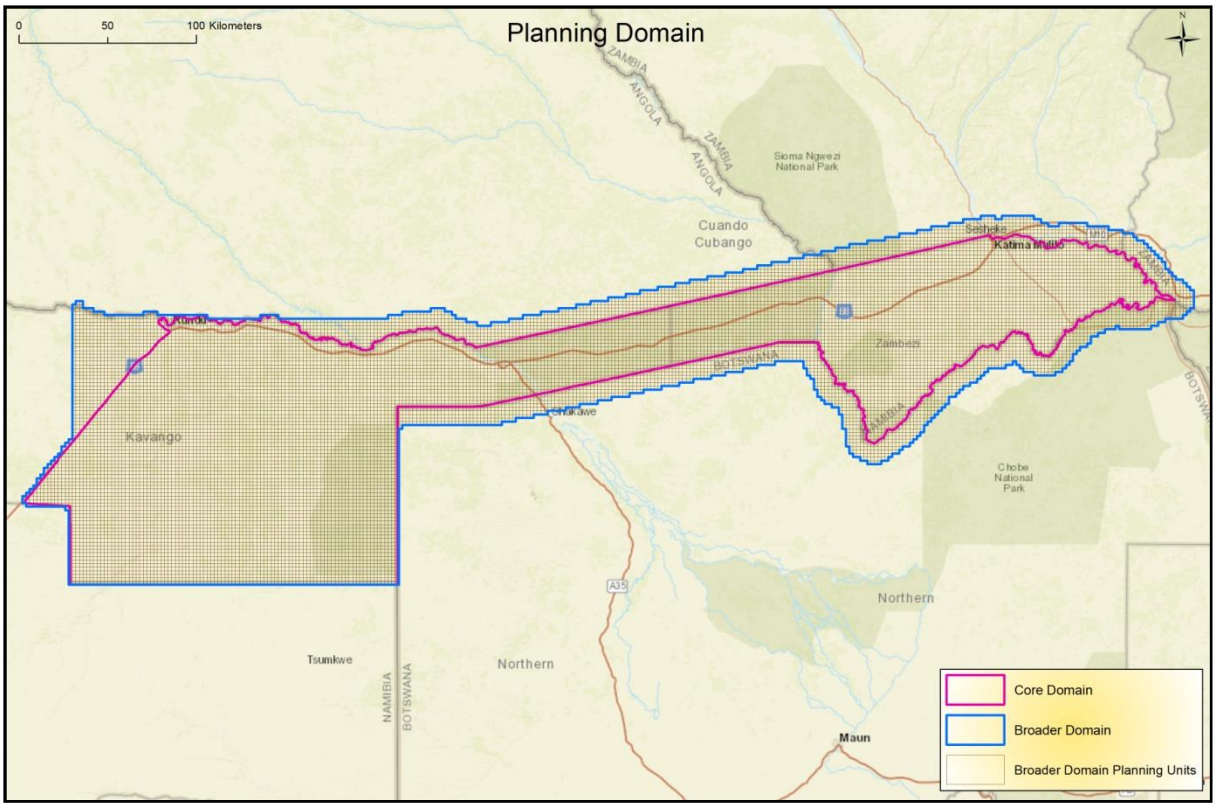


Figure 3: Map of the planning domain, which incorporates the Zambezi Region, to the east, and Kavango East Region, to the west.

Systematic conservation planning concept

This assessment is based on a Systematic Conservation Planning (SCP) concept. SCP is the process of deciding where, when and how to allocate limited biodiversity conservation resources to minimize the loss of biodiversity, ecosystem services and other valuable aspects of the natural environment at the least cost to other conflicting sectors. The benefits of such a robust evidence-based, conservation planning approach have been demonstrated in a wide variety of terrestrial, aquatic and marine environments and scales, from regions to reserves, across the globe.

Since it emerged in the 1990s (Margules and Pressey, 2000) and coupled with decision-support software such as MARXAN (Ball et al., 2009), GIS-based SCP has rapidly become an important tool for planning for biodiversity conservation at various scales. SCP provides efficient spatial solutions to resource allocation problems, and explicitly considers ecological representation and long-term persistence requirements. Often SCP processes are used to identify ecologically representative and well-connected systems of Protected Areas and other effective area-based conservation measures. SCP is also cost efficient and reduces conflicts by minimizing spatial competition with other sectors.

The planning process is essentially a sequential data-integration method that builds on the input of the best available data. The SCP process can be broken down into a series of inter-linked activities that are summarised in Figure 4 and Figure 5 below. Each individual activity can consist of several iterative steps and may require adaptive feedback loops. These stages for the assessment are explained in more detail in the subsequent sections of this report.

Figure 4: Systematic Conservation Planning process summary.

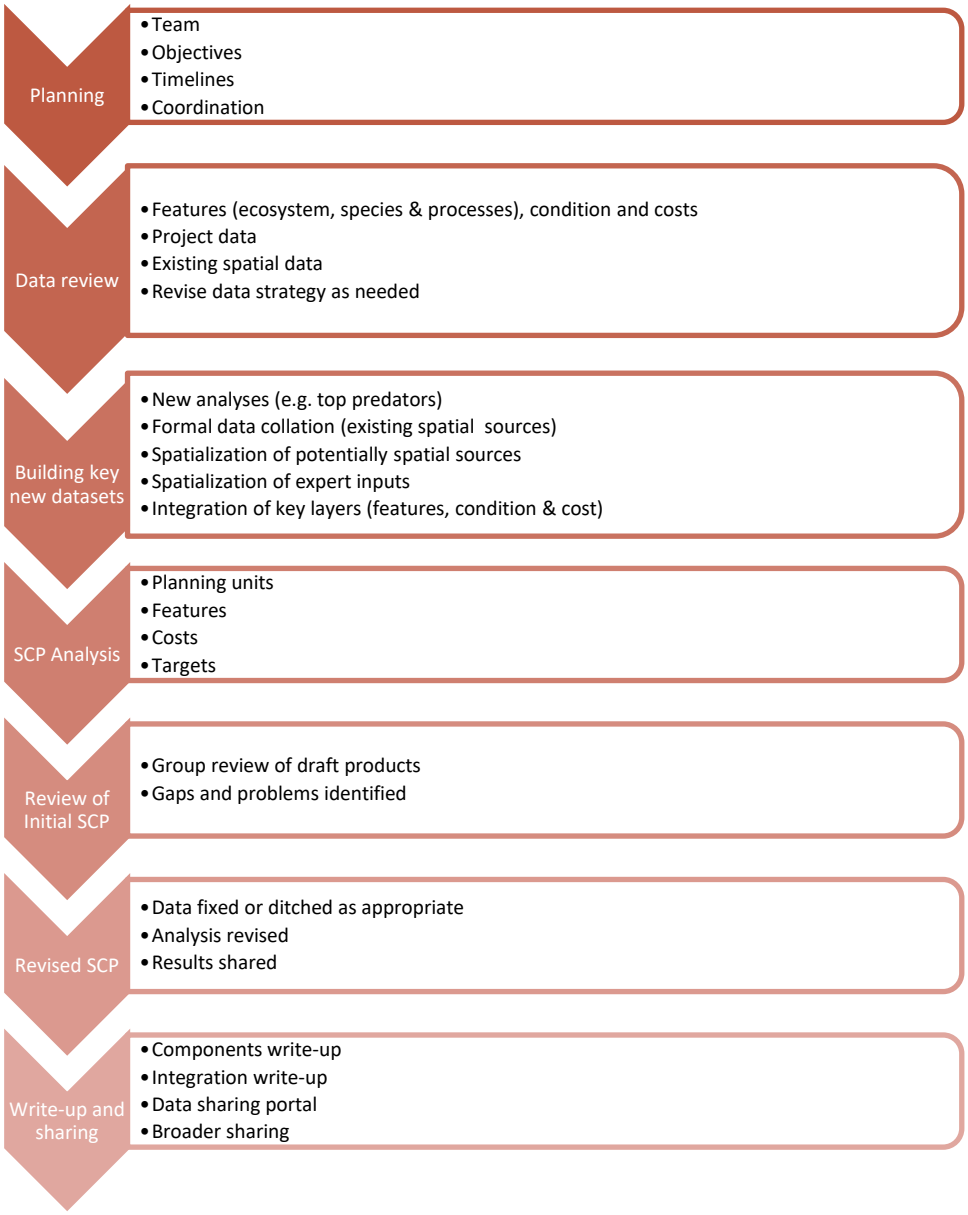


Figure 5: Summary of the Overall Project Planning Approach.

Planning units

To facilitate data collection and analysis, the planning domain was divided into 4 116 2x2-km planning units (Figure 6). This was done in order to:

- Provide a framework for integration of datasets of varying types (biodiversity features, pressures, human uses etc.).
- Ensure that all data collected were in a compatible format.
- Allow for the summary of continuous data layers to useable units.
- Provide a background map for experts/stakeholders to identify priority areas for specific features and uses, either manually or electronically.
- Provide required units for the Systematic Conservation Planning software MARXAN (Ball et al., 2009).
- Provide a basis for sharing datasets used in the assessment that cannot be shared in their original form due to data ownership or publication issues. This allows the project to share the digested values that were incorporated into the planning process and reference the original source.

The 4 km^2 unit size was chosen because:

- This planning unit size had successfully been used in previous expert/stakeholder mapping processes.
- It was reasonably matched to the range of resolutions of different spatial data inputs.

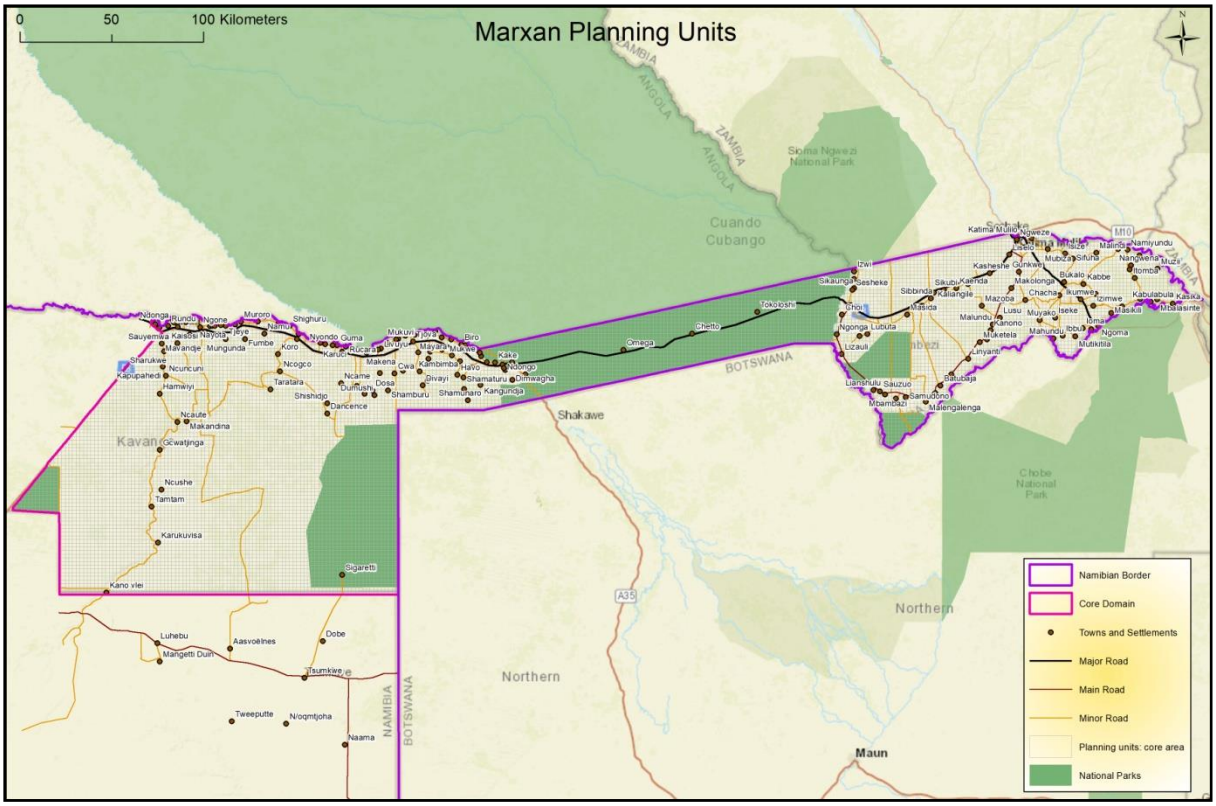


Figure 6: Map showing the 2x2-km planning units used for the assessment. These units were used for data collection, data integration and for the conservation planning analyses.

Data collection and integration

The Zambezi-Kavango East rapid Systematic Conservation Plan is based on existing datasets, supplemented by expert and stakeholder knowledge. Figure 7 below provides details on data review and the dataset building stages of the planning process.

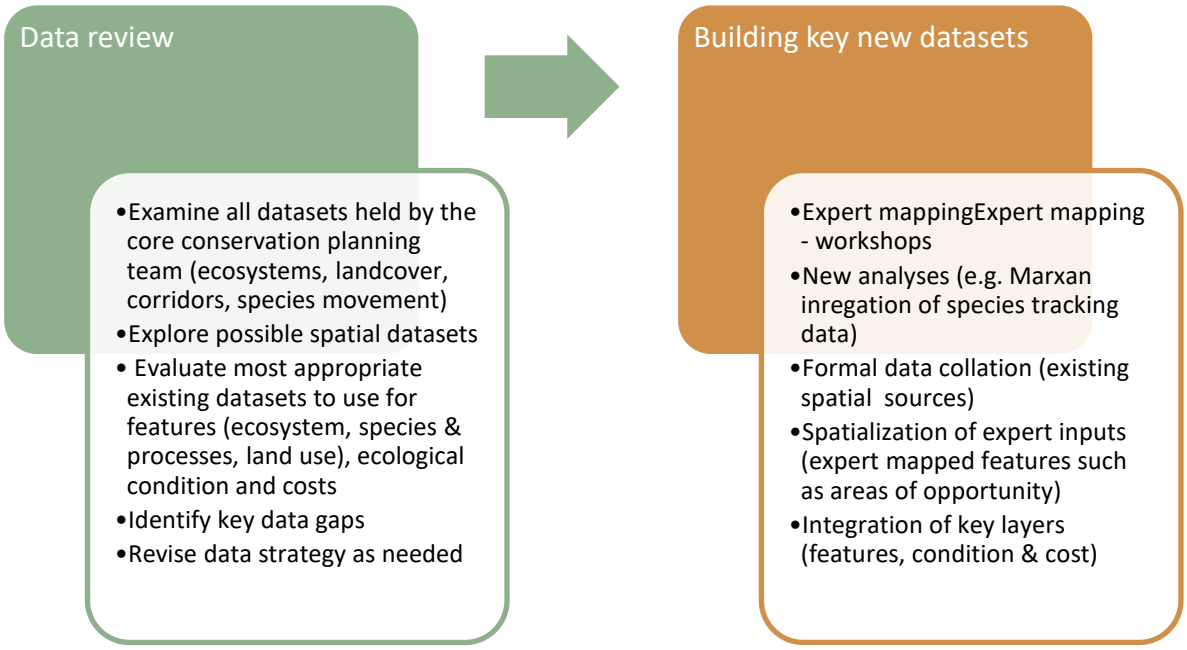


Figure 7: Additional details on data review and dataset building stages of the planning process.

Where available, the analyses used published data, but often these do not exist for the required inputs, and experts and local stakeholders needed to be consulted to fill spatial data gaps. Stakeholder/expert engagement is a standard part of any conservation planning process. The Zambezi-Kavango East Project used a structured expert mapping process with individuals with experts knowledge of the region and understanding of where critical activities occur, such as wildlife dispersal areas, critical ecosystems etc. Engagement took place mostly in organized sessions (see Section "Expert Mapped Features – Opportunities and Constraints"). Experts were asked to provide an existing spatial dataset or to draw the information on the Project gridded (2x2 km) map (Figure 6 and Figure 17 of the Section "Expert Mapped Features"). Within the broader context of the Zambezi-Kavango East Project, the expert mapping process contributed to the process by helping people understand the planning process, enabling them to contribute, and by aligning biodiversity objectives with the requirements of other sustainable uses and users of the region. Experts/stakeholders were identified by WWF Namibia.

MARXAN analysis

The MARXAN decision support tool developed by Ian Ball and Hugh Possingham (2009) was utilised for the spatial prioritization. This is the most widely adopted site-selection tool used by conservation groups globally, having been applied to local and regional planning efforts in over 60 countries around the world (Ball et al., 2009). MARXAN is designed to provide an objective approach to spatial prioritization that is adaptable and repeatable, based on an algorithm that evaluates very large numbers of possible alternatives, and retains the most efficient solutions given a specific set of criteria. It is a stand-alone software program that provides decision support to conservation planners by identifying efficient areas that combine to satisfy ecological, social and economic objectives. It utilises data on species, ecosystems and other biodiversity features, combined with data on planning unit costs (or constraints), to identify sets of sites that meet all biodiversity representation goals, while minimizing the total cost of the solution. Hence, it ensures a spatially optimal configuration of sites.

The approach follows a number of steps (Figure 8). Firstly, key input data on biodiversity features were collated, as were data on pressures and ecological condition of habitats, and the existing Protected Areas and Conservation Areas. Quantitative targets were set for how much of each biodiversity feature needs to be retained in a natural or semi-natural state. The initial data were used to identify the areas of least cost to conservation or existing resource users and activities. These components were iteratively combined in MARXAN to identify the highest priority natural areas that should be kept in this state to support long-term sustainable non-destructive use and secure the region's ecological and aesthetic value.

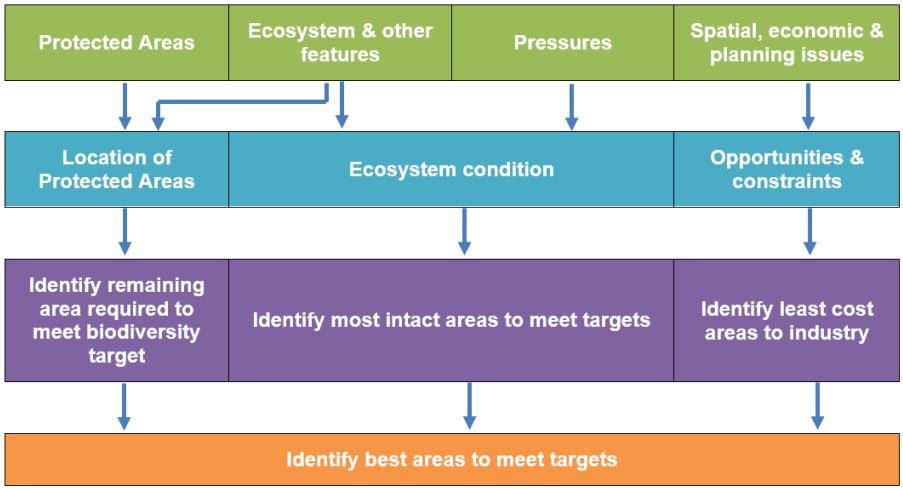


Figure 8: Summary of the Systematic Conservation Planning (SCP) process applied in this project. Note that although some sections are shown as separate processes to aid understanding of the approach, in the actual SCP process they are part of a single optimization.

Several design principles or rules were implemented during the spatial prioritization:

- The assessment intended to meet targets (see Table 4) for all features while reducing conflict with other competing activities. A cost surface was used to: (1) avoid areas in poor ecological condition where possible; (2) favour areas where habitats were likely to be in the best ecological condition, where opportunities existed for conservation activities, and where costs for implementing conservation were lowest; and (3) to avoid areas with highest levels of conflict with major sectors and activities (crop production, areas with high cattle density, urban areas, mining) where the opportunity cost for society of implementing conservation activities is highest. These concepts were incorporated through basing the cost of a planning unit on the level of intensity of key sectors and activities present in the unit.
- The assessment aimed to avoid a fragmented set of priority areas as far as possible. This issue was addressed using two approaches:
    - Many biodiversity features focused on connectivity in the landscape. These included both expert mapped features (e.g. linkages) and specific biodiversity data (e.g. wildlife tracking data for key species).
    - Use was made of MARXAN boundary length approaches to prioritize adjacent rather than scattered solutions. An attempt was made to identify contiguous blocks of high priority areas rather than a scatter of priority sites. This was done through careful calibration of the boundary length modifier to ensure the production of an appropriately clumped output without becoming unnecessarily spatially inefficient.

- The assessment aimed to meet all targets as far as possible but did not force the selection of poor condition areas. This balance was obtained by an iterative calibration of the MARXAN input variables.
- Areas in good ecological condition were strongly favoured using a cost surface where sites in poor ecological condition or that contained high levels of competing or incompatible activities were avoided (see cost surface explanation below).
- The spatial requirements for meeting targets for biodiversity features were deliberately aligned with the spatial requirements of compatible activities. Priority sites were identified for compatible uses (e.g. the areas identified for tourism, fishery reserves, conservancies, extensive agriculture) and these were explicitly included in the conservation plan. Targets were set for these features (see Table 4).

A set of Priority Focus Areas (referred to as Conservation Priority Areas) were identified using the following method:

- Data layers were prepared using ESRI ArcGIS 10.6.
- The analyses used 4 km^2 grids for the spatial prioritization. This scale represented a compromise between the finer-scale data available for some ecosystem types and pressures in the eastern part of the planning domain, in Zambezi, and the coarser-scale ecosystem and threats data in the western part of the planning domain, in Kavango East. Current Protected Areas were embedded into the planning unit grid in order to facilitate the evaluation of priority areas that could connect to the PAs in the MARXAN analysis.
- Boundary lengths between each planning unit were calculated in meters. These boundary lengths are used, in combination with the Boundary Length modifier (BLM), to identify spatially efficient and connected combinations of planning units.
- Data, targets and cost surfaces were inputted into the MARXAN decision support tool using the CLUZ interface in ArcView 3.2 developed by Dr Bob Smith, Durrell Institute of Conservation and Ecology (http://www.kent.ac.uk/dice/cluz/).
- Data on 149 distinct biodiversity and use features were included into the analysis. These were used to develop a site-by-features matrix that describes how much of each ecosystem type is found within each planning unit.
- The analysis used MARXAN version 1.8.10.
- The analysis followed standard MARXAN processes as outlined in the MARXAN good practices handbook (Ardron et al., 2008).
- A cost surface was used to ensure preferential selection of sites that are in the best possible ecological condition and where there are the lowest levels of conflict with other incompatible activities. This cost surface development is described in the "**Cost surface**" section.
- An iterative approach was used to identify appropriate Species Penalty Factor (SPF) values and Boundary Length modifier (BLM). Satisfactory inclusion of biodiversity features in a spatially efficient and ecologically connected layout was obtained using an SPF value of 1,000,000,000 and a BLM of 2. These values were calibrated using an iterative manual calibration method, compliant with the objectives outlined in the MARXAN good practices handbook (Ardron et al., 2008).
- A final MARXAN spatial prioritization was undertaken using 1 000 runs of 1 000 000 iterations each for seven different conservation planning scenarios (Table 2). The basic output of the MARXAN-based process described here is a **selection frequency map**. This map gives a representation of how important each planning unit is for meeting targets and summarizes the number of times (expressed as a percentage) that a planning unit is included in potential spatial

configurations that meet the targets and minimize costs according to the parameters used in the MARXAN analysis.

- An expert review process was undertaken to select the most appropriate conservation planning scenario.
- The results of the selected conservation planning scenario were split into a set of priority areas based on selection frequency and expert review of feasibility/ priority. To do this, the most frequently selected planning units (generally areas selected more than 50% of the time, but with some manual interpolation to produce coherent units). These priority areas and categories aid in understanding the spatial prioritization, are useful for describing selected areas, and are easier to include in implementation plans (Table 3).

Table 2: MARXAN was run for seven conservation planning targets or scenarios.

Scenario	Features / Definitions
Baseline	Generally, targets of 30% were used with higher targets for high conservation value habitat types, special features (e.g. wetlands), special process areas (e.g. floodplains) and expertly mapped features (e.g. wildlife dispersal areas). Refer Table 4 for all targets.
Low Target	Targets set at half of baseline targets (see above). Refer Table 4 for all targets.
Landscape Connectivity One	Higher conservation targets for connectivity features (e.g. wildlife corridors and rivers). Refer Table 4 for all targets.
Landscape Connectivity Two	Moderately (between the baseline and the targets used for Landscape Connectivity One) higher targets for connectivity features. Refer Table 4 for all targets.
No Zone	Target scenario does not assume conservancy zones i.e. does not lock in existing conservancy conservation zones.
No Fixed Corridors	Target scenario does not strongly favour identified corridors i.e. does not lock in pre-identified wildlife corridors.
Outside Protected Areas (PA)	Similar targets to baseline, but the contributions of existing PAs are excluded. This effectively means the planning and target setting is done outside of PAs.

Table 3. The MARXAN planning units were split into four spatial planning categories, which includes the two Conservation Priority Areas, for the recommended scenario.

Spatial Planning Category	Definitions
National Parks	The National Parks within the planning domain (see **Protected Areas** Section).
Highest Conservation Priority Areas	These are most important and for immediate conservation actions. They are generally less fragmented and have overall higher irreplaceability values. These areas are most important for overall landscape linkages, and often loss of these areas would result in a significant decrease in landscape connectivity. They were identified as the most important conservation areas in the expert workshop.

Spatial Planning Category	Definitions
Additional Conservation Priority Areas	These are additional areas of conservation importance; but may be of lower significance. They are often slightly more fragmented and have lower irreplaceability values. In some cases, these areas are less connected with the rest of the priority areas network (i.e. they are important, but the remainder of the network is not dependent on them). Alternatively, these were areas identified in the expert workshop as possibly having significant implementation constraints.
Other Areas	Areas outside the above conservation priority areas.

Target setting

Setting quantitative targets for biodiversity features is central to the systematic conservation planning methodology. It allows the planning process to efficiently identify places that can achieve targets for multiple features. Quantitative targets were set for how much of each biodiversity feature needs to be retained in a natural or semi-natural state in order to safeguard a representative portion of that feature such that it will persist in the future (see Table 4).

The Zambezi-Kavango East SCP set targets both for pure biodiversity features (e.g. ecosystem types or areas required by elephant) and for the areas required for compatible sustainable activities, such as tourism, fishery reserves and extensive agriculture. This allows aligning the objectives of multiple sectors, where possible, and developing an efficient integrated environmental output of the requirements for all sectors.

Targets were set for the range of biodiversity features used in the planning process (Table 4). As a starting target value for ecosystem types, the 30% target set out in Target 2 of the Post 2020 Global Biodiversity Framework was used (Erdelen, 2020; Nicholson et al., 2021). Targets for individual were then either increased or decreased based on the conservation value, threat status or rarity of features, or on the objectives of a scenario (See Table 4).

Table 4: Targets used for the spatial prioritization.

			Scenario						
Type	Feature	ID	Baseline	Low	Connect One	Connect Two	No Zone	No Fixed Corridors	Outside
Fine-scale terrestrial ecosystems	Impalila woodland	1	50	25	50	50	50	50	50
	Linyanti woodland	2	50	25	50	50	50	50	50
	Maningimanzi woodland and channel	3	50	25	50	50	50	50	50
	Okavango-Kwando grassland	4	50	25	50	50	50	50	50
	Okavango/Kwando valley woodland	5	50	25	50	50	50	50	50
	Omuramba fringe woodland	6	50	25	50	50	50	50	50
	Rivers and open water	7	50	25	50	50	50	50	50
	Salambala Camelthorn woodland	8	50	25	50	50	50	50	50
	Zambezi woodland	9	50	25	50	50	50	50	50
	Burkea-Terminalia woodland	10	30	15	30	30	30	30	30

Type	Feature	ID	Scenario						
			Baseline	Low	Connect One	Connect Two	No Zone	No Fixed Corridors	Outside
	Burkea shrubland	11	30	15	30	30	30	30	30
	Chobe grassland-hummock mosaic	12	30	15	30	30	30	30	30
	Chobe Swamp grassland	13	30	15	30	30	30	30	30
	Mopane-Aristida woodland	14	30	15	30	30	30	30	30
	Mopane-Terminalia woodland	15	30	15	30	30	30	30	30
	Mudumu Mulapo woodland	16	30	15	30	30	30	30	30
	Okavango valley fields and shrubland	17	30	15	30	30	30	30	30
	Teak shrubland	18	30	15	30	30	30	30	30
	Zambezi floodplain grassland	19	30	15	30	30	30	30	30
	Zambezi transition grassland	20	30	15	30	30	30	30	30
	Bukalo-Liambezi grassland	21	40	20	40	40	40	40	40
	Burkea-Combretum woodland	22	40	20	40	40	40	40	40
	Burkea-Kiaat-False Mopane woodland	23	40	20	40	40	40	40	40
	Burkea-Teak woodland	24	40	20	40	40	40	40	40
	Chobe wetland	25	40	20	40	40	40	40	40
	Dry Mamili grassland	26	40	20	40	40	40	40	40
	Gunkwe mulapos	27	40	20	40	40	40	40	40
	Kwando-Linyanti grassland	28	40	20	40	40	40	40	40
	Liambezi-Linyanti grassland	29	40	20	40	40	40	40	40
	Mopane-Burkea woodland	30	40	20	40	40	40	40	40
	Omuramba grassland	31	40	20	40	40	40	40	40
	Open Camelthorn woodland	32	40	20	40	40	40	40	40
	Teak savanna	33	40	20	40	40	40	40	40
	Teak woodland	34	40	20	40	40	40	40	40
	Wet Mamili grassland	35	40	20	40	40	40	40	40
	Zambezi floodplain channels	36	40	20	40	40	40	40	40
Broad-scale terrestrial ecosystems	Caprivi Floodplains	37	50	25	50	50	50	50	50
	Caprivi mopane woodland	38	30	15	30	30	30	30	30
	Eastern drainage	39	30	15	30	30	30	30	30
	North-eastern Kalahari woodlands	40	30	15	30	30	30	30	30
	Northern Kalahari	41	10	5	10	10	10	10	10
	Okavango valley	42	50	25	50	50	50	50	50
	Omatako drainage	43	50	25	50	50	50	50	50
	Riverine woodlands and islands	44	50	25	50	50	50	50	50
Species tracking and survey data	Wildlife dispersal areas	45	30	15	30	30	30	30	30
	Wild Dog Tracking Data	46	70	35	90	70	70	70	70
	Buffalo Tracking Data	47	70	35	90	70	70	70	70
	Hyena Tracking Data	48	70	35	90	70	70	70	70
	Lion Tracking Data	49	70	35	90	70	70	70	70
	Elephant Tracking Data	50	70	35	90	70	70	70	70
	Zebra Tracking Data	51	70	35	90	70	70	70	70
	Elephant Survey 2013 - 2019	52	70	35	90	70	70	70	70
Hydrological Features	International River	53	70	35	70	70	70	70	70
	Namibian River	54	70	35	70	70	70	70	70
	Pan	55	70	35	70	70	70	70	70
	Swamp	56	70	35	70	70	70	70	70
	Water	57	70	35	70	70	70	70	70
	Caprivi Flood Risk	58	70	35	70	70	70	70	70
Corridors	Wildlife Corridor 2020	59	100	50	100	100	100	0	100
	Zambezi Land Use Plan Corridor	60	70	35	90	70	70	0	70
	Broad International Corridors	61	50	25	50	50	50	50	50
Conservancy	Conservancy Conservation Compatible Zones	62	100	50	100	100	0	100	100
	Registered Conservancies	63	70	35	70	70	70	70	70

Type	Feature	ID	Scenario						
			Baseline	Low	Connect One	Connect Two	No Zone	No Fixed Corridors	Outside
	Emerging Conservancies	64	50	25	50	50	50	50	50
Additional species	Elephant	65	40	20	40	40	40	40	40
	Aardwolf	66	40	20	40	40	40	40	40
	Badger, Honey	67	40	20	40	40	40	40	40
	Caracal	68	40	20	40	40	40	40	40
	Cat, African Wild	69	40	20	40	40	40	40	40
	Cheetah	70	40	20	40	40	40	40	40
	Civet	71	40	20	40	40	40	40	40
	Fox, Bat-eared	72	40	20	40	40	40	40	40
	Fox, Cape	73	40	20	40	40	40	40	40
	Genet, Common large-spotted	74	40	20	40	40	40	40	40
	Genet, Small-spotted	75	40	20	40	40	40	40	40
	Hyaena, Brown	76	40	20	40	40	40	40	40
	Hyaena, Spotted	77	40	20	40	40	40	40	40
	Jackal, Black-backed	78	40	20	40	40	40	40	40
	Jackal, Side-striped	79	40	20	40	40	40	40	40
	Leopard	80	40	20	40	40	40	40	40
	Lion	81	40	20	40	40	40	40	40
	Mongoose, Banded	82	40	20	40	40	40	40	40
	Mongoose, Dwarf	83	40	20	40	40	40	40	40
	Mongoose, Selous's	84	40	20	40	40	40	40	40
	Mongoose, Slender	85	40	20	40	40	40	40	40
	Otter, Cape Clawless	86	40	20	40	40	40	40	40
	Polecat, Striped	87	40	20	40	40	40	40	40
	Wild Dog	88	40	20	40	40	40	40	40
Zambezi land use plan	Zambezi Plan - Conservation Buffer	90	70	35	70	70	70	70	70
	Zambezi Plan - Conservation Core	91	100	50	100	100	100	100	100
	Zambezi Plan - Fish Protection	92	100	50	100	100	100	100	100
	Zambezi Plan - Fish Lake	93	70	35	70	70	70	70	70
	Caprivi Forest Reserve	94	90	45	90	90	90	90	90
	Zambezi Plan - Household Fishing Areas	95	50	25	50	50	50	50	50
	Zambezi Plan - Tourism Focus Areas	96	50	25	50	50	50	50	50
	Zambezi Plan - Tourism Priority Areas	97	50	25	50	50	50	50	50
Conservation alignmentt	Communal Forests	98	70	35	70	70	70	70	70
	Fish Protection	99	100	50	100	100	100	100	100
	Protected Area in Adjacent Country	100	100	50	100	100	100	100	100
Expert mapped features	JM Cuando floodplain 10 km buffer	101	70	35	70	70	70	70	70
	JM Cuando Floodplains	102	70	35	70	70	70	70	70
	JM Cubango Okavango valley and river	103	70	35	70	70	70	70	70
	JM Dunes and interdunes	104	60	30	60	60	60	60	60
	JM Gunkwe molapos	105	70	35	70	70	70	70	70
	JM Impalila island	106	70	35	70	70	70	70	70
	JM Liambezi	107	70	35	70	70	70	70	70
	JM Linyanti swamps	108	70	35	70	70	70	70	70
	JM Maningimanzi woodlands	109	60	30	60	60	60	60	60
	JM Zambezi floodplains	110	70	35	70	70	70	70	70
	LH 1 - Linyati Swamp and Bdyera Conservancy	111	60	30	90	90	60	60	60
	LH 2 - Lion Range	112	60	30	90	90	60	60	60
	LH 3 - Predator Connectivity	113	60	30	90	60	60	60	60
	LH 4 - Ndumu Lion Range	114	60	30	90	60	60	60	60
	LH 5 - Lion Connectivity	115	60	30	90	90	60	60	60
	LH 6 - Priority Wetland	116	60	30	60	60	60	60	60

Type	Feature	ID	Scenario						
			Baseline	Low	Connect One	Connect Two	No Zone	No Fixed Corridors	Outside
	LH 7 - Wild Dog Connectivity and Recovery	117	60	30	90	60	60	60	60
	CM1 - Livingstone Baobab Area	118	60	30	60	60	60	60	60
	CMECF - Emerging Community Forest	119	60	30	60	60	60	60	60
	JS1 - Elephant Drinking Route	120	60	30	90	60	60	60	60
	JS2 - Human Wildlife Conflict Mitigation Area	121	60	30	90	100	60	60	60
	JS3 - Zebra Migration	122	60	30	90	60	60	60	60
	JS4 - Floodplain - fish breeding	123	60	30	60	60	60	60	60
	JS5 - Park Linkage	124	80	40	90	100	80	80	80
	PL 1 Kongola	125	60	30	60	60	60	60	60
	PL 2 Sibbinda	126	60	30	60	60	60	60	60
	PL 3 Wildlife Movement	127	60	30	90	60	60	60	60
	PL 4 Riverine Forest	128	60	30	60	60	60	60	60
	MW1 Potential Fish Reserve	129	60	30	60	60	60	60	60
	Kap 1 Wildlife Introduction Opportunity	130	60	30	60	60	60	60	60
	Kap 2 Fire Control Opportunity	131	60	30	60	60	60	60	60
	Kap 3 Community Forest Products	132	60	30	60	60	60	60	60
	DM1 - Lake Nyabezi Emerging Conservancy	133	60	30	60	60	60	60	60
	DM2 - Linyati Emerging Conservancy	134	60	30	60	60	60	60	60
	DM3 - Kabbe Emerging Conservancy	135	60	30	60	60	60	60	60
	DM4 - Nsudwa Emerging Conservancy	136	60	30	60	60	60	60	60
	DM5 - Ikaba Emerging Conservancy	137	60	30	60	60	60	60	60
	BHFR1 - Emerging Fish Reserve	138	60	30	60	60	60	60	60
	BHFR2 - Emerging Fish Reserve	139	60	30	60	60	60	60	60
	BHFR3 - Emerging Fish Reserve	140	60	30	60	60	60	60	60
	BHFR4 - Emerging Fish Reserve	141	60	30	60	60	60	60	60
	BHFR5 - Emerging Fish Reserve	142	60	30	60	60	60	60	60
	BHFR6 - Emerging Fish Reserve	143	60	30	60	60	60	60	60
	BHFR7 - Emerging Fish Reserve	144	60	30	60	60	60	60	60
	BHFR8 - Emerging Fish Reserve	145	60	30	60	60	60	60	60
	BHFR9 - Emerging Fish Reserve	146	60	30	60	60	60	60	60
	BHFR10 - Emerging Fish Reserve	147	60	30	60	60	60	60	60
	BHCF1 - Bukalo Corridor	148	60	30	90	90	60	60	60
	BHCF2 - Malindi Corridor	149	60	30	90	90	60	60	60

Spatial Biodiversity Data

Ecosystem Types

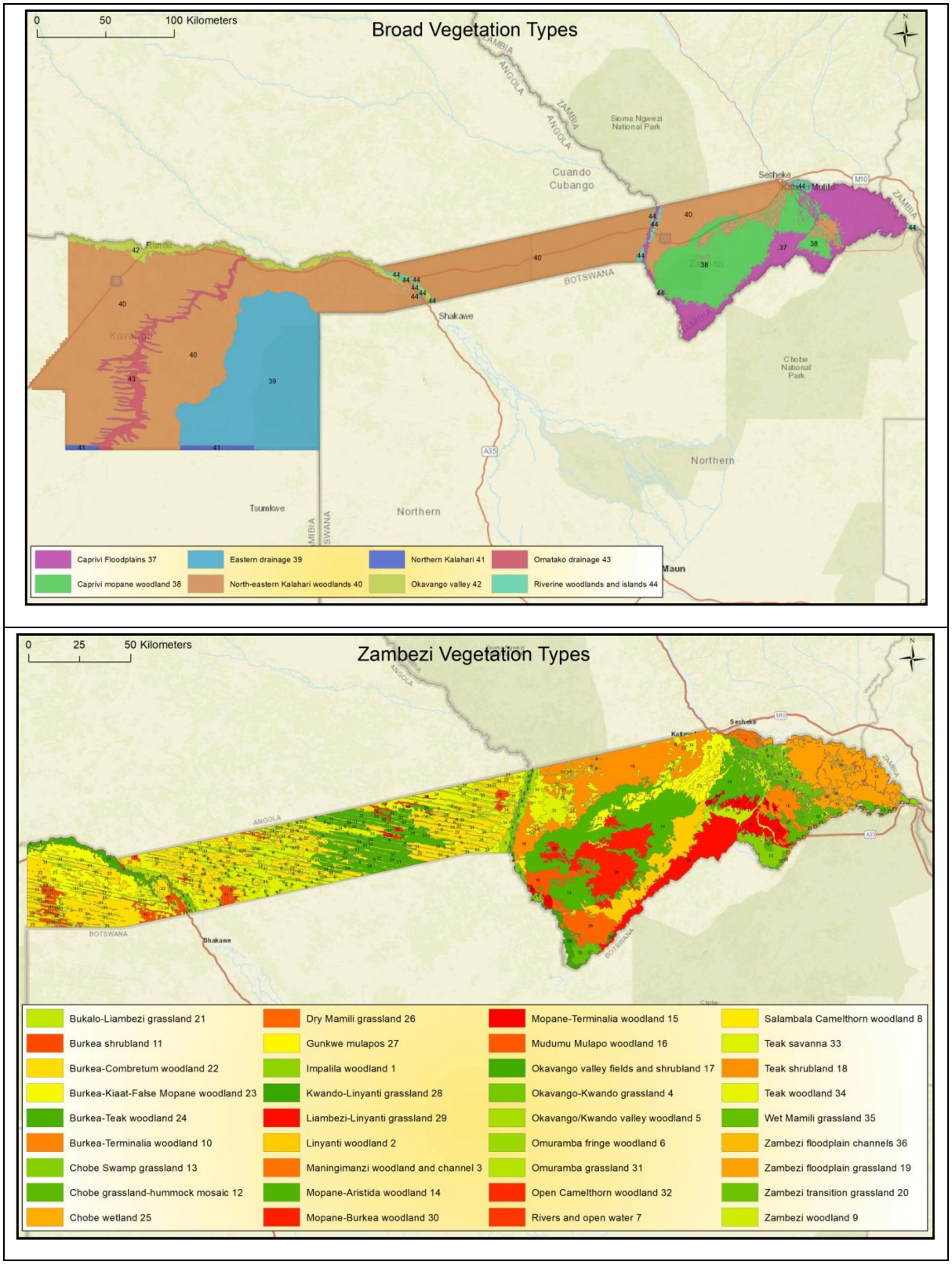


Figure 9: The broad-scale vegetation map (2002) for the Zambezi-Kavango East regions (Top) and a fine-scale Zambezi Vegetation Map (1996) (Bottom) for the Zambezi Region and the eastern portion of Kavango East, Namibia.

Description

A broad-scale vegetation map is available for the entire planning domain (Figure 9 and Table 5), was developed by the 'Atlasing for Namibia Project' (Ministry of Environment and Tourism, 2002). Eight broad vegetation types are described, with the North-Eastern Kalahari Woodlands constituting the dominant ecosystem type. A fine-scale vegetation map was used for the Zambezi Region and the eastern most part of Kavango East, referred to as the Zambezi Vegetation Map (Figure 9 and Table 6) (Mendelsohn and Roberts, 1996). It was published in 1996 and covers the former Caprivi Strip. Thirty-six habitats were delineated, ranging from grasslands to woodlands, and shrublands to freshwater habitats. Nine of these are rated high in terms of conservation value, comprising mostly of the Woodlands unit. Sixteen are medium conservation value and the remaining 11 are of low conservation value. These values were used to adjust the targets for different ecosystem types.

Table 5. Broad-scale vegetation types of the Zambezi-Kavango East Regions, Namibia (Ministry of Environment and Tourism, 2002).

Broad Vegetation Type	ID	Area (Hectares)	Area (%)
Caprivi Floodplains	37	380,637	8.0%
Caprivi Mopane Woodland	38	461,256	9.7%
Eastern Drainage	39	849,923	17.9%
North-Eastern Kalahari Woodlands	40	2,720,217	57.1%
Northern Kalahari	41	29,524	0.6%
Okavango Valley	42	116,605	2.4%
Omatako Drainage	43	167,671	3.5%
Riverine Woodlands and Islands	44	34,844	0.7%
	Grand Total	**4,760,677**	**100,0%**

Table 6. Fine-scale terrestrial ecosystems of the Zambezi-Kavango East Regions (1996), Namibia (Mendelsohn and Roberts, 1996).

Vegetation Structure	Conservation Value	Vegetation Type	ID	Area (Hectares)	Area (%)
High Closed Grassland	**Medium**	Kwando-Linyanti grassland	28	12,094	0.6%
		Wet Mamili grassland	35	9,487	0.5%
High Closed Grassland Total				**21.581**	**1,1%**
High Closed Shrubland	**Low**	Burkea shrubland	11	39,272	2.0%
		Okavango valley fields and shrubland	17	18,713	0.9%
High Closed Shrubland Total				**57.985**	**2,9%**
High Closed Woodland	**High**	Impalila woodland	1	1,833	0.1%
		Linyanti woodland	2	62,268	3.1%
		Maningimanzi woodland and channel	3	8,773	0.4%
		Omuramba fringe woodland	6	25,743	1.3%
		Salambala Camelthorn woodland	8	1,959	0.1%
		Zambezi woodland	9	9,990	0.5%
	Medium	Burkea-Combretum woodland	22	271,722	13.6%

Vegetation Structure	Conservation Value	Vegetation Type	ID	Area (Hectares)	Area (%)
		Burkea-Kiaat-False Mopane woodland	23	114,265	5.7%
		Burkea-Teak woodland	24	103,727	5.2%
		Open Camelthorn woodland	32	7,965	0.4%
		Teak woodland	34	174,173	8.7%
	Low	Burkea-Terminalia woodland	10	24,195	1.2%
		Mudumu Mulapo woodland	16	22,878	1.1%
High Closed Woodland Total				**829,491**	**41,4%**
High Open Woodland	**Medium**	Teak savanna	33	94,524	4.7%
	Low	Teak shrubland	18	153,011	7.6%
High Open Woodland Total				**247,535**	**12,4%**
Tall Closed Grassland	**Medium**	Dry Mamili grassland	26	33,977	1.7%
		Omuramba grassland	31	85,491	4.3%
Tall Closed Grassland Total				**119,468**	**6,0%**
Tall Closed Woodland	**Medium**	Bukalo-Liambezi grassland	21	22,326	1.1%
		Mopane-Burkea woodland	30	84,557	4.2%
	Low	Mopane-Aristida woodland	14	237,430	11.9%
		Mopane-Terminalia woodland	15	37,510	1.9%
Tall Closed Woodland Total				**381,823**	**19,1%**
Tall Open Grassland	**High**	Okavango-Kwando grassland	4	18,222	0.9%
	Medium	Gunkwe mulapos	27	14,841	0.7%
	Low	Chobe grassland-hummock mosaic	12	29,448	1.5%
		Chobe Swamp grassland	13	17,680	0.9%
		Zambezi floodplain grassland	19	116,812	5.8%
		Zambezi transition grassland	20	30,854	1.5%
Tall Open Grassland Total				**227,857**	**11,4%**
Tall Open Woodland	**High**	Okavango/Kwando valley woodland	5	23,627	1.2%
	Medium	Liambezi-Linyanti grassland	29	61,713	3.1%
Tall Open Woodland Total				**85,340**	**4,3%**
Wetland	**High**	Rivers and open water	7	16,619	0.8%
	Medium	Chobe wetland	25	7,323	0.4%
		Zambezi floodplain channels	36	6,371	0.3%
Wetland Total				**30,313**	**1,5%**
			Grand Total	**2,001,393**	**100,0%**

Overview of mapping methods and layer incorporation

The Zambezi Vegetation Map was developed by Mendelsohn and Roberts (1996) and serves as the best available data for the Zambezi Region and a relatively small area of the eastern half of Kavango East, formerly Caprivi Strip. The broad vegetation map was developed by the 'Atlasing for Namibia Project' (Ministry of Environment and Tourism, 2002).

Each ecosystem type was included in the systematic conservation plan with proportional targets based on the type's extent (ha) within the planning domain and the assigned conservation value based on

the conservation value (High, Medium or Low) identified in the original study (Mendelsohn, J.M. and Roberts, C.S., 1996). Targets were scaled so that a relatively higher portion of high conservation value types were included, with lower relative requirements for common types (Table 4).

Data providers

The map data provided by WWF was sourced from Mendelsohn and Roberts (1996) and the broad-scale map from the Digital Atlas of Namibia website.

Protected Areas

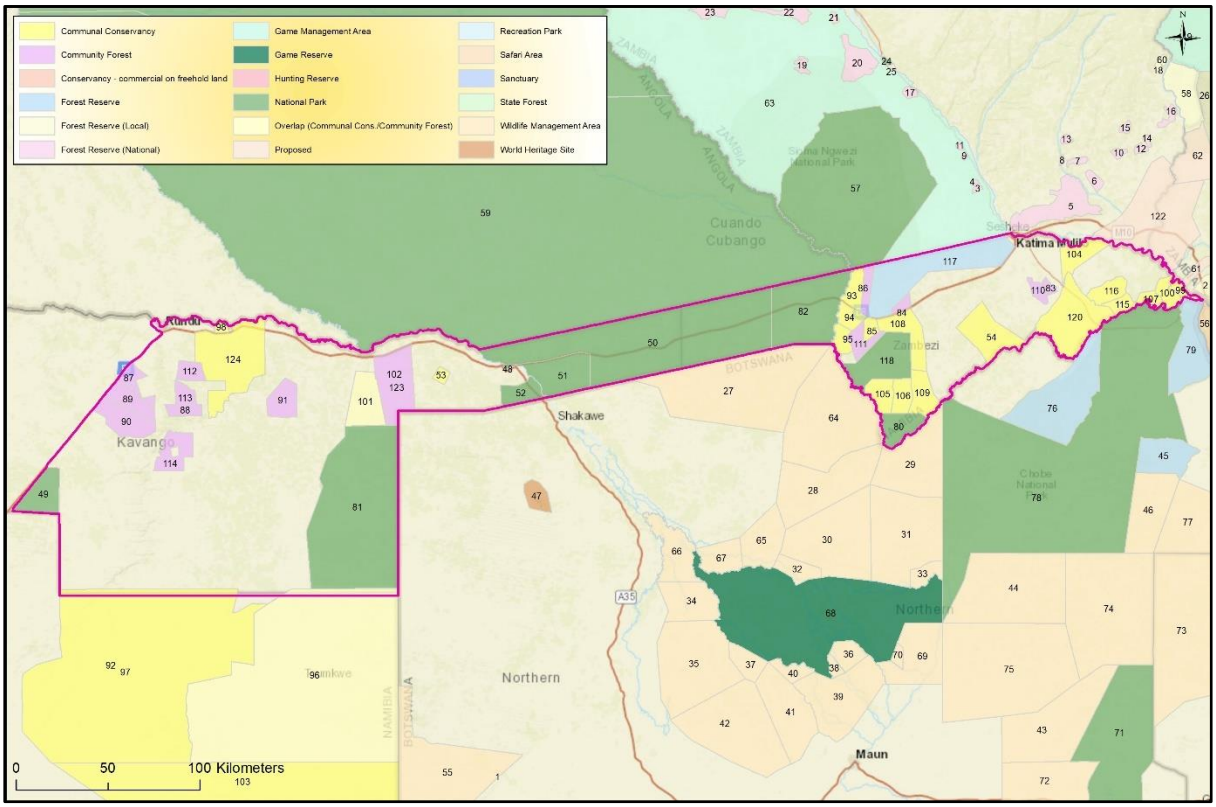


Figure 10: Map showing Protected Areas (i.e. formal conservation areas such as National Parks) and Conservation Areas (e.g. conservancies and community forests) in the Zambezi and Kavango East Region of Namibia and across the neighbouring KAZA TFCA countries. Note that the PA labels are given in Table 7 and Table 8.

Description

Many Protected Areas and Conservation Areas that fall within Zambezi-Kavango East Region and across the larger landscape of the KAZA TFCA countries (Figure 10, Table 7 and Table 8).

The formal Protected Areas in the Zambezi-Kavango East Region are mostly comprised of National Parks and include: Mudumu National Park (118) and Nkasa Rupara National Park (80) with the Caprivi / Zambezi State Forest (117), in the Zambezi Region; as well as Bwabwata National Park (50, 51, 52 & 82), Khaudum National Park (81), Mangetti National Park (49) and Popa National Park (48) in the Kavango East Region. Cumulatively, the National Parks in the Zambezi-Kavango East Region protect a total of 1,158,395 ha (or 25.6%) of the planning domain (Table 15, “Overall Priorities” Section).

Table 7: Formal Protected Areas in the Zambezi and Kavango East Region of Namibia and across the neighbouring KAZA TFCA countries.

Name	Type	Country	Area (ha)	Label
Luengue-Luiana	National Park	Angola	4,464,342	59
Mavinga	National Park	Angola	4,102,087	121
Sub-Total Angola			**8.566.429 ha**	
Maikaelo	Forest Reserve	Botswana	53,666	45
Chobe	Forest Reserve	Botswana	147,279	76
Kasane FR and Extension	Forest Reserve	Botswana	80,503	79
Nxai Pan	National Park	Botswana	248,734	71
Chobe	National Park	Botswana	1,056,047	78
Tsodilo Hills	World Heritage Site	Botswana	18,522	47
Sub-Total Botswana			**1.604.750 ha**	
Caprivi (Zambezi)	Forest Reserve	Namibia	132,250	117
Popa	National Park	Namibia	41	48
Mangetti	National Park	Namibia	41,567	49
Bwabwata (Multiple-Use Area)	National Park	Namibia	404,852	50
Bwabwata (Buffalo Core Area)	National Park	Namibia	62,674	51
Bwabwata (Mahango)	National Park	Namibia	24,485	52
Nkasa Rupara	National Park	Namibia	31,902	80
Khaudum	National Park	Namibia	383,798	81
Bwabwata (Kwando Core Area)	National Park	Namibia	135,423	82
Mudumu	National Park	Namibia	72,015	118
Sub-Total Namibia			**1.289.007 ha**	
Malanda	Forest Reserve (Local)	Zambia	17,171	2
Nanga	Forest Reserve (Local)	Zambia	1,572	18
Machili	Forest Reserve (Local)	Zambia	49,272	58
Kanyanga	Forest Reserve (Local)	Zambia	2,156	60
Lusu	Forest Reserve (National)	Zambia	1,430	3
Chiobe	Forest Reserve (National)	Zambia	984	4
Masese	Forest Reserve (National)	Zambia	61,504	5
Samatela	Forest Reserve (National)	Zambia	6,333	6
Nanyota	Forest Reserve (National)	Zambia	3,401	7
Zungubo	Forest Reserve (National)	Zambia	913	8
Kasenu	Forest Reserve (National)	Zambia	1,036	9
Lumino	Forest Reserve (National)	Zambia	3,322	10
Nanduka	Forest Reserve (National)	Zambia	1,017	11
Kayumbwana	Forest Reserve (National)	Zambia	3,125	12
Kateme	Forest Reserve (National)	Zambia	2,757	13
Nangombe	Forest Reserve (National)	Zambia	1,722	14
Sijulu	Forest Reserve (National)	Zambia	2,949	15
Kazunamena	Forest Reserve (National)	Zambia	6,143	16
Shokosha	Forest Reserve (National)	Zambia	3,800	17

Name	Type	Country	Area (ha)	Label
Sikabenga	Forest Reserve (National)	Zambia	4,716	19
Nampiu	Forest Reserve (National)	Zambia	29,063	20
Lilengo	Forest Reserve (National)	Zambia	2,181	21
Shelangu East	Forest Reserve (National)	Zambia	12,610	22
Shelangu West	Forest Reserve (National)	Zambia	11,576	23
Ngonye Falls	National Park	Zambia	1,785	24
Sioma Ngwezi	National Park	Zambia	503,121	57
Nachitwe	Overlap (GMA/FR-Loc)	Zambia	70,575	26
Sub-Total Namibia			**806.233 ha**	
TOTAL			**12.266.419 ha**	

Table 8: Conservation Areas in the Zambezi and Kavango East Region of Namibia and across the neighbouring KAZA TFCA countries.

Name	Type	Country	Area (ha)	Label
Moremi	Game Reserve	Botswana	488,465	68
NG/5	Hunting Reserve	Botswana	96	1
NG/13	Wildlife Management Area	Botswana	286,973	27
NG/16	Wildlife Management Area	Botswana	134,382	28
NG/15	Wildlife Management Area	Botswana	120,310	29
NG/20	Wildlife Management Area	Botswana	165,235	30
NG/18	Wildlife Management Area	Botswana	174,881	31
NG/21	Wildlife Management Area	Botswana	22,974	32
NG/19	Wildlife Management Area	Botswana	17,041	33
NG/25	Wildlife Management Area	Botswana	60,323	34
NG/26	Wildlife Management Area	Botswana	174,090	35
NG/31	Wildlife Management Area	Botswana	21,751	36
NG/27A	Wildlife Management Area	Botswana	24,569	37
NG/17	Wildlife Management Area	Botswana	6,371	38
NG/32	Wildlife Management Area	Botswana	122,321	39
NG/27B	Wildlife Management Area	Botswana	15,869	40
NG/30	Wildlife Management Area	Botswana	95,067	41
NG/29	Wildlife Management Area	Botswana	184,878	42
NG/47	Wildlife Management Area	Botswana	168,598	43
NG/41	Wildlife Management Area	Botswana	220,004	44
CH/11	Wildlife Management Area	Botswana	87,806	46
NG/4	Wildlife Management Area	Botswana	252,248	55
NG/14	Wildlife Management Area	Botswana	225,256	64
NG/22	Wildlife Management Area	Botswana	57,765	65
NG/24	Wildlife Management Area	Botswana	58,768	66
NG/23	Wildlife Management Area	Botswana	36,046	67
NG/34	Wildlife Management Area	Botswana	86,303	69
NG/33	Wildlife Management Area	Botswana	6,124	70
NG/49	Wildlife Management Area	Botswana	112,799	72

Name	Type	Country	Area (ha)	Label
CT/1	Wildlife Management Area	Botswana	379,192	73
NG/42	Wildlife Management Area	Botswana	290,999	74
NG/43	Wildlife Management Area	Botswana	343,821	75
CH/12	Wildlife Management Area	Botswana	150,090	77
Sub-Total Botswana			**4.591.413 ha**	
Shamungwa	Communal Conservancy	Namibia	5,346	53
Bamunu	Communal Conservancy	Namibia	55,600	54
Kwandu	Communal Conservancy	Namibia	18,571	93
Mayuni	Communal Conservancy	Namibia	15,115	94
Mashi	Communal Conservancy	Namibia	29,671	95
N#a Jaqna	Communal Conservancy	Namibia	912,109	97
Joseph Mbambangandu	Communal Conservancy	Namibia	4,162	98
Impalila	Communal Conservancy	Namibia	7,251	99
Kasika	Communal Conservancy	Namibia	14,663	100
Muduva Nyangana	Communal Conservancy	Namibia	61,486	102
Ondjou	Communal Conservancy	Namibia	872,017	103
Sikunga	Communal Conservancy	Namibia	28,665	104
Balyerwa	Communal Conservancy	Namibia	22,517	105
Wuparo	Communal Conservancy	Namibia	18,964	106
Kabulabula	Communal Conservancy	Namibia	8,910	107
Sobbe	Communal Conservancy	Namibia	39,078	108
Dzoti	Communal Conservancy	Namibia	28,716	109
Nakabolelwa	Communal Conservancy	Namibia	11,390	115
Lusese	Communal Conservancy	Namibia	20,678	116
Salambala	Communal Conservancy	Namibia	93,003	120
Kapinga kaMwalye	Communal Conservancy	Namibia	126,874	124
Sikanjabuka	Community Forest	Namibia	4,158	83
Masida	Community Forest	Namibia	19,679	84
Lubuta	Community Forest	Namibia	17,024	85
Kwandu	Community Forest	Namibia	21,171	86
Ncumcara	Community Forest	Namibia	15,866	87
Ncute	Community Forest	Namibia	11,841	88
Ncamagoro	Community Forest	Namibia	25,557	89
Mbeyo	Community Forest	Namibia	40,949	90
Hans Kanyinga	Community Forest	Namibia	27,910	91
M'Kata	Community Forest	Namibia	85,191	92
Zilitene	Community Forest	Namibia	8,182	110
Sachona	Community Forest	Namibia	12,080	111
Likwaterera	Community Forest	Namibia	14,062	112
Cuma	Community Forest	Namibia	11,593	113
Gcwatjinga	Community Forest	Namibia	31,760	114
Muduva Nyangana	Community Forest	Namibia	68,977	123
Nyae Nyae	Conservancy and Community Forest	Namibia	899,101	96

Name	Type	Country	Area (ha)	Label
George Mukoya	Conservancy and Community Forest	Namibia	48,640	101
Sub-Total Namibia			**3.758.530 ha**	
West Zambezi	Game Management Area	Zambia	1,839,879	63
Mulobezi	Game Management Area	Zambia	350,143	119
Ngonye Falls	Proposed	Zambia	1,029	25
Situwa Corridor	Proposed	Zambia	10,212	61
Nyawa (Simalaha)	Proposed	Zambia	57,440	62
Simalaha	Proposed	Zambia	182,349	122
Sub-Total Zambia			**2.441.051 ha**	
Matetsi	Safari Area	Zimbabwe	106,606	56
Sub-Total Zimbabwe			**106.606 ha**	
TOTAL			**10.897.601 ha**	

Overview of mapping methods and incorporation into planning

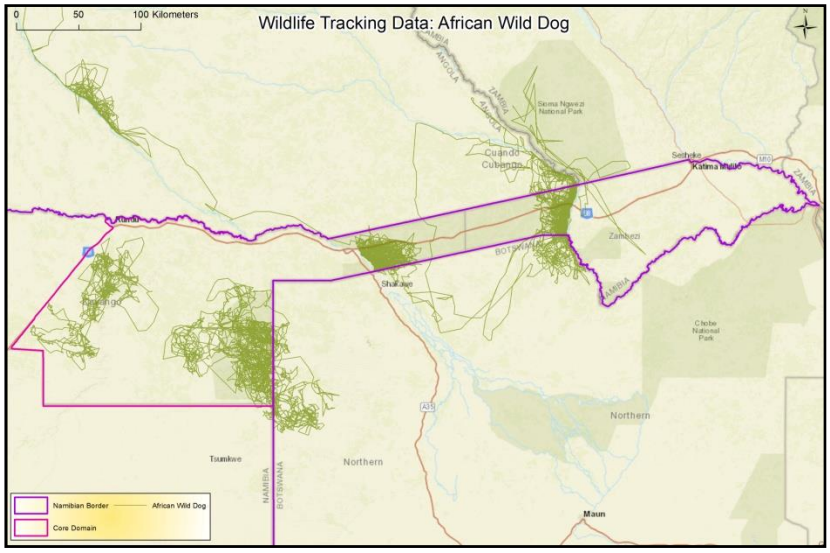
The following are key points in the mapping methodology:

- A key planning task is to ensure alignment across Protected Areas (PAs) between neighbouring countries in the KAZA TFCA. This was done in MARXAN by setting a 100% target for all PAs adjacent to the Zambezi-Kavango East planning domain. This target enables strong edge matching and spatial alignment or joining.
- Formal Protected Areas within the planning domain (e.g. the National Parks) were hardwired into the conservation planning results, as "Conserved". This is a planning category within MARXAN which guarantees that the PAs are consistently part of the identified conservation network.
- Conservation Areas within the planning domain (e.g. conservancies, fish reserves and communal forests) were not fixed into the MARXAN outcomes as "Conserved", but rather incorporated as conservation features with varying targets. This approach was necessary for two reasons: (i) not all conservancies can be considered protected as these are zoned multi-use landscapes (e.g. there are settlement and agricultural zones); and (ii) to investigate the conservancy network and identify areas of particular importance. In this case, for alignment with CBNRM projects. Therefore, Conservation Areas cannot be fixed in a priori as "Conserved" (as are PAs).
- The map shows the range of different PAs and Conservation Areas across the broader landscape. This does not imply strong conservation outcomes for these areas. Further, full resolution of boundary issues, overlaps and alignments were beyond the scope of this analysis, especially outside of the core planning domain.
- For completeness of the map, various "in progress" or proposed Protected Areas (e.g. the Caprivi/ Zambezi State Forest) and Conservation Areas are included. The treatment of these areas, such as the proposed forest reserves and emerging conservancies, are dealt with in more detail in the Section "Opportunities: Conservancies, Conservation Zones and Communal Forests".

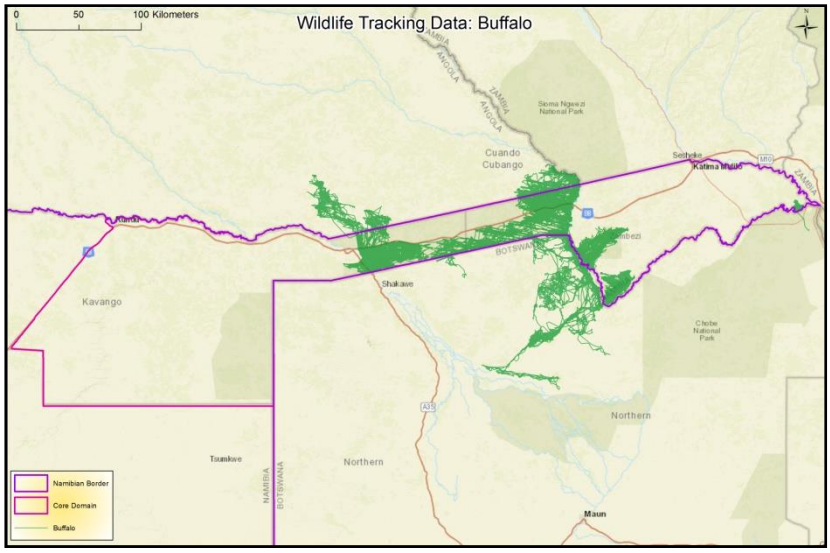
Data providers

The data is from the Peace Parks KAZA dataset provided by WWF.

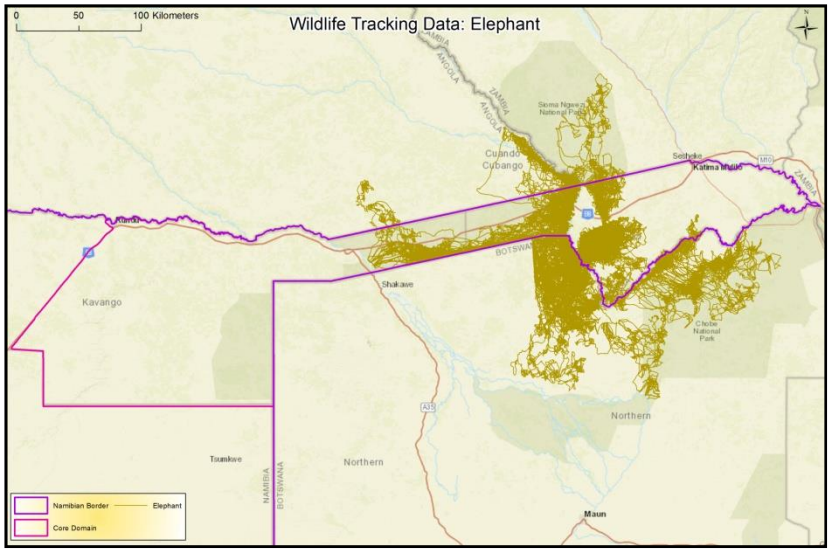
Key Species Data – Tracking and Survey Data



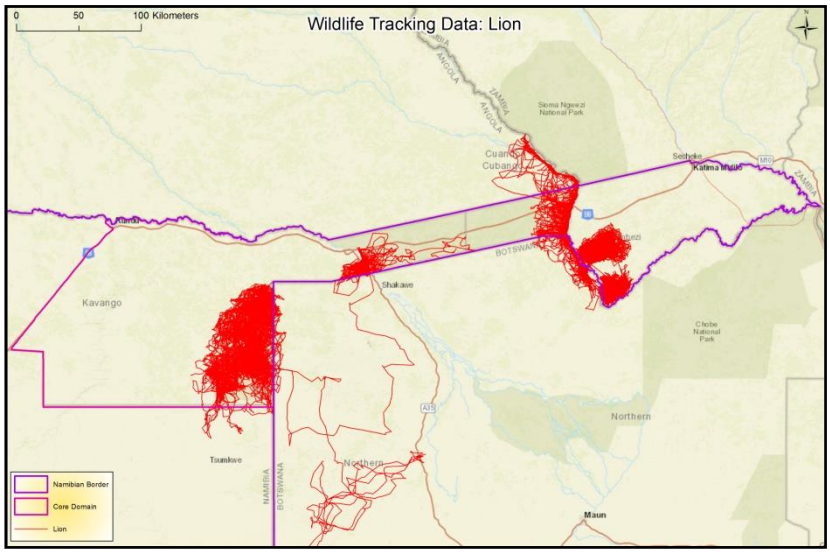
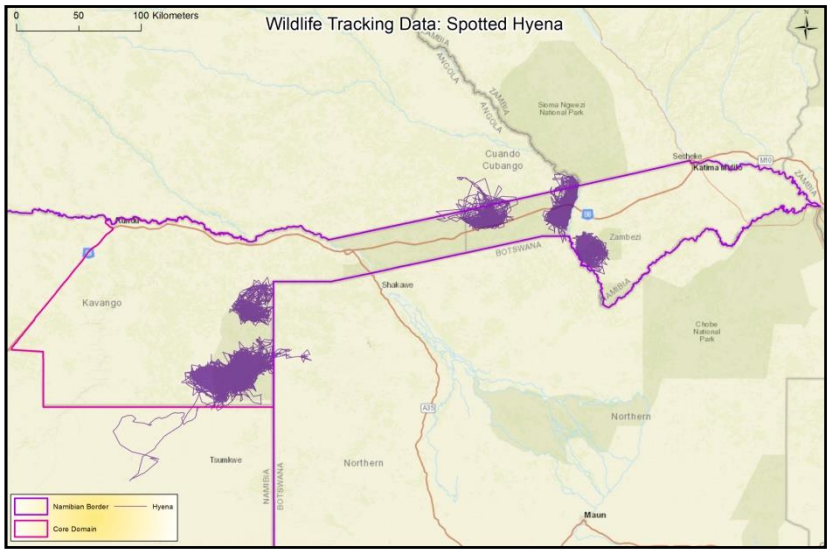
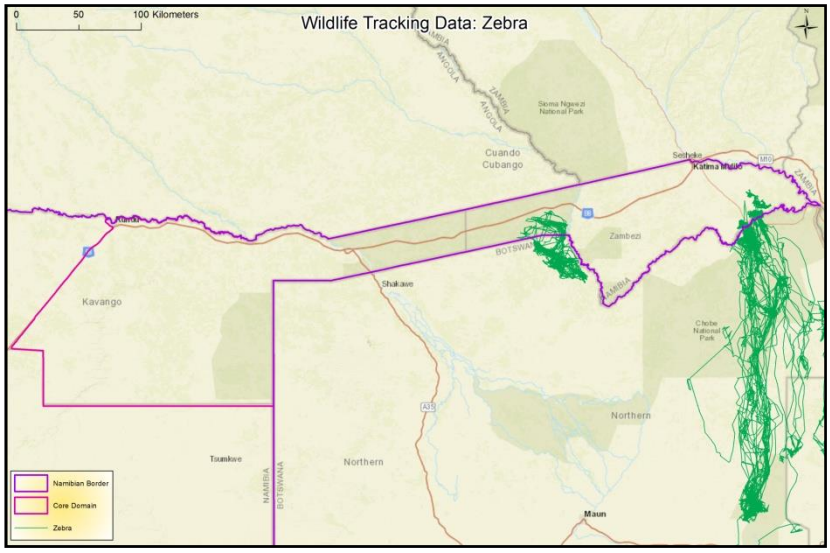
11a) African Wild Dog – 14 separate groups from the WWF tracking data.

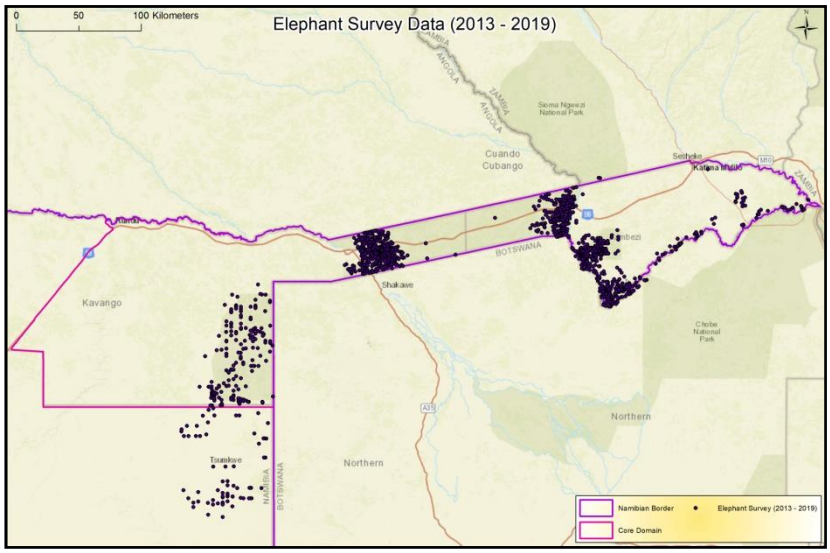


11b) Buffalo - 42 separate groups from the WWF tracking data.



11c) Elephant - separate groups from the WWF tracking data.

	11d) Lion - 39 separate groups from the WWF tracking data.
	11e). Spotted Hyena - 20 separate groups from the WWF tracking data.
	11f) Plains Zebra - 14 separate groups from the WWF tracking data.



11g) MEFT Elephant survey data - All 1,983 aerial survey data records were used (2013, 2015 & 2019).

Figure 11: GPS collar tracking of top predator and iconic species, African Wild Dog, Buffalo, Hyena, Lion, Elephant and Zebra (2010 – 2019) for the Kavango East - Zambezi Regions, with additional MEFT aerial survey data for Elephant (2013, 2015 & 2019).

Description

Mammal movements were derived from collar data on six individual species for the 2010 – 2019 period, namely: African Wild Dog (*Lycaon pictus*), Buffalo (*Syncerus caffer*), Elephant (*Loxodonta africana*), Spotted Hyena (*Crocuta Crocuta*), Lion (*Panthera leo*) and Zebra (*Equus quagga*) (Figure 11). Five of these six iconic species are threatened in terms of the 'IUCN Red List of Threatened Species' (accessed 14 December 2021). These include the African Wild Dog (Endangered), African Savanna Elephant (Endangered), Buffalo (Near Threatened), Lion (Vulnerable) and Plains Zebra (Near Threatened). Although the Spotted Hyena is classified as Least Concern, its population numbers are declining, especially outside PAs and it is a keystone species for landscape ecological function.

The tracking data show high levels of connectivity between the Protected Areas and adjacent regions, with a number of species moving widely within Namibia's Zambezi-Kavango East Region and neighbouring countries. Additional Elephant aerial survey data from MEFT was used for the periods 2013, 2015 and 2019.

Overview of data sources and incorporation into planning

The map was compiled by Dr Stephen Holness from WWF tracking collar data and the MEFT aerial surveys data (2013, 2015, 2019).

Each species or feature was included as a separate biodiversity feature in the conservation planning process, with a target as described in the targets section (Table 4).

Additional Species Distribution Data – Point Data

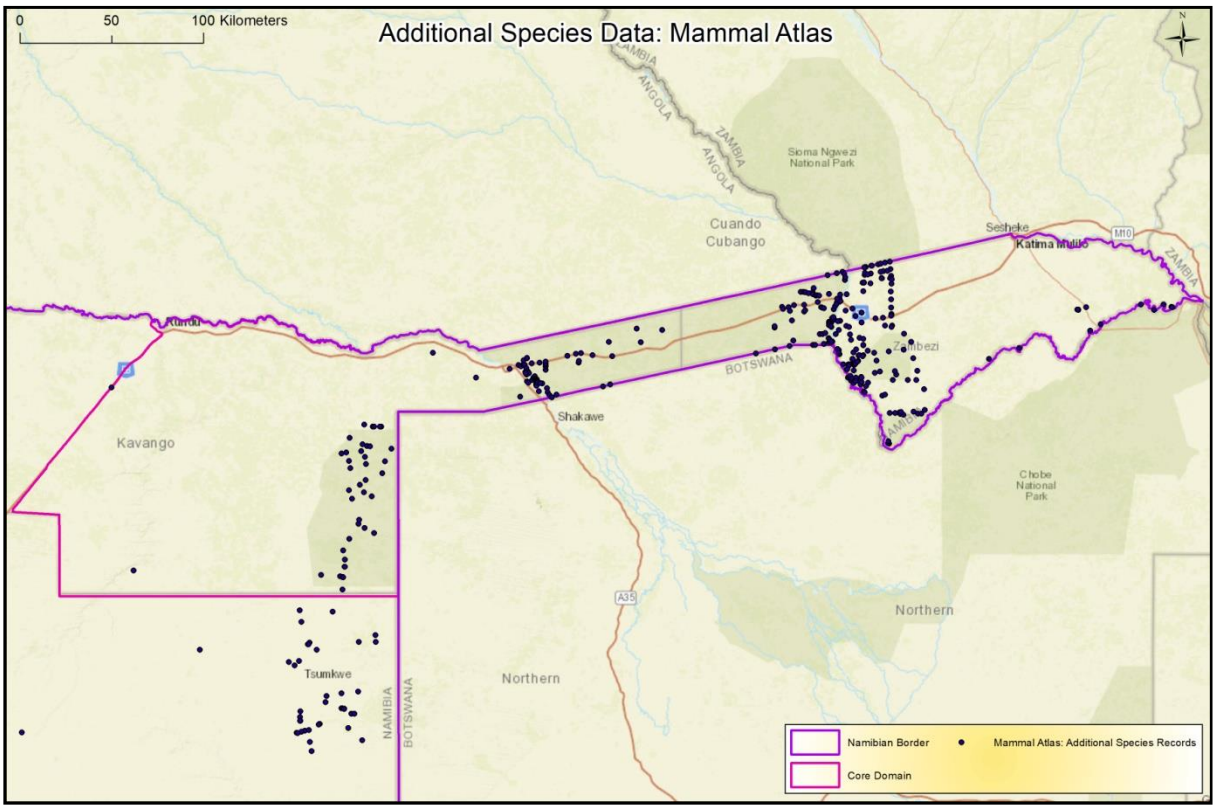


Figure 12. Map showing additional mammal species distribution records in point form. (Note: The map shows records for all species, but each species was separately included in the MARXAN analysis).

Description

Figure 12 shows additional mammal species distribution data. The point data constitutes 539 records of interest from within the planning domain (Table 9).

Table 9. List of additional mammal species distribution data

Common Name	Feature ID	Common Name	Feature ID
Aardwolf	66	Hyaena, Spotted	77
Badger, Honey	67	Jackal, Black-backed	78
Caracal	68	Jackal, Side-striped	79
Cat, African Wild	69	Leopard	80
Cheetah	70	Lion	81
Civet	71	Mongoose, Banded	82
Elephant	65	Mongoose, Dwarf	83
Fox, Bat-eared	72	Mongoose, Selous's	84
Fox, Cape	73	Mongoose, Slender	85
Genet, Common large-spotted	74	Otter, Cape Clawless	86
Genet, Small-spotted	75	Polecat, Striped	87
Hyaena, Brown	76	Wild Dog	88

Overview of data sources and incorporation into planning

The map was compiled by Dr Stephen Holness from point data sourced from Namibian Atlas of Citizen Science records (http://www.the-eis.com/atlas/). Each species was included as a separate biodiversity feature; and coded as either present or absent. Targets were then set against the total number of planning units, where a species was present. Certain species were excluded where there were too few records (e.g. Serval had only two records).

Ecological Processes – Wildlife Dispersal Areas (WDA) and Broad International Corridors

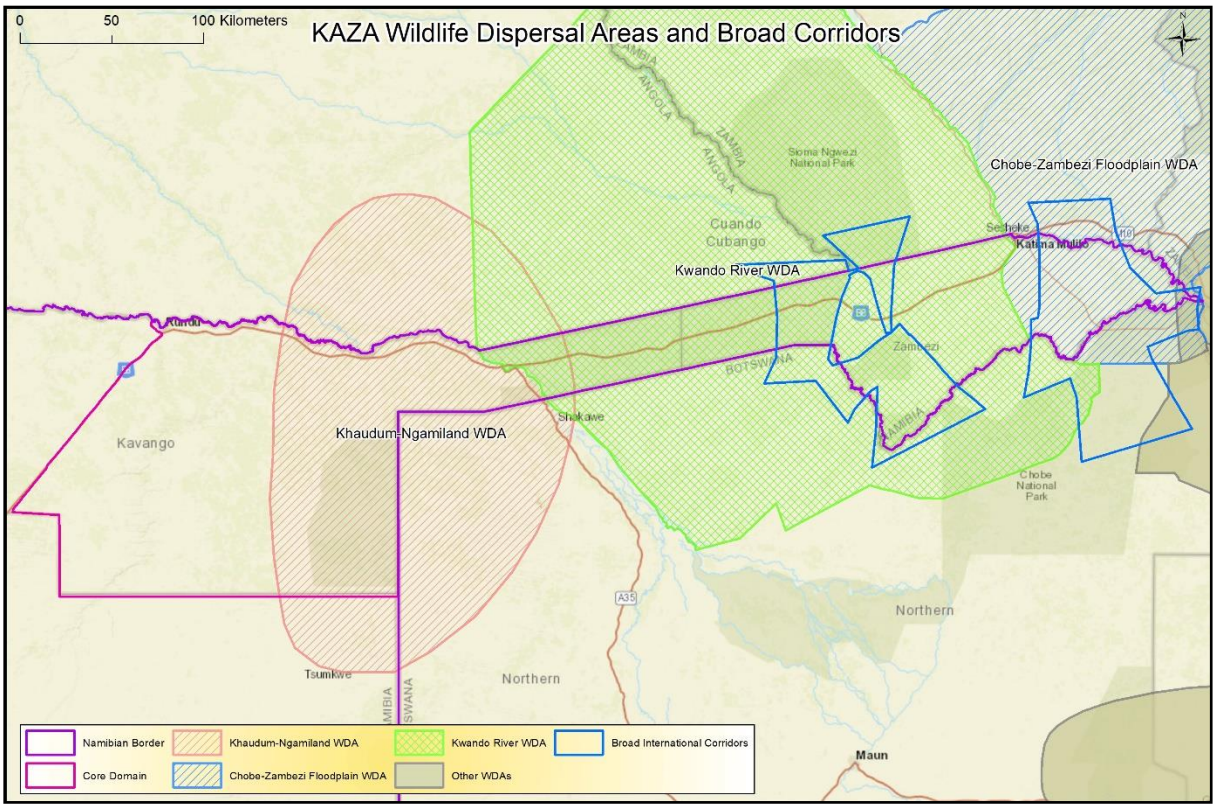


Figure 13: Map of the three KAZA TFCA wildlife dispersal areas that overlap the planning domain. The identified broad international corridors are also shown.

Description

The wildlife dispersal areas (WDA) are large-scale ecological process areas (Figure 13). There are six WDA or wildlife corridors of national and international importance within the KAZA TFCA. Of the six, three fall across the planning domain, from west to east: Khaudum-Ngamiland, Kwando River and Chobe-Zambezi Floodplain WDAs. These WDAs secure landscape connectivity for wildlife movement patterns, large river and wetland systems; and other critical ecological processes. In addition, some broad international wildlife corridors have been identified in the Zambezi region (outlined in blue on Figure 13). The wildlife corridors effectively link eight national parks across the KAZA region, all in neighbouring countries to each other, with Namibia's Zambezi-Kavango East being a key passageway.

The Khaudum-Ngamiland WDA is situated in Kavango East, within the eastern half of the region, extending into Botswana to the east and Angola to the north. It therefore provides passage from

Khaudum National Park in the south to Luengue-Luiana National Park in Angola, to the north; and also eastward to Bwabwata National Park, along the former Caprivi Strip.

The Kwando River WDA overlaps most of the Zambezi Region. Transboundary borders are unfenced, allowing the free movement of elephant from Chobe up along the Kwando River, in the Mudumu and Bwabwata National Parks of Namibia, into Luengue-Luiana National Park in Angola and into Sioma-Ngwezi National Park in Zambia.

The Chobe-Zambezi Floodplain WDA falls to the far east of the planning domain, linking Botswana in the south and east, to Zambia in the north. It covers the eastern Zambezi Floodplain, with Lake Liambezi to the west supporting floodplain and wetland habitat important for elephant, buffalo and zebra. The corridor comprises portions of seven conservancies, including Salambala, Nakabolelwa, Lusese, Kabulabula, Kasika, Impalila and Sikunga**.**

Overview of data sources and incorporation into planning

The existing mapped wildlife dispersal areas (WDAs) and the broad international corridors were used based on data provided by WWF for this project (WWF, 2020). The WDAs and broad corridors that overlapped the planning domain were each incorporated into the systematic conservation plan as single features. The targets set are described in the target section (Table 4).

Ecological Processes – Zambezi Wildlife Corridors

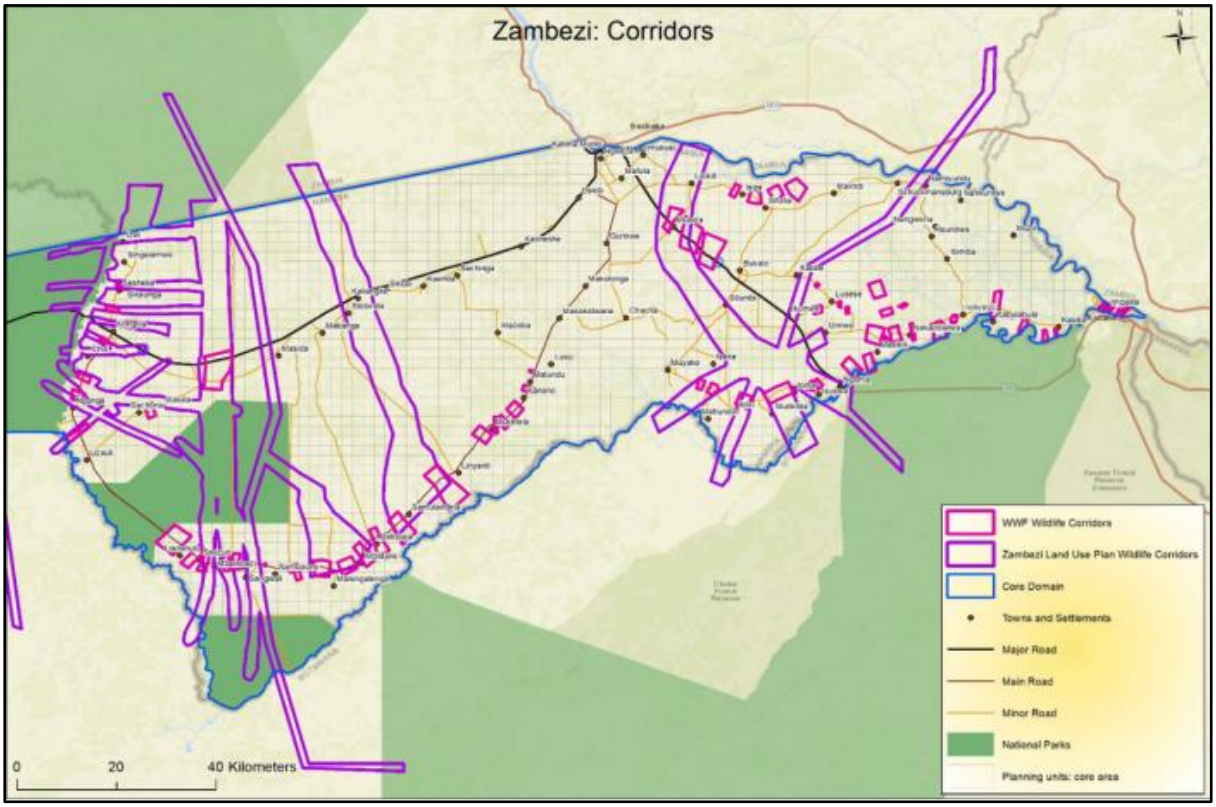


Figure 14: Local level wildlife corridors have been mapped at a fine scale (Ministry of Lands and Resettlement, 2015; WWF, 2020), referred to as the WWF Wildlife Corridors and the Zambezi Land Use Plan Wildlife Corridors.

Description

Local level wildlife corridors have been mapped at a fine scale for the Zambezi Region (Ministry of Lands and Resettlement, 2015; WWF, 2020), referred to as the WWF Wildlife Corridors and the Zambezi Land Use Plan Wildlife Corridors (Figure 14). These corridors are closely associated with the wildlife conservancies (see Figure 26). The Zambezi Land Use Plan Wildlife Corridors are situated mostly in the western and eastern portions of the region connecting National Parks and other Protected Areas in Namibia and in adjacent countries. The smaller and more specifically identified WWF Wildlife Corridors on the other hand were delineated based on observed wildlife routes across roads and through farmland areas.

Overview of data sources and incorporation into planning

The existing local level wildlife corridors were based on data provided by WWF for this project (Ministry of Lands and Resettlement, 2015; WWF, 2020). The corridors that overlapped the planning domain, but were outside of Protected Areas, were each incorporated into the systematic conservation plan as single features. The targets set are described in the target section (Table 4).

Ecological Processes – Rivers and Wetlands

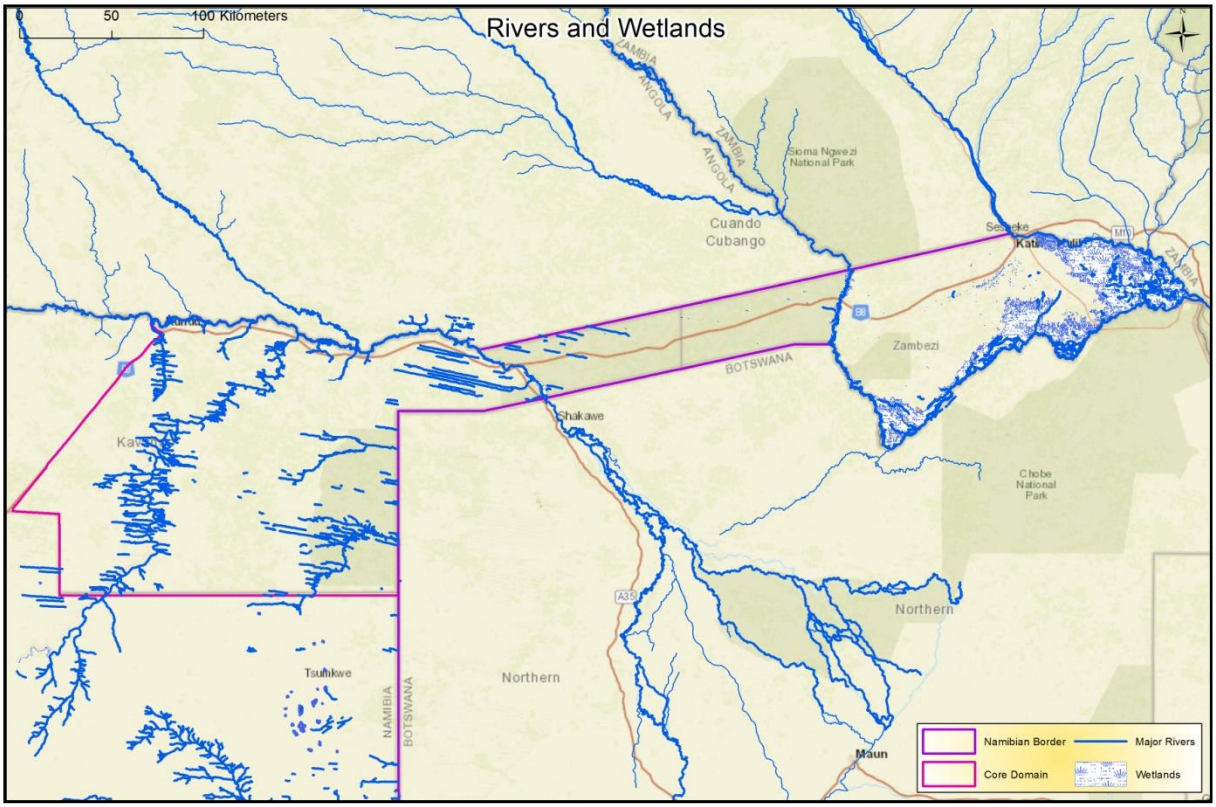


Figure 15: Ecological (hydrological) process areas represented by rivers and wetlands (Note: This map is a slightly generalized version of freshwater resources and is for illustrative purposes only).

Description

The freshwater ecosystems of the region, namely rivers and wetlands (pans, swamps and floodplains), were sourced from topocadstral maps produced by Namibian Surveys and Mapping (Figure 15). Major rivers and associated drainage systems of Kavango East comprise Cubango (Kavango) River, along its

northern boundary, and its tributary Omtaka River. Drainage systems in the Okavango Catchment, around Khaudum NP, are also important hydrological process area corridors. The Kwando, Linyanti, Chobe and Zambezi rivers flow through the Zambezi Region. Swamps in Zambezi are extensive, occurring along the Zambezi-Chobe Floodplains, including Lake Liambezi, and along the Kavango River into Kavango East.

Overview of data sources and incorporation into planning

The base topocadastral data layers of freshwater features were produced by Namibia Surveys and Mapping. The freshwater ecosystems map is comprised of a major international rivers layer, a Namibian rivers layer, and three wetland layers (pans, swamps, lakes). These were incorporated into the systematic conservation plan as process areas with a target as described in the targets section (Table 4). Map data provided by WWF.

Ecological Processes – Zambezi Flood Process Areas or Flood Risk Areas

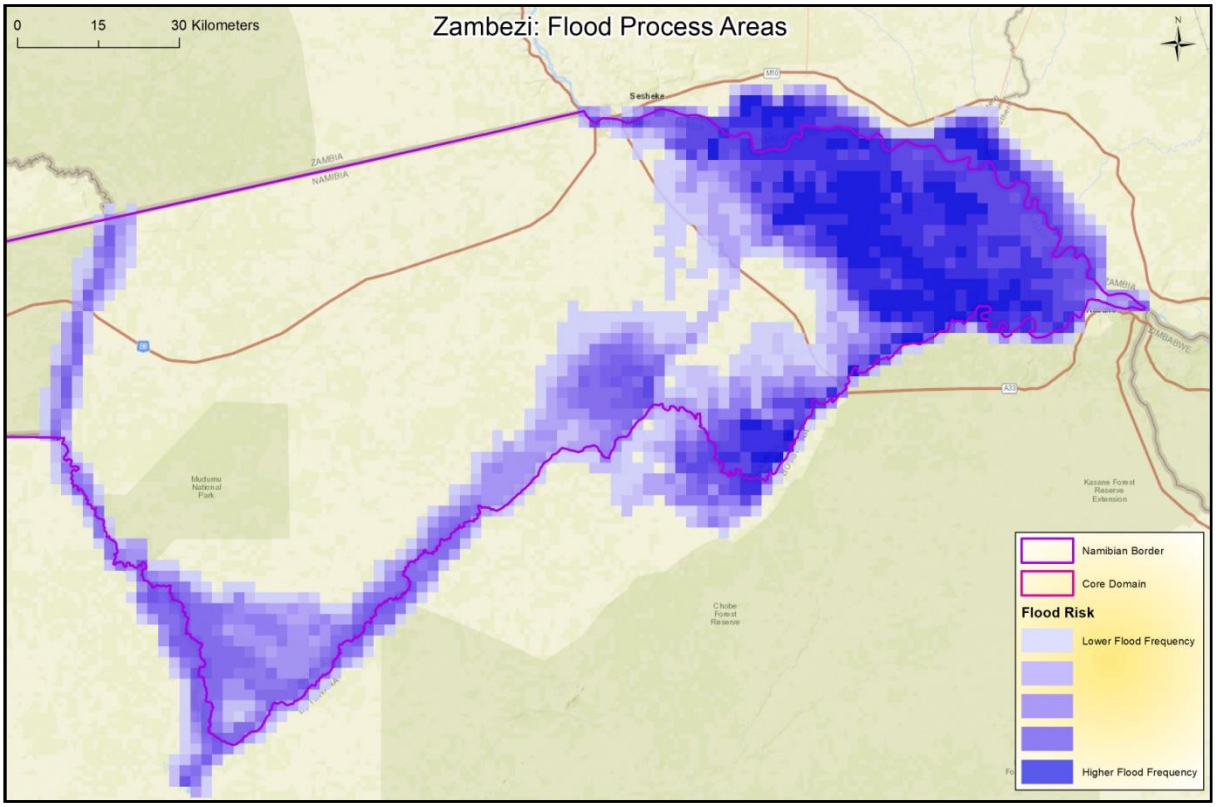


Figure 16: Zambezi flood risk areas.

Description

The flood risk modelling data was used to identify key floodplains that need to be maintained to sustain rivers and wetlands; and where human settlement should be avoided (Figure 16). Flooding, especially in the eastern Zambezi Region around the Zambezi and Chobe rivers, takes place on an annual basis resulting in large areas that are incompatible with settlement expansion or future development. The layer therefore improved the coverage of floodplain related processes.

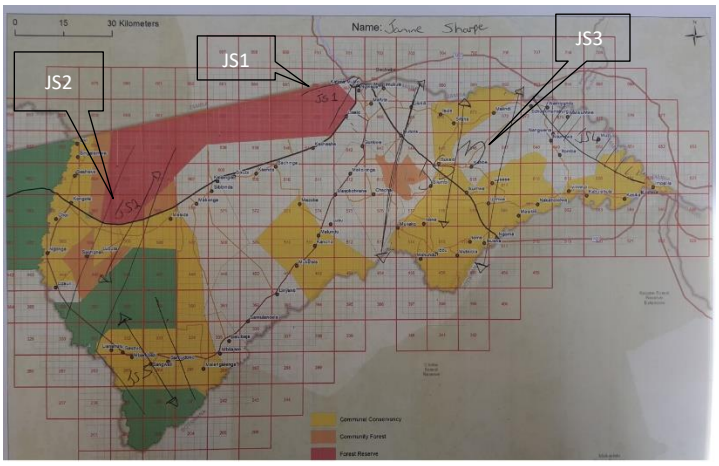
Overview of data sources and incorporation into planning

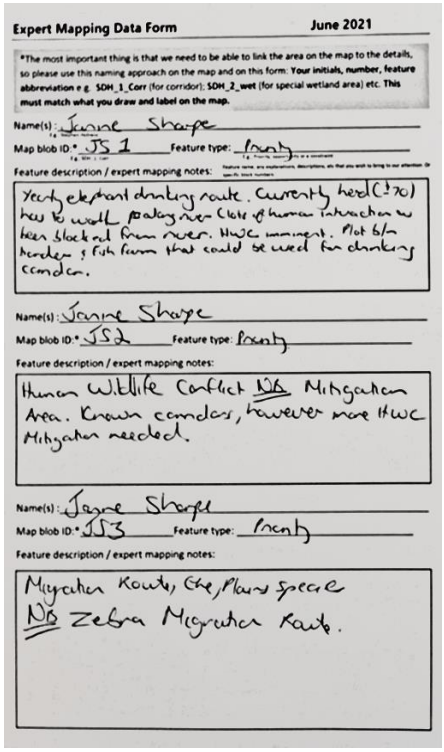
The map was based on the Caprivi flood assessment (Nathanael and Mendelsohn, 2013). The raw data was converted to a 0-10 flood risk categorization, based on quantiles, after removing no data and non-valid categories. An aggregated score for each planning unit was then done based on the sum of all pixel scores in a unit. The "Flood process" units are arbitrary; but allow the assessment to target highest frequency flood areas.

A total flood risk score was calculated for each planning unit. Targets were set against the total cumulative score for all planning units to ensure that areas of highest value were prioritized in the selection process. Targets were set against the aggregated "flood process" value for the whole planning area (Table 4).

Map data provided by WWF was sourced from Nathanael and Mendelsohn (2013).

Expert Mapped Features – Opportunities and Constraints





Expert Mapping Data Form June 2021

*The most important thing is that we need to be able to link the area on the map to the details, so please use this naming approach on the map and on this form: **Your initials, number, feature abbreviation** e.g. **SDH_1_Corr** (for corridor); **SDH_2_wet** (for special wetland area) etc. **This must match what you draw and label on the map.**

Name(s): Janine Sharpe
Map blob ID:* JS 1 Feature type: Poachy
Feature description / expert mapping notes:
Year elephant drinking route. Currently herd (±70) has to walk along near close of human interaction as been blocked from river. HWC imminent. Plot b/w herders & fish farm that could be used for drinking corridor.

Name(s): Janine Sharpe
Map blob ID:* JS2 Feature type: Poachy
Feature description / expert mapping notes:
Human Wildlife Conflict NB Mitigation Area. Known corridors, however more HWC Mitigation needed.

Name(s): Janine Sharpe
Map blob ID:* JS3 Feature type: Poachy
Feature description / expert mapping notes:
Migration Route, Elephant, Plains Species
NB Zebra Migration Route.

Figure 17: An example of expert mapped features (Top) with the associated metadata form (Bottom) provided during the expert mapping workshop.

Description

A mapping session was held to acquire a range of expert mapped conservation features, which either represented opportunities or constraints. These features range from ecosystems, species and ecological processes (corridors); to conservation opportunities (e.g. alignments with emerging conservation actions), or constraints (e.g. areas with limited opportunities for conservation actions). An example of such expert data outputs is provided in Figure 17 above. Some experts mapped features and provided metadata during the workshop, while others undertook this remotely and submitted the data subsequent to the June 2021 workshop.

Mapping inputs were obtained from:

- John Mendelsohn
- Lisa Hansen
- Carol Murphy
- Janine Sharpe
- Pauline Lindeque
- Aldrin Mwilima
- Bargrey Kapelwa
- Dominic Muema
- Britta Hackenberg

The expert mapped data is presented in Table 10 and Figure 18 to Figure 22 below.

Table 10: Expert mapped data provided by the experts, with feature number, name and additional information.

Feature No	Feature Name	Expert	Additional information
102	**Cuando Floodplains**	John Mendelsohn	The Cuando and its floodplain is a linear oasis, providing water to many animals and people along its length. This value is particularly high during the dry season. Much of the actual floodplain of *Phragmites* and other macrophytes seems to be permanently wet, and is probably not very rich in nutrients, fish and other biomass and biodiversity. However, the Cuando River's main channel does move, creating wetter and drier areas which will stimulate biological production. The floodplain vegetation will also be an important refuge for many aquatic birds and other animals.
101	**Cuando Floodplain 10 km buffer**	John Mendelsohn	Together with the nearby floodplain, this buffer supports much wildlife and livestock, and many people. Riverine forest adds to the area's diversity and value. Lodges on the margins of the swamp contribute significantly to local incomes and economic activity. The value of this zone is largely a consequence of its proximity to the floodplain. As a consequence of being next to the floodplain, soils to its west are considerably more fertile than those elsewhere in the buffer area. This quality adds value to the buffer areas.
103	**Cubango Okavango Valley and River**	John Mendelsohn	The river is the main source of water for the Okavango Delta. Along its length the river also supports a variety of aquatic life. Its floodplains are important recruitment areas for fish, aquatic invertebrates, birds etc. Many local residents use the river water for their domestic needs and for their livestock. Where they remain, riverine woodlands support many bird species and some wildlife. Islands in the Andara area are revered burial grounds for Hambukushu leaders. Many lodges along the river add to its economic value and add to local incomes and economic activity.
104	**Dunes and Interdunes**	John Mendelsohn	This is the mosaic of taller teak and *Burkea* woodland on the deep dune sands dunes and *Acacia* and *Combretum* woodlands of more loamy soils in the interdunes. The teak and Burkea woodlands are degraded into shrubland by frequent hot fires while crop farming and heavy grazing pressures impinge on the interdunes. Wildlife in the area is naturally at low densities but a considerable

Feature No	Feature Name	Expert	Additional information
			diversity of large mammals and other charismatic species is present.
105	**Gunkwe Mulapos**	John Mendelsohn	This grassland unit is limited to the braided system of drainage lines which run through the extensive Kalahari sand deposits running south-west from Katima Mulilo. Ephemeral pans of water that develop after good rains support good numbers and a good variety of wetland species, including at least one rare killifish (Tweddle, D. 2007. Nothobranchius kafuensis. The IUCN Red List of Threatened Species 2007: e.T63384A12654667. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T63384A12654667.en. Downloaded on 09 July 2021).
106	**Impalila Island**	John Mendelsohn	The basalt rocks that form Impalila Island provide an environment quite different from the rest of Caprivi. Many species of trees and plants occur nowhere else in Namibia. The island's high biodiversity therefore gives it high conservation value.
107	**Lake Liambezi Wetland Priority**	John Mendelsohn	Lake Liambezi is highly productive biologically because it is ephemeral. Being dry for years detracts from its value because people then perceive it to be defunct. It is the largest lake in Namibia and produces fish of considerable commercial value. As a breeding site for aquatic birds, it may well produce a high proportion of southern Africa's wetland birds. The lake is most productive immediately after it floods, after being dry for many years. Even when production declines the lake's marshlands are likely to be an important refuge for many aquatic birds and other animals.
108	**Linyanti Swamp**	John Mendelsohn	Much of Linyanti Swamp is ephemeral and productive for the same reasons as Liambezi. Its productivity is perhaps lower because it has surface water more often. However, the Linyanti River does move, creating wetter and drier areas. The Swamp will also be an important refuge for many aquatic birds and other animals. Lodges on the margins of the Swamp add to its economic value and to local incomes and economic activity.
109	**Maningimanzi woodlands**	John Mendelsohn	Like Impalila, these woodlands provide the only habitat for species rare in Namibia or that only occur further north in more tropical areas. This is a mosaic of woodlands and channels. Parts of the woodland are dense and tall forest.
110	**Zambezi floodplains**	John Mendelsohn	The broad area of occasionally inundated floodplains has relatively rich soils which support grazing lawns, aquatic plant communities and woodlands on islands of higher ground. Large herbivores occur here, and the ephemeral wetlands are likely to be important breeding grounds for fish, amphibians and aquatic birds. The floodplains attract tourists which sustain lodges and the incomes they provide to residents of the floodplains.
111	**LH 1 - Linyati Swamp and Balyerwa Conservancy**	Lise Hanssen	Connects lion dispersal routes between Ndumu and Nkasa Rupara National Parks, and between Namibia and Botswana. Broader links to Silinda Spillway and Okavango Delta. Also includes Lupola Island which is important for resident lions.
112	**LH 2 - Lion Range**	Lise Hanssen	Woodland Lion range from Nkasa Rupara National Park.

Feature No	Feature Name	Expert	Additional information
113	**LH 3 - Predator Connectivity**	Lise Hanssen	Woodland Lion, Spotted Hyaena, Wild Dog and Leopard connectivity between Sioma Ngwezi NP in Zambia and Mudumu landscape, possibly also broader linkages south and west to Botswana.
114	**LH 4 - Mdumu Lion Range**	Lise Hanssen	Extension of Mdumu Lion range. Is also a cheetah dispersal route through Mdumu landscape.
115	**LH 5 - Lion Connectivity**	Lise Hanssen	Lion connectivity between Nkasa Rupara NP and Chobe NP in Botswana.
116	**LH 6 - Priority Wetland**	Lise Hanssen	Should be a Ramsar site.
117	**LH 7 - Wild Dog Connectivity and Recovery**	Lise Hanssen	Wild Dog connectivity and recovery.
118	**CM1 - Livingstone Baobab Area**	Carol Murphy	Mbilajwe Village. Baobab that David Livingstone wrote about. Note: We need a community mapping exercise to map special woodland patches and important cultural sites.
119	**CMECF - Emerging Community Forest**	Carol Murphy	Emerging community forest around Katima Mulilo.
120	**JS1 - Elephant Drinking Route**	Janine Sharpe	Yearly Elephant drinking route. Current herd (+- 70) must walk along river with lots of human interaction as have been blocked from river. Human wildlife conflict imminent. Potential clear route next to fish farm and border.
121	**JS2 - Human Wildlife Conflict Mitigation Area**	Janine Sharpe	Important area for mitigating human wildlife conflict (HWC). Known corridor, however more HWC mitigation is needed.
122	**JS3 - Zebra Migration**	Janine Sharpe	Migration route for Elephant and plains species. Important Zebra migration route.
123	**JS4 - Floodplain - fish breeding**	Janine Sharpe	Floodplains - fish breeding grounds.
124	**JS5 - Park Linkage**	Janine Sharpe	Open up route between parks.
125	**PL 1 Kongola**	Pauline Lindeque	Opportunity to develop as a tourism supply hub / economic development / diversification hub.
126	**PL 2 Sibbinda**	Pauline Lindeque	Opportunity to develop as a tourism supply hub / economic development / diversification hub.
127	**PL 3 Wildlife Movement**	Pauline Lindeque	Key area for wildlife movement, but corridors are rapidly being blocked by development.

Feature No	Feature Name	Expert	Additional information
128	**PL 4 Riverine Forest**	Pauline Lindeque	Priority feature and possible constraint as Elephants may negatively impact Baobabs.
129	**MW1 Potential Fish Reserve**	Aldrin Mwilima	There are a number of channels that can be potential fish reserves. Important as there are no fish reserves around that area.
130	**Kap 1 Wildlife Introduction Opportunity**	Bargrey Kapelwa	Opportunities to introduce rare wildlife species. Community awareness programmes needed to avoid poaching.
131	**Kap 2 Fire Control Opportunity**	Bargrey Kapelwa	New fire cutlines are needed to control wildfire.
132	**Kap 3 Community Forest Products**	Bargrey Kapelwa	Community to have access for timber from state forest area as a benefit.
133	**DM1 - Lake Nyabezi Emerging Conservancy**	Dominic Muema	Emerging conservancy
134	**DM2 - Linyati Emerging Conservancy**	Dominic Muema	Emerging conservancy.
135	**DM3 - Kabbe Emerging Conservancy**	Dominic Muema	Emerging conservancy.
136	**DM4 - Nsudwa Emerging Conservancy**	Dominic Muema	Emerging conservancy.
137	**DM5 - Ikaba Emerging Conservancy**	Dominic Muema	Emerging conservancy.
138	**BHFR1 - Emerging Fish Reserve**	Britta Hackenberg	Emerging fish reserves.
139	**BHFR2 - Emerging Fish Reserve**	Britta Hackenberg	Emerging fish reserves.
140	**BHFR3 - Emerging Fish Reserve**	Britta Hackenberg	Emerging fish reserves.
141	**BHFR4 - Emerging Fish Reserve**	Britta Hackenberg	Emerging fish reserves.

Feature No	Feature Name	Expert	Additional information
142	**BHFR5 - Emerging Fish Reserve**	Britta Hackenberg	Emerging fish reserves.
143	**BHFR6 - Emerging Fish Reserve**	Britta Hackenberg	Emerging fish reserves.
144	**BHFR7 - Emerging Fish Reserve**	Britta Hackenberg	Emerging fish reserves.
145	**BHFR8 - Emerging Fish Reserve**	Britta Hackenberg	Emerging fish reserves.
146	**BHFR9 - Emerging Fish Reserve**	Britta Hackenberg	Emerging fish reserves.
147	**BHFR10 - Emerging Fish Reserve**	Britta Hackenberg	Emerging fish reserves.
148	**BHCF1 - Bukalo Corridor**	Britta Hackenberg	Potential corridor.
149	**BHCF2 - Malindi Corridor**	Britta Hackenberg	Potential corridor.

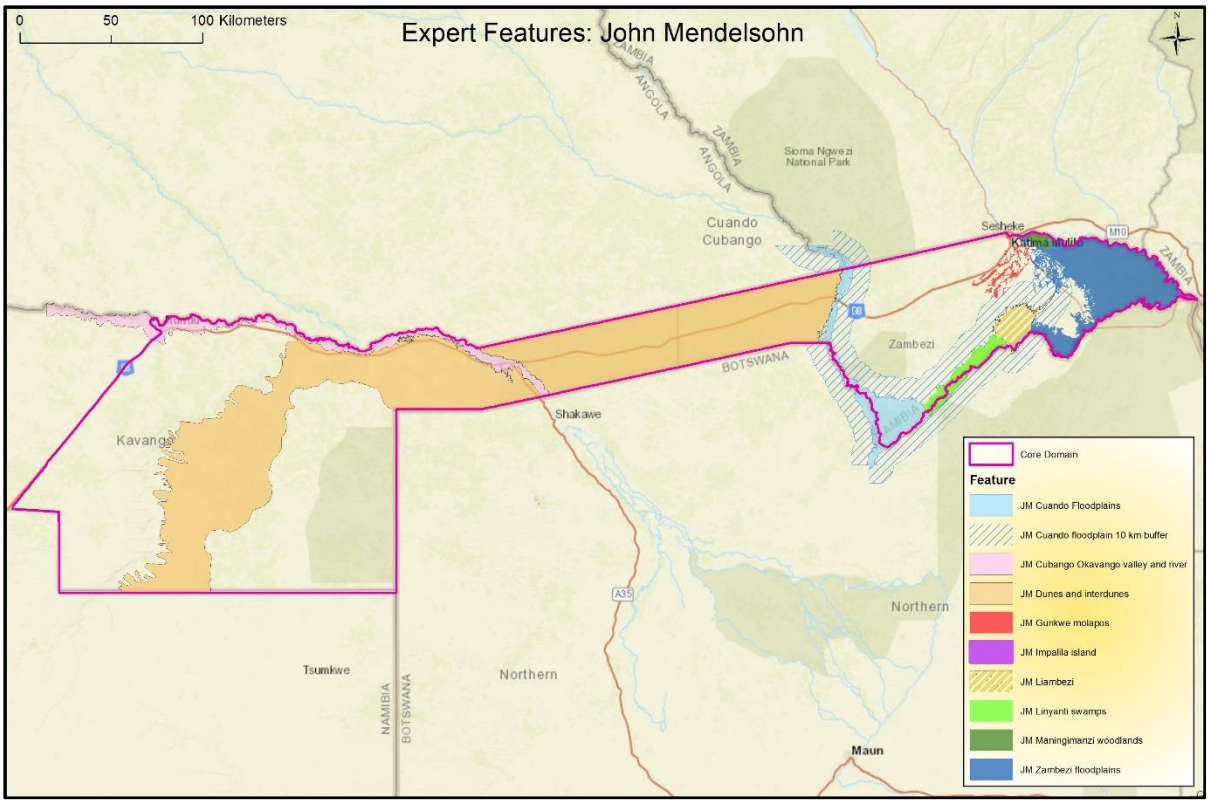


Figure 18: Expert mapped biodiversity features by John Mendelsohn, which includes a range of terrestrial and aquatic vegetation habitats / ecosystem types.

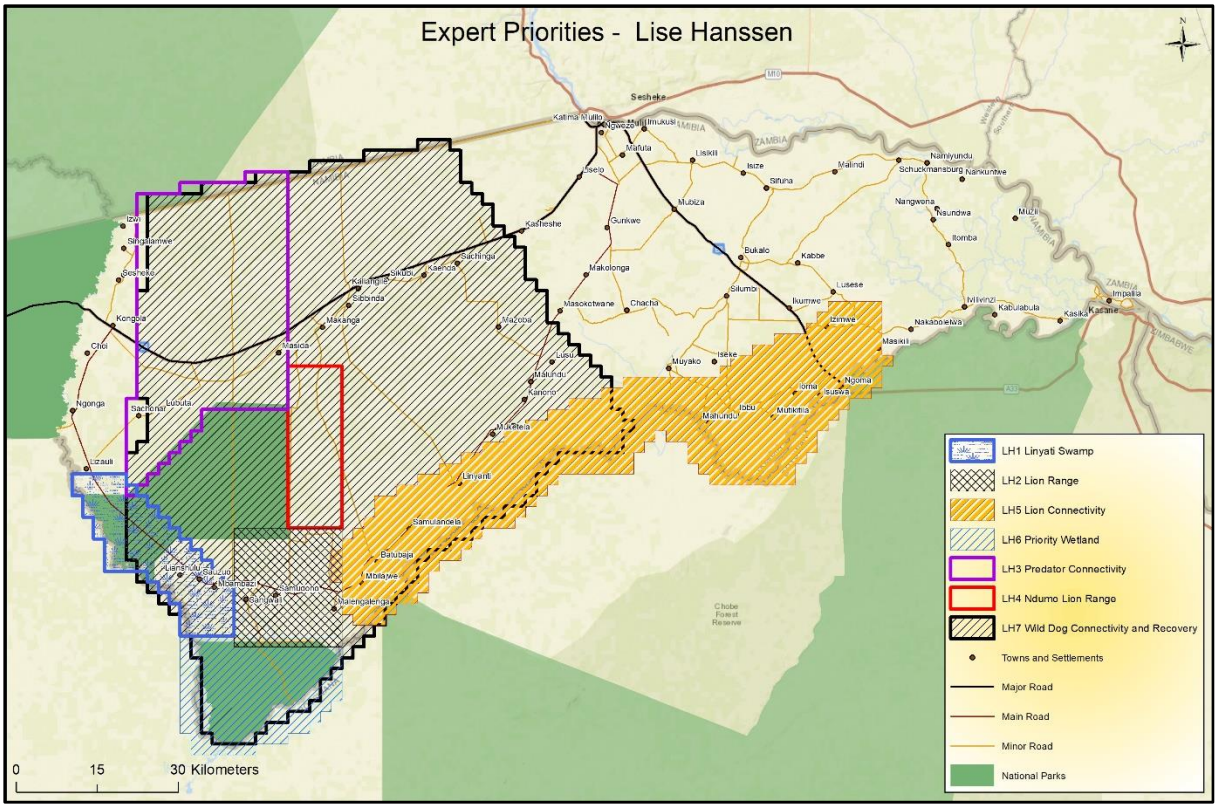


Figure 19: Expert mapped biodiversity features by Lise Hansen, which includes wildlife migration routes for lion, spotted hyaena, wild dog, cheetah and leopard; and Linyati Swamp, a priority wetland.

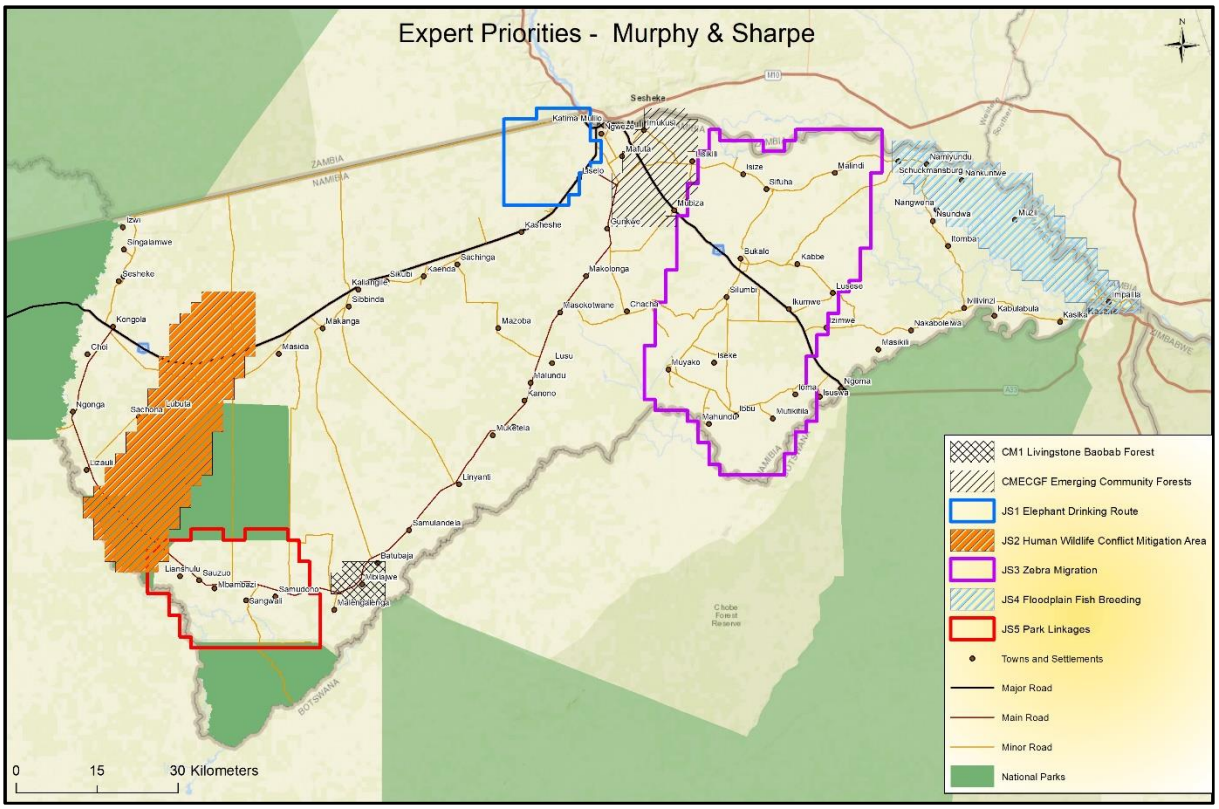


Figure 20: Expert mapped features by Carol Murphy and Janine Sharpe, which includes wildlife migration routes, emerging community forests and important fish breeding grounds.

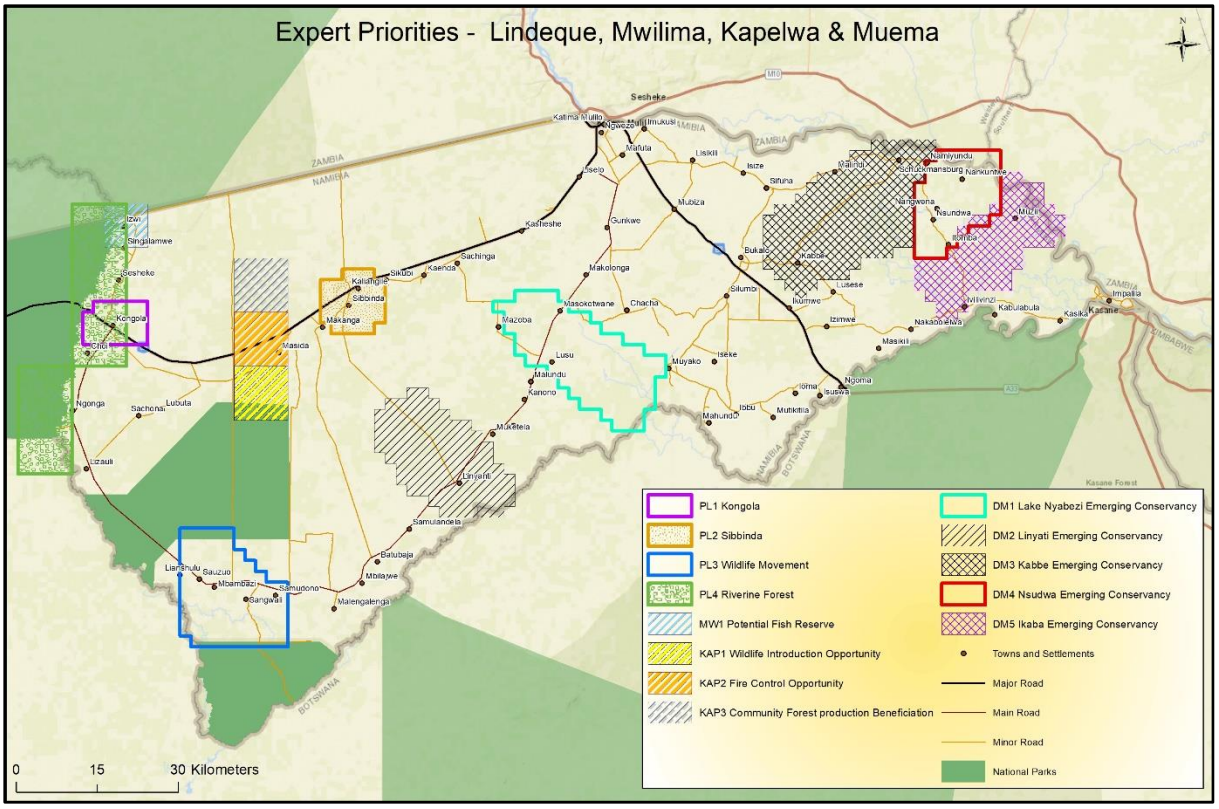


Figure 21: Expert mapped features by Pauline Lindeque, Aldrin Mwilima, Bargrey Kapelwa and Dominic Muema, which includes priority areas for wildlife movement, wildfire control, socio-economic opportunities and emerging conservancies.

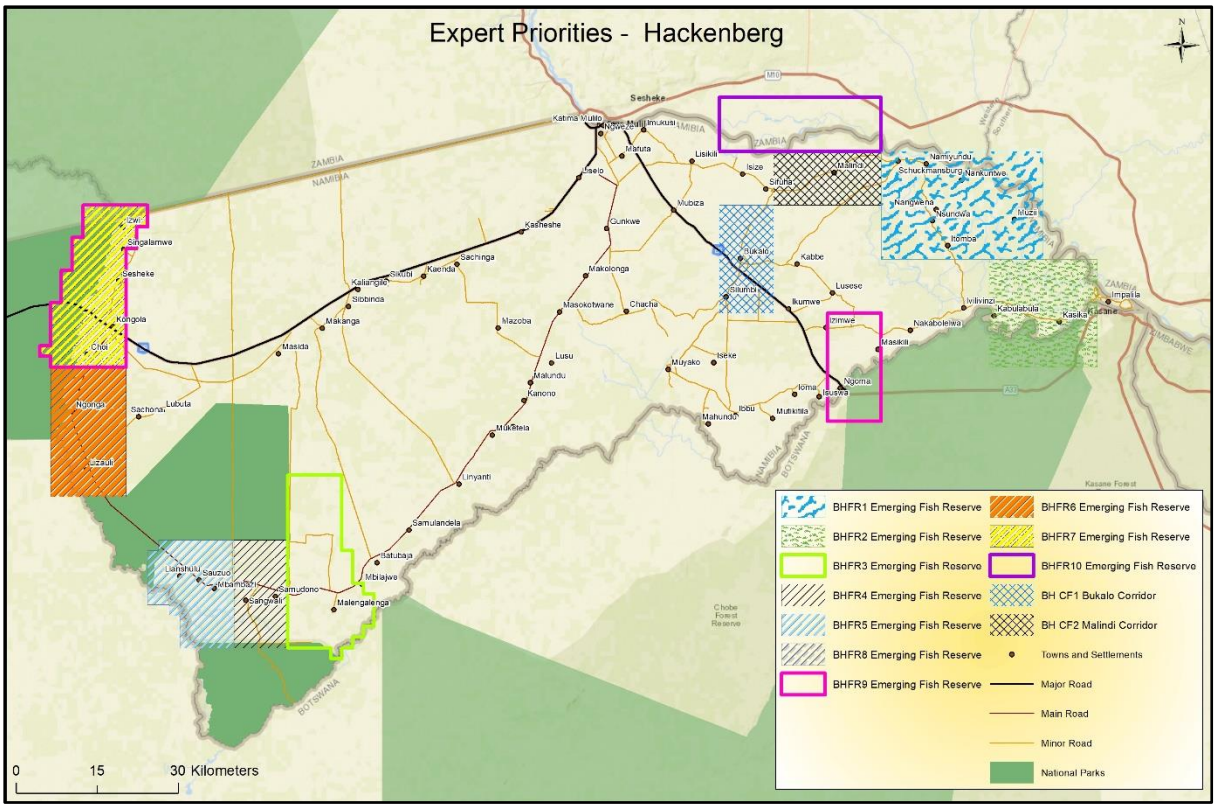


Figure 22: Expert mapped features by Britta Hackenberg, which includes priority areas for ten emerging fish reserves and two potential corridors.

Overview of data sources and incorporation into planning

Each expertly mapped area was included in the MARXAN analyses as individual features (note the feature numbers in Table 10. As very few constraint areas were mapped, these were added to the expert mapping reported shown in Figure 33 and Figure 34. The targets set are described in the target section (Table 4).

Ecological Condition Features

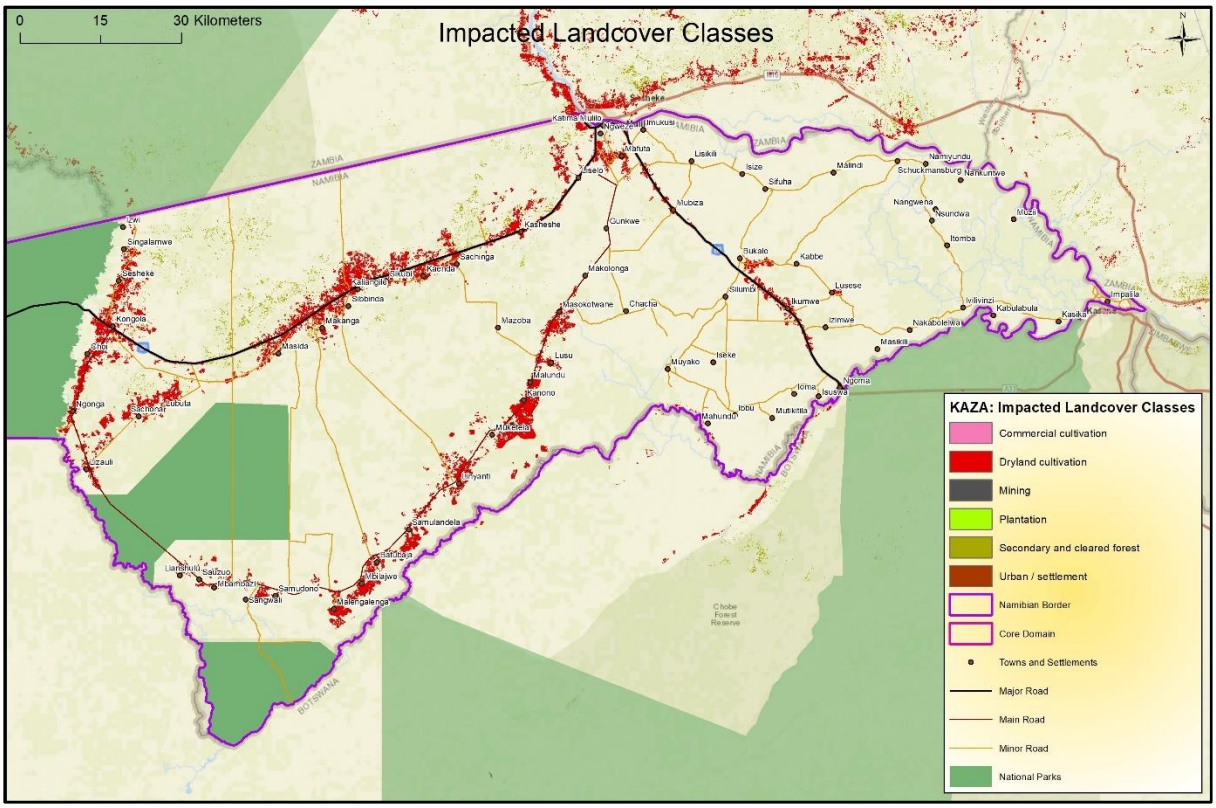


Figure 23: The Zambezi Region's ecological condition layer derived from the 2005 KAZA TFCA landcover map (Schultz et al., 2018).

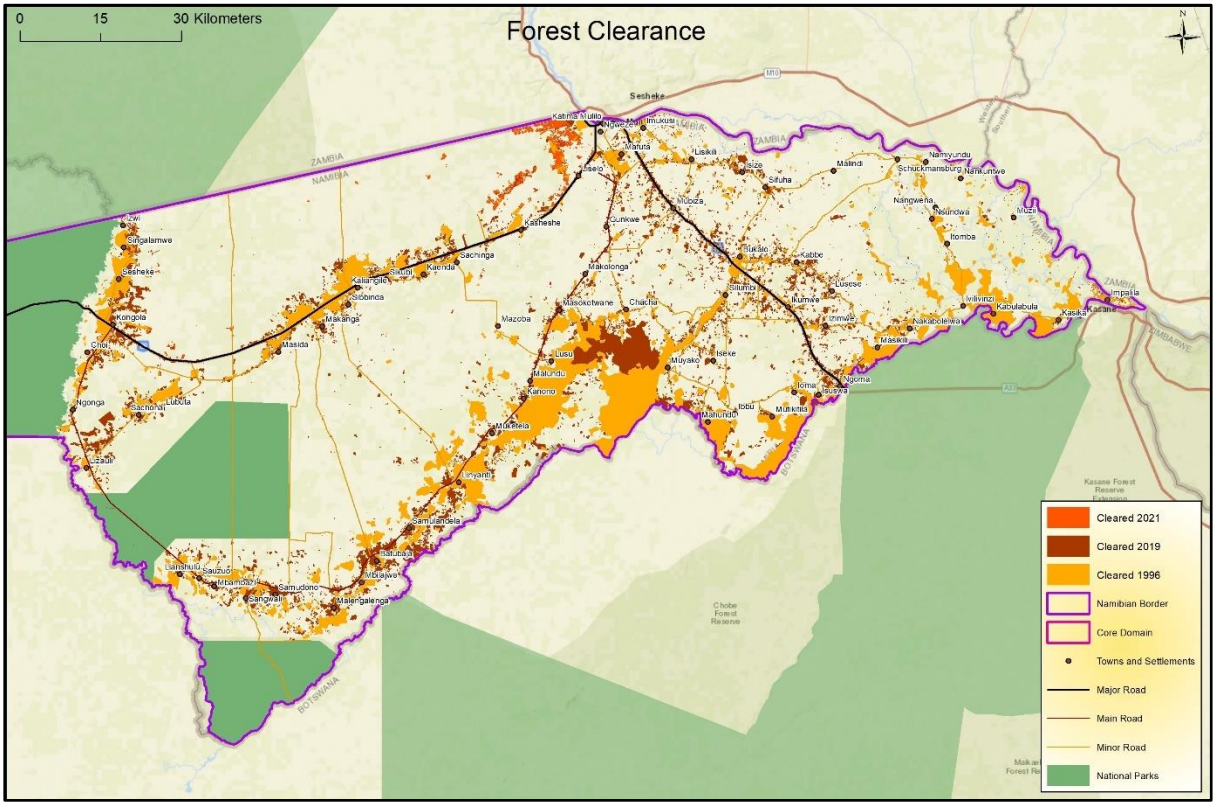


Figure 24: Forest clearance during 1996, 2019 and 2021 in the Zambezi Region, which contributes to interpreting ecological condition or land cover (Schultz, M., 2017).

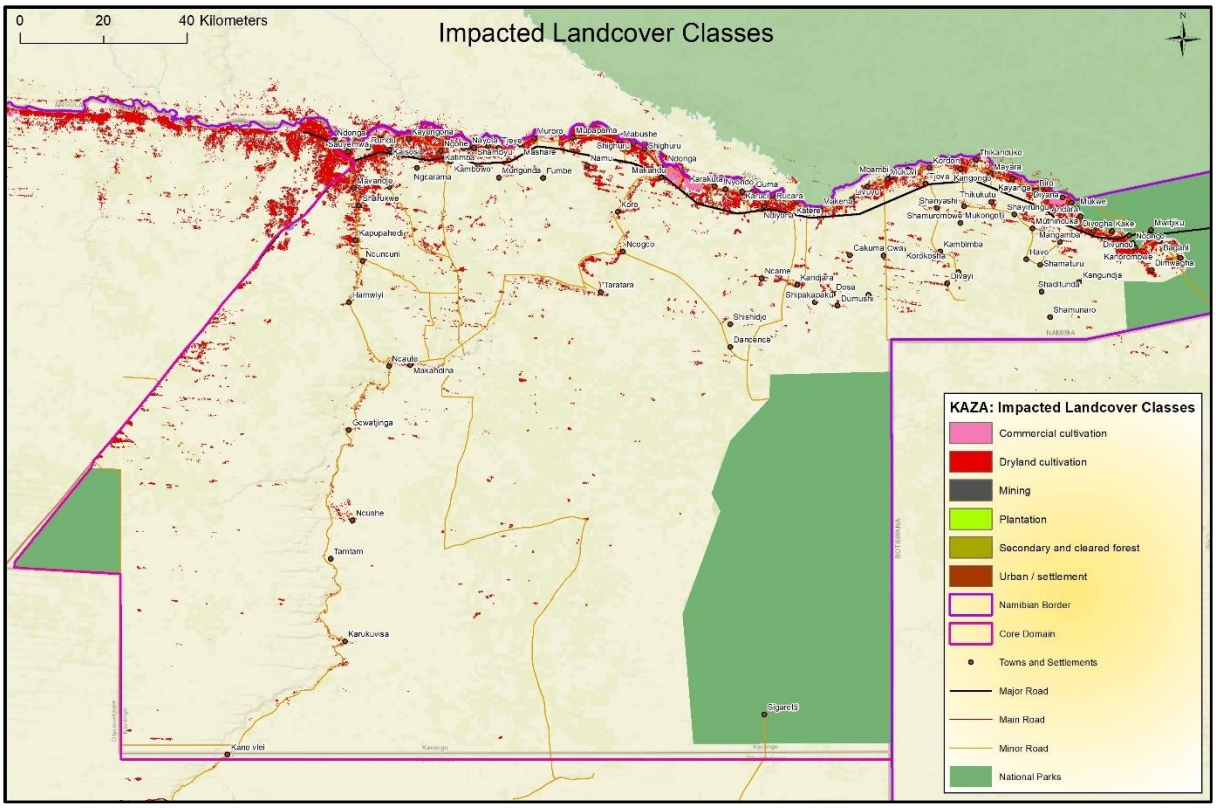


Figure 25: The Kavango East Region's ecological condition layer derived from the 2005 KAZA TFCA landcover map (Schultz et al., 2018).

Description

The layers incorporating ecological condition across the Zambezi and Kavango East regions of Namibia, were derived from impacted landcover classes of the 2005 KAZA TFCA landcover map (Schultz et al., 2018; Schultz, M., 2017) (Figure 23 and Figure 25). The landcover map is comprised of impacted landcover classes including: commercial cultivation, dryland cultivation, mining, plantation, secondary and cleared forest; and urban/ settlement.

In addition to this, the ecological condition for the Zambezi Region was further interpreted from cleared forest areas that were mapped for the periods 1996, 2019 and 2021 (Figure 24) (Schultz, M., 2017).

Table 11 presents the KAZA TFCA landcover data (2005) for Zambezi and Kavango East and Table 12 shows the forest clearance data. It appears that the 2005 landcover data is significantly less sensitive in identifying non-natural landcover classes versus the more detailed forest loss data, and observed reality. This is clear when comparing the 2005 Zambezi landcover classes in Table 11 with the WWF Zambezi Forest clearance data in Table 12 below.

Additional data was therefore used and built into the costs surface rather than being part of the ecological condition layers. These included forest clearance data, roads, buildings and dwellings, population density, cattle density and land rights (refer Figure 28 and Figure 29, Section "Cost Surface: Socio-economic and land use cost features").

Table 11: KAZA TFCA landcover data (2005), showing percentage values for 'Natural' versus 'Not Natural'.

Region	Natural	Not Natural			
		Agriculture	Secondary Bushland	Urban Settlement	Mining
Zambezi	95.9%	3.6%	0.4%	0.1%	0.0000%
Kavango East	96.7%	3.2%	0.0%	0.1%	0.0003%
Total	96.5%	3.3%	0.1%	0.1%	0.0002%

Table 12: The Zambezi WWF Forest clearance data combined for the periods 1996, 2019 and 2021 (hectares and percentage values).

Category	Area (ha)	Area (Percent)
Cleared	197 148	13.7%
Not Cleared	1 245 016	86.3%
Grand Total	**1 442 164**	**100.0%**

Overview of data sources and incorporation into planning

The available impacted landcover classes of the 2005 KAZA TFCA landcover map and the WWF forest clearance areas were incorporated via the systematic plan cost surface, with higher costs associated with the "Not Natural" classes (See the Cost surface section on page 57).

Data provided by WWF as per the resources indicated; (Schultz et al., 2018) and (Schultz, M., 2017).

Opportunities: Conservancies, Conservation Zones and Communal Forests

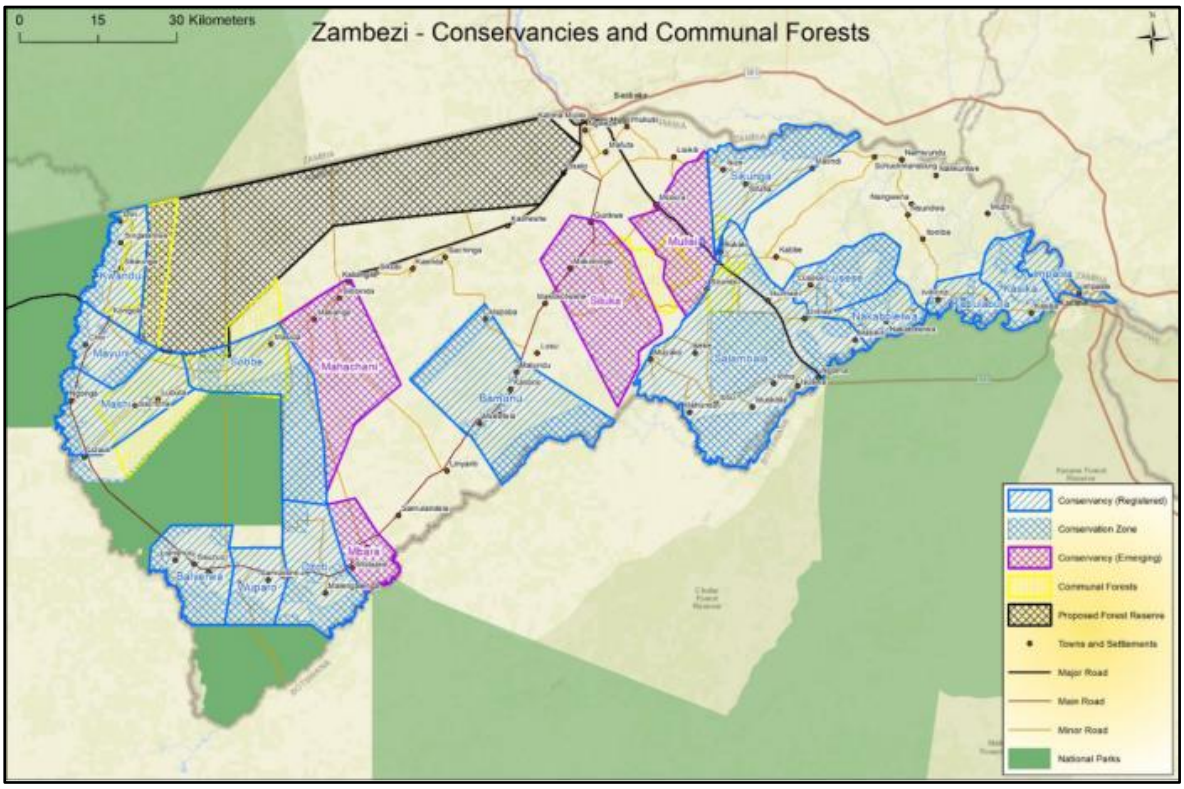


Figure 26: Namibia's Zambezi Region conservancies, conservancy conservation zones, communal forests and the proposed Caprivi / Zambezi State Forest Reserve.

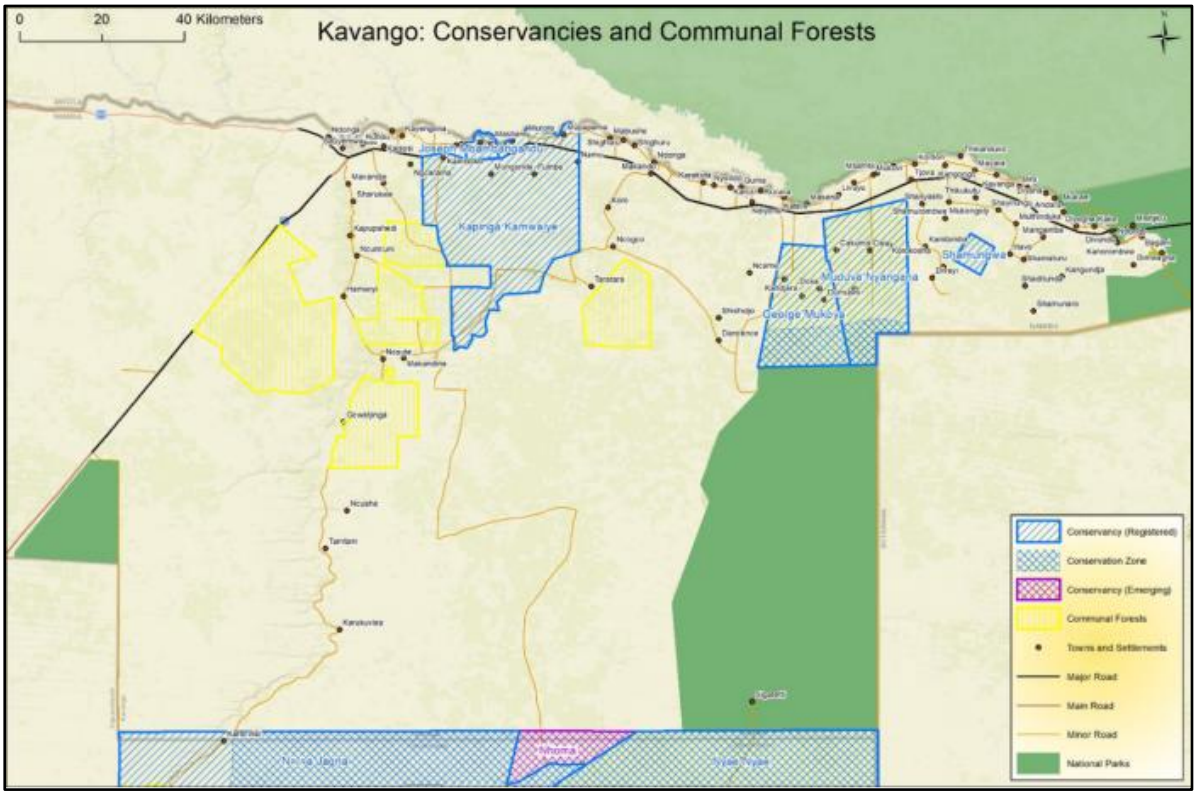


Figure 27: Namibia's Kavango East Region conservancies, conservancy conservation zones and communal forests.

Description

Registered conservancies, emerging conservancies and other conservation initiatives are key areas for alignment with spatial priorities, as these represent community based natural resource management (CBNRM) areas (Figure 26 and Figure 27). These key conservation opportunities include (Table 13):

- **Registered Conservancies**, which include 15 conservancies in Zambezi (408,893 ha), five conservancies in Kavango East (246,614 ha) and only the northern portions of two conservancies of Namibia's Otjozondjupa Region.
- **Emerging conservancies**, which include 4 emerging conservancies in Zambezi (123,463 ha) and only the northern portion of Nhoma Conservancy of Namibia's Otjozondjupa Region.
- The proposed/in progress **Caprivi / Zambezi State Forest Reserve**, in Zambezi which measures 150,346 ha.
- **Communal Forest Areas**, which measure 401,409 ha. Many communal forests overlap, at least partially, with conservancies in Zambezi, and complete some key linkages. In Kavango East, most are stand-alone areas.

In addition to registered conservancy boundaries, the conservation zones of these conservancies were separately considered. The conservancy conservation zones are as follows:

- Exclusive Wildlife: All Wildlife Utilization
- Exclusive Wildlife: No Disturbance
- Exclusive Wildlife: Tourism Only (No Hunting)
- Exclusive Wildlife: Trophy Hunting Only
- Multiple Use: Hunting Priority
- Multiple Use: Tourism Priority

Table 13: Registered (existing) conservancies and emerging conservancies in the Zambezi and Kavango East Regions, with hectare (ha) statistics.

Conservancy	Category	Region	Size (ha)
Salambala	Existing Conservancy	Zambezi	92,999
Kwandu	Existing Conservancy	Zambezi	18,956
Mayuni	Existing Conservancy	Zambezi	15,060
Mashi	Existing Conservancy	Zambezi	29,677
Impalila	Existing Conservancy	Zambezi	7,251
Kasika	Existing Conservancy	Zambezi	14,663
Sikunga	Existing Conservancy	Zambezi	28,664
Balyerwa	Existing Conservancy	Zambezi	22,524
Wuparo	Existing Conservancy	Zambezi	14,756
Bamunu	Existing Conservancy	Zambezi	55,600
Kabulabula	Existing Conservancy	Zambezi	8,911
Sobbe	Existing Conservancy	Zambezi	39,074
Dzoti	Existing Conservancy	Zambezi	28,686
Nakabolelwa	Existing Conservancy	Zambezi	11,406
Lusese	Existing Conservancy	Zambezi	20,666
		Sub-Total Existing - Zambezi	**408,893**
Siluka	Emerging Conservancy	Zambezi	43,356
Mahachani	Emerging Conservancy	Zambezi	39,759
Mulisi	Emerging Conservancy	Zambezi	26,919
Mbara	Emerging Conservancy	Zambezi	13,429

Conservancy	Category	Region	Size (ha)
		Sub-Total Emerging - Zambezi	**123,463**
		Total - Zambezi	**532,356**
Joseph Mbambangandu	Existing Conservancy	Kavango	4,292
George Mukoya	Existing Conservancy	Kavango	48,638
Muduva Nyangana	Existing Conservancy	Kavango	61,464
Shamungwa	Existing Conservancy	Kavango	5,346
Kapinga Kamwalye	Existing Conservancy	Kavango	126,874
		Sub-Total Existing - Kavango East	**246,614**
		Grand Total Zambezi-Kavango East Region	**778,970**
In addition, small portions of the following conservancies fall within Kavango East:			
Nyae Nyae	Existing Conservancy	Otjozondjupa	899,505
N=/=a Jaqna	Existing Conservancy	Otjozondjupa	912,345
Nhoma	Emerging Conservancy	Otjozondjupa	21,492
		Total – Otjozondjupa Region	**1,833,342**

Overview of data sources and incorporation into planning

The conservancies (existing and emerging), conservancy conservation zones, communal forest areas and the Caprivi Forest Reserve, which overlapped the planning domain and were outside of formal Protected Areas, were each incorporated into the systematic conservation plan as features. Settlement and cropping areas, multiple use areas with livestock priority areas and areas designated as “agricultural farm” were not included in the analyses. The targets set are described in the target section. WWF provided the data for this project.

Cost Surface: Socio-economic and land use cost features

Cost surface approach and components

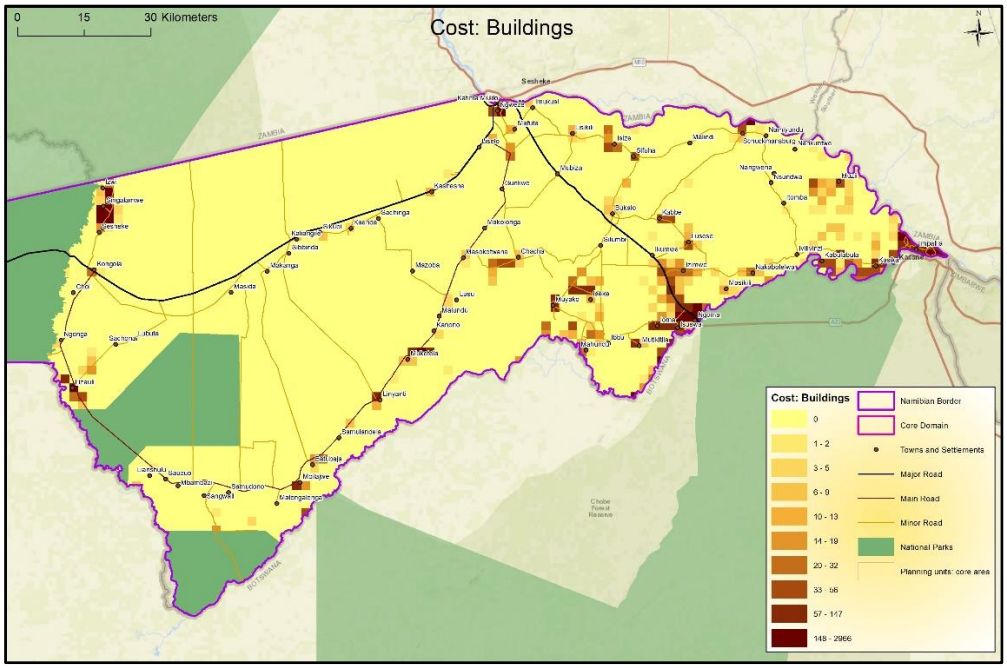
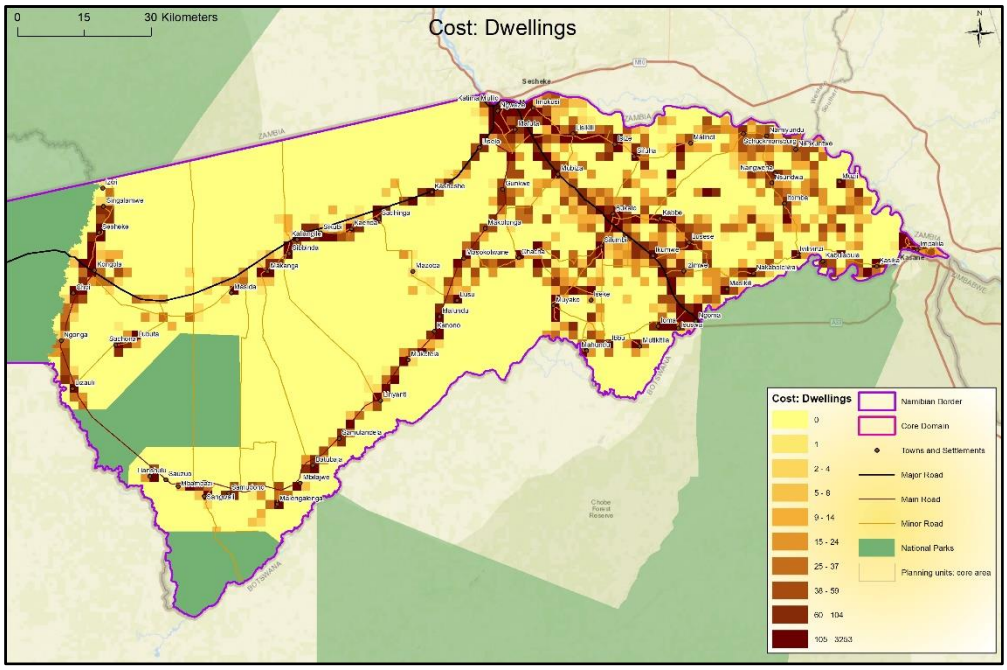
A cost surface (Figure 30 on Page 57) was used in the MARXAN analysis in order to ensure an efficient solution and to avoid areas that are in **poor ecological condition** (e.g. transformed landcover classes such as urban or arable fields, or with recent forest cover loss), are **used intensively by incompatible activities** (e.g. where rights are allocated for conservation incompatible uses), or have high socio-economic cost (e.g. are important for cattle or have high population densities). The integration of the components in the MARXAN Cost Layer examined in the section starting on Page 57.

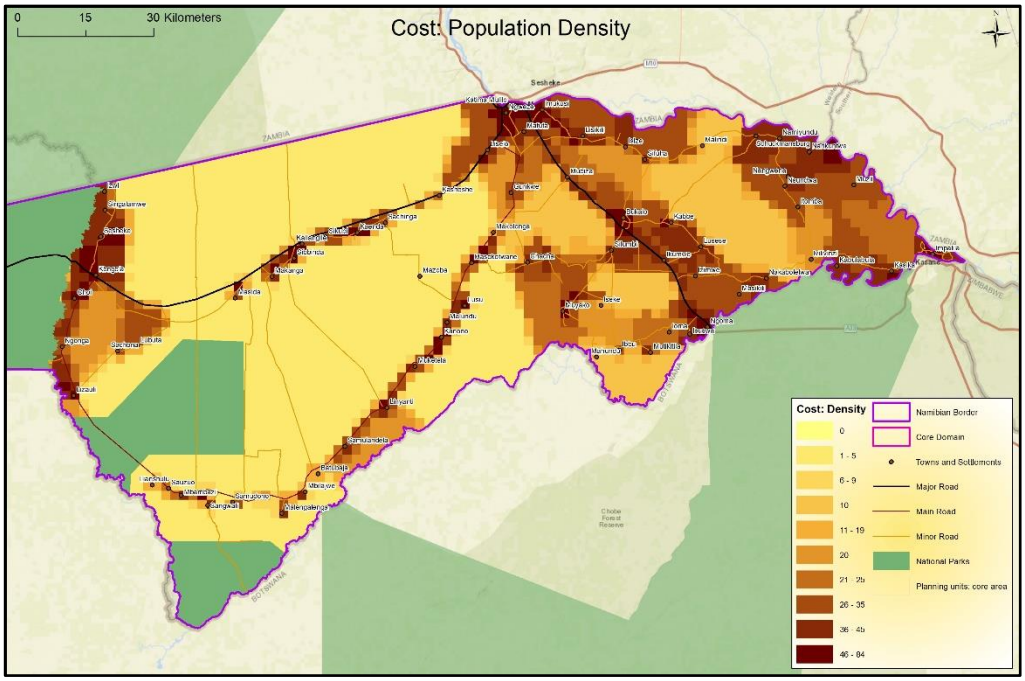
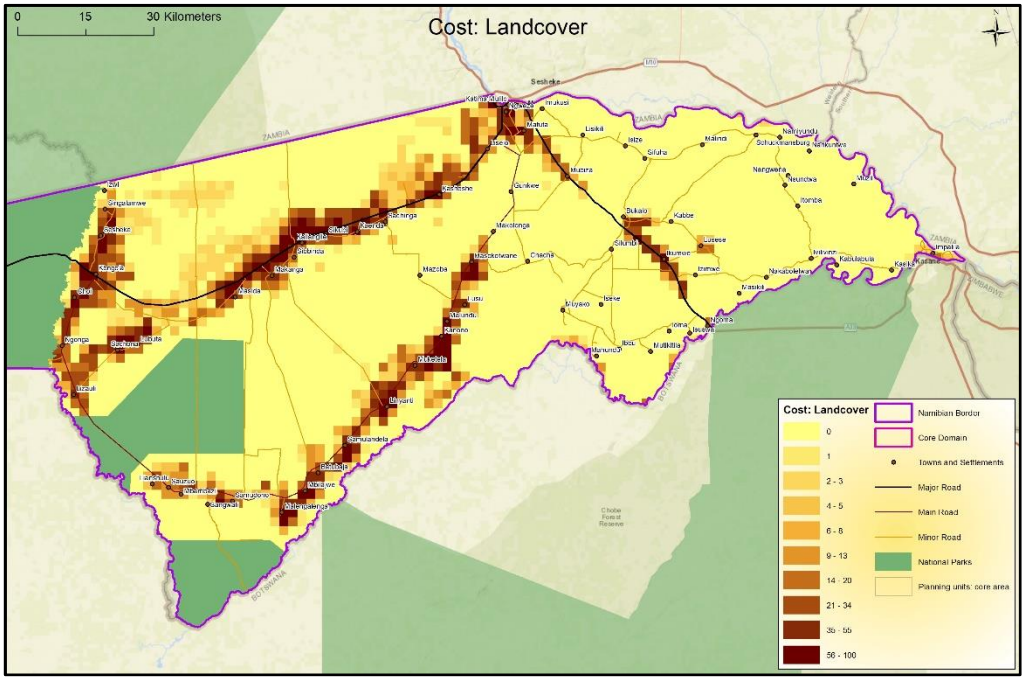
The cost surface elements used are summarized in Table 14. These include a range of features which include both ecological condition and socio-economic components. We used the available data on buildings, dwellings, population density, landcover, transport, deforestation, villages, cattle density, competing rights, irrigation zoning and mining and prospecting rights. The cost surface for the Zambezi Region is not directly comparable with Kavango-East. This is because additional information such as more detailed data (e.g. landcover data on forest clearance, data on land rights, and data on cattle and dwellings from aerial surveys) was available for Zambezi, whereas information for Kavango East was limited although still informative (see Table 14). The maps of these cost surface elements are given in the composite Figure 28 and Figure 29 over the next few pages.

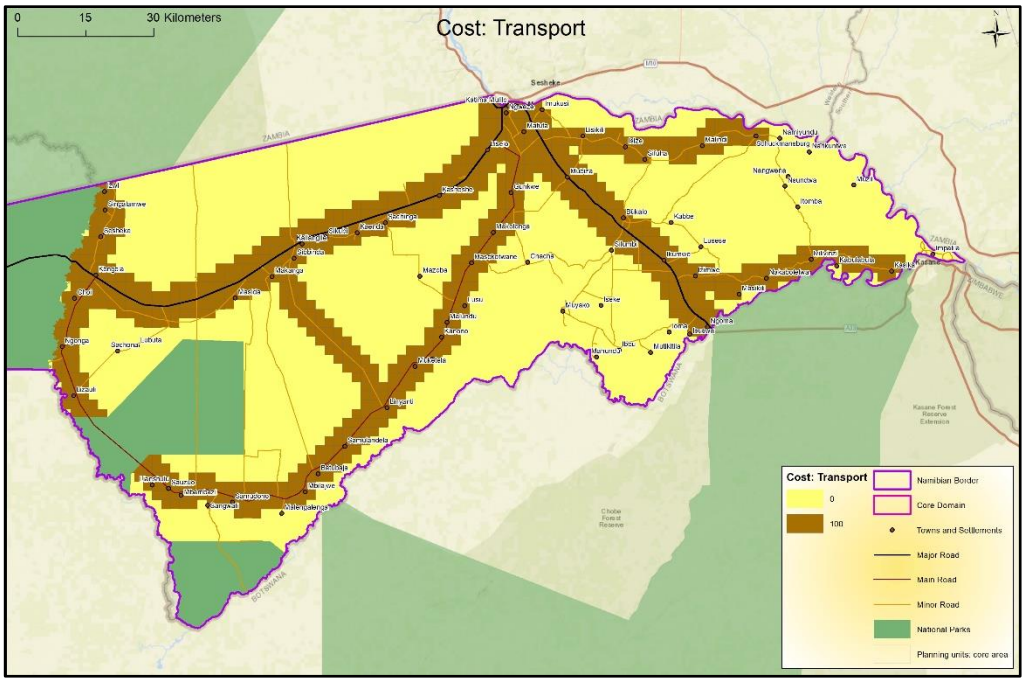
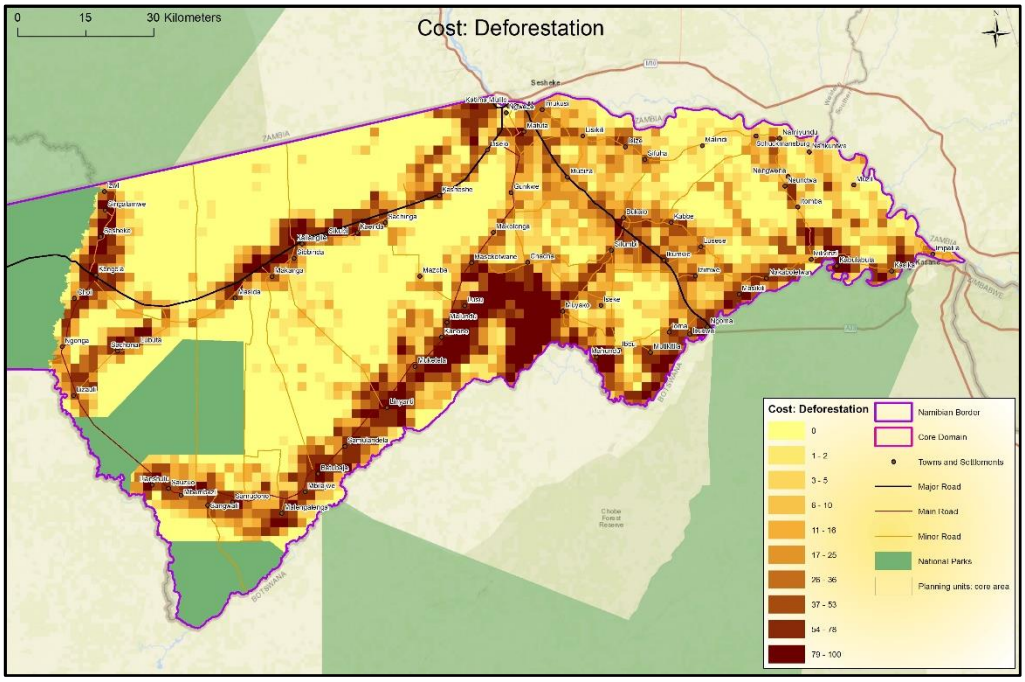
Table 14. Elements incorporated into the cost surface for Zambezi and Kavango East Regions.

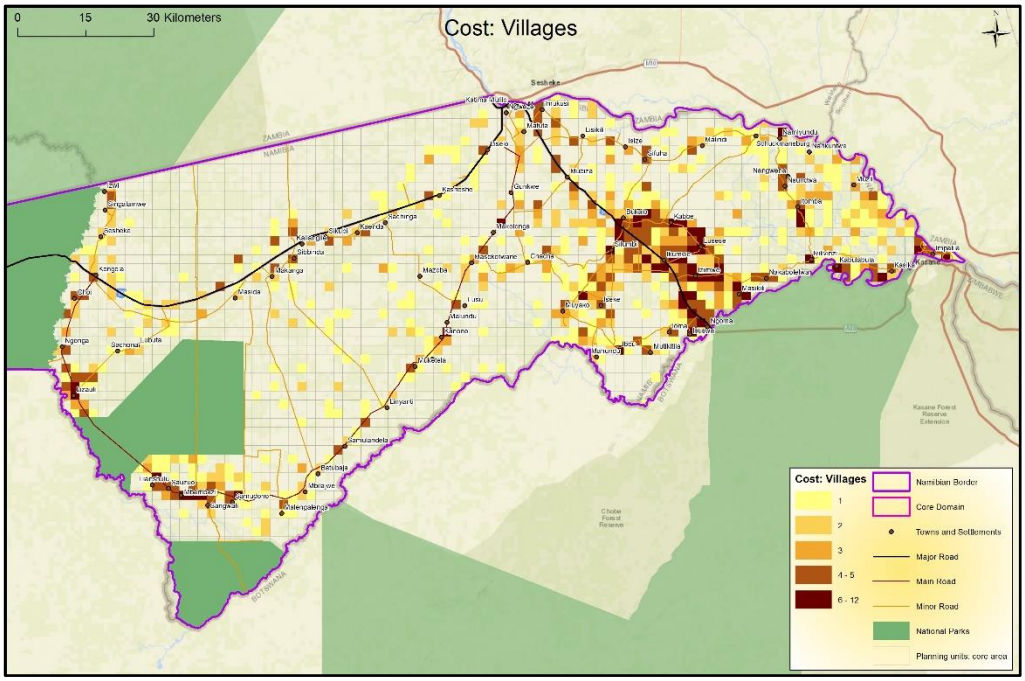
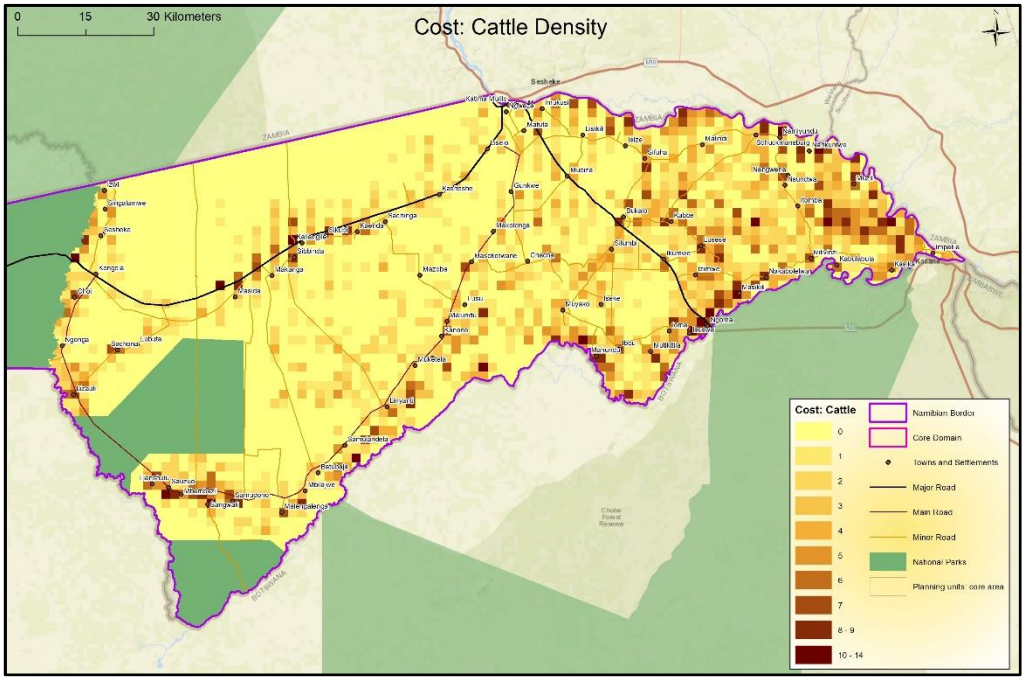
Data	Zambezi	Kavango East	Data Source
Buildings	√	√	Open Street map data from http://download.geofabrik.de/africa.html
Dwellings	√	√	Namibian census data for 2011, supplied by WWF
Population Density	√	√	Namibian census data for 2011, supplied by WWF
Landcover (including commercial and dryland cultivation, mining, plantation, secondary and cleared forest, urban/ settlement)	√	√	Landcover data for KAZA (2005) supplied by WWF.
Cleared forest areas (1996, 2019, 2021)	√	X	Forest clearance during 1996, 2019 and 2021 in the Zambezi Region (Schultz, M., 2017).
Mining and prospecting rights	√	√	Mining data on exploration and mining rights, supplied by WWF.
Transport routes	√	X	Integrated Regional Land Use Plan for the Zambezi Region (2015).
Villages	√	X	Data from the MEFT aerial surveys data (2013, 2015, 2019).

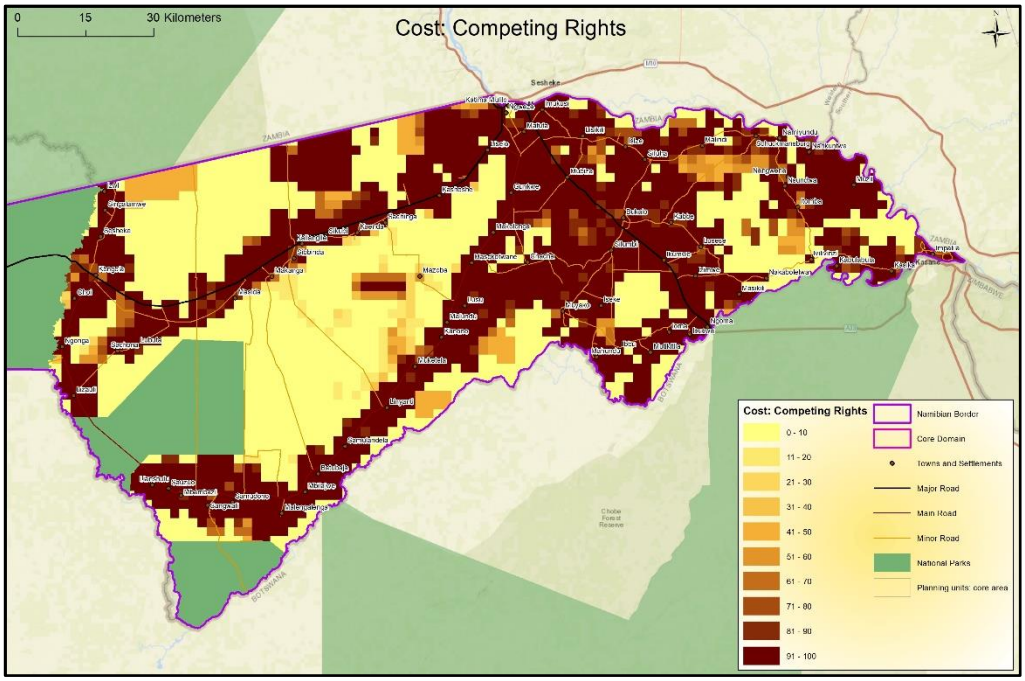
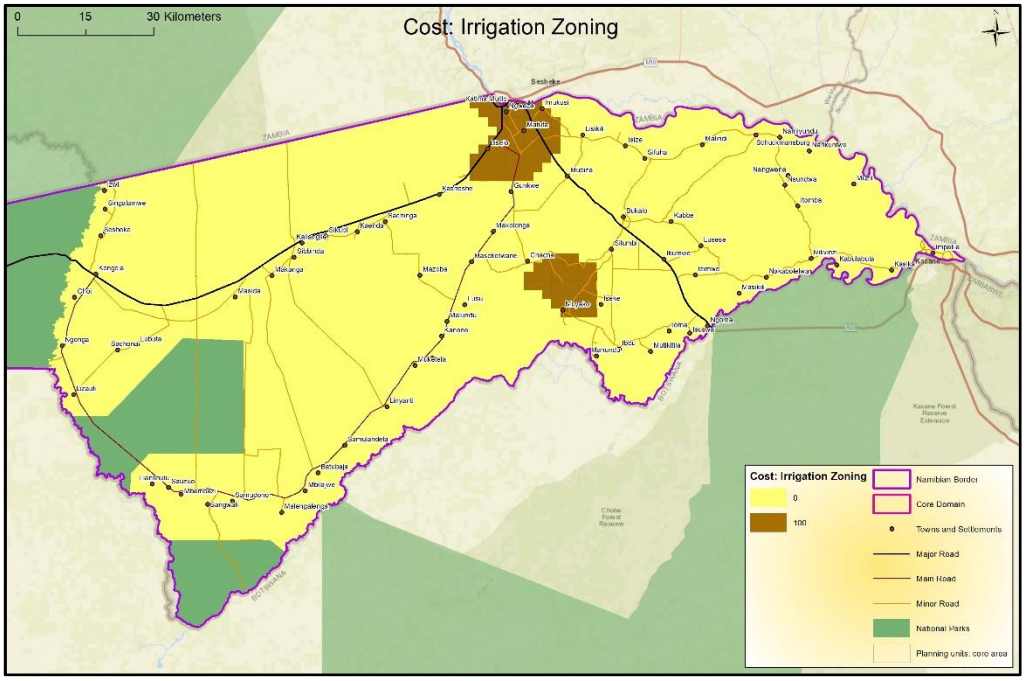
Data	Zambezi	Kavango East	Data Source
Cattle density	√	X	Data from the MEFT aerial surveys data (2013, 2015, 2019).
Competing rights	√	X	Integrated Regional Land Use Plan for the Zambezi Region (2015).
Irrigation zoning	√	X	Integrated Regional Land Use Plan for the Zambezi Region (2015).

Zambezi Cost Layers	
	Figure 28a) Zambezi Cost Layer Buildings
	Figure 28b) Zambezi Cost Layer Dwellings

Zambezi Cost Layers	
	Figure 28c) Zambezi Cost Layer Population Density
	Figure 28d) Zambezi Cost Layer Landcover

Zambezi Cost Layers	
	Figure 28e) Zambezi Cost Layer Transport
	Figure 28f) Zambezi Cost Layer Deforest-ation

Zambezi Cost Layers	
	Figure 28g) Zambezi Cost Layer Villages
	Figure 28h) Zambezi Cost Layer Cattle Density

Zambezi Cost Layers	
	Figure 28i) Zambezi Cost Layer Competing Rights
	Figure 28j) Zambezi Cost Layer Irrigation Zoning

Zambezi Cost Layers

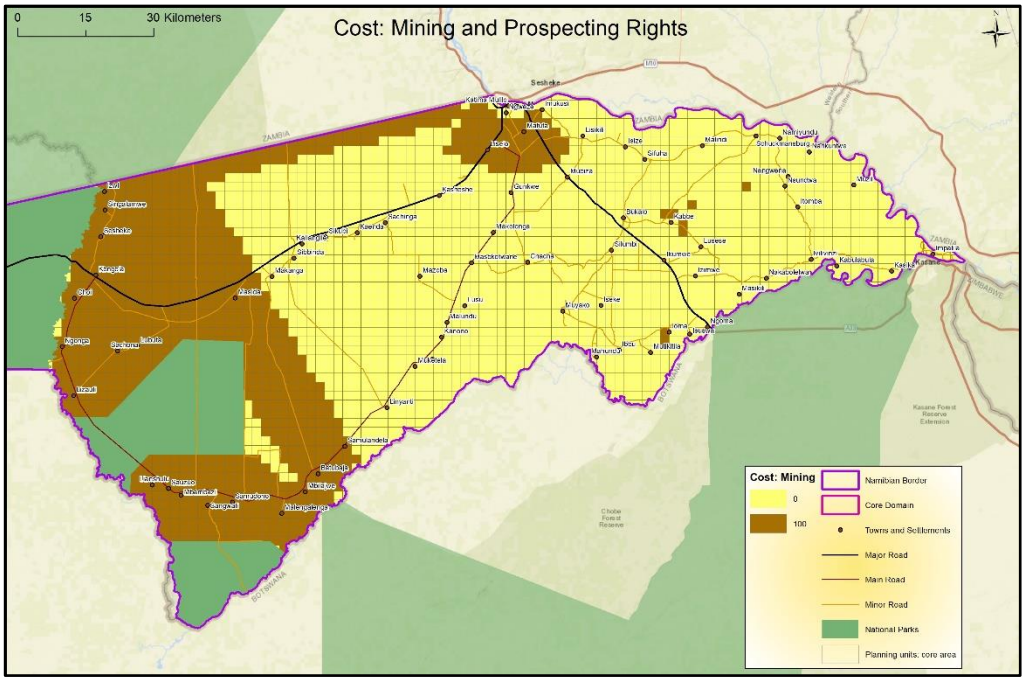


Figure 28k) Zambezi Cost Layer Mining and Prospecting Rights

Figure 28: The socio-economic cost layers for the Zambezi Region: Buildings, dwellings, population density, landcover, transport, deforestation, villages, cattle density, competing rights, irrigation zoning and mining & prospecting rights.

Kavango East Cost Layers

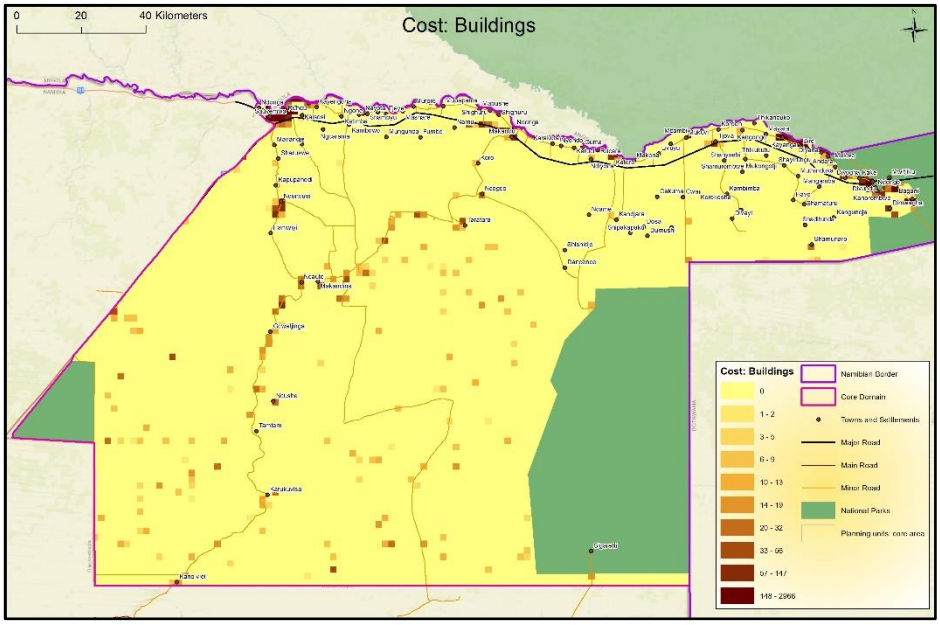
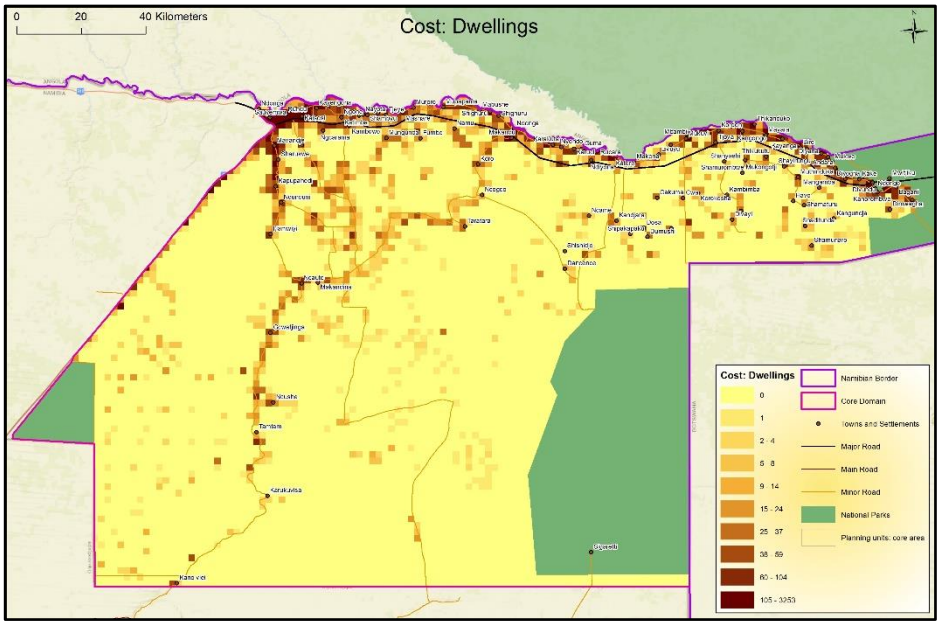
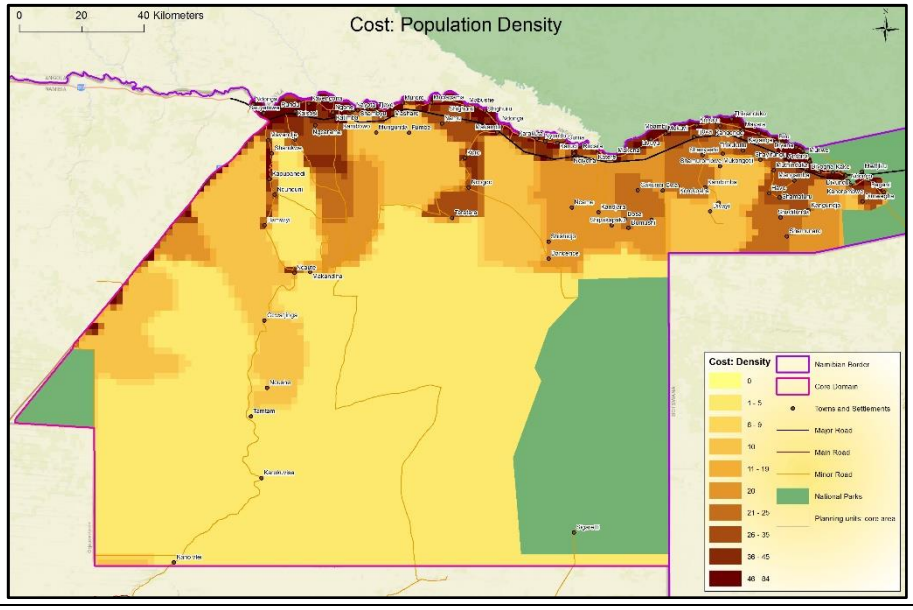


Figure 29a) Kavango East Cost Layer: Buildings

Kavango East Cost Layers	
	Figure 29b) Kavango East Cost Layer: Dwellings
	Figure 29c) Kavango East Cost Layer: Population Density

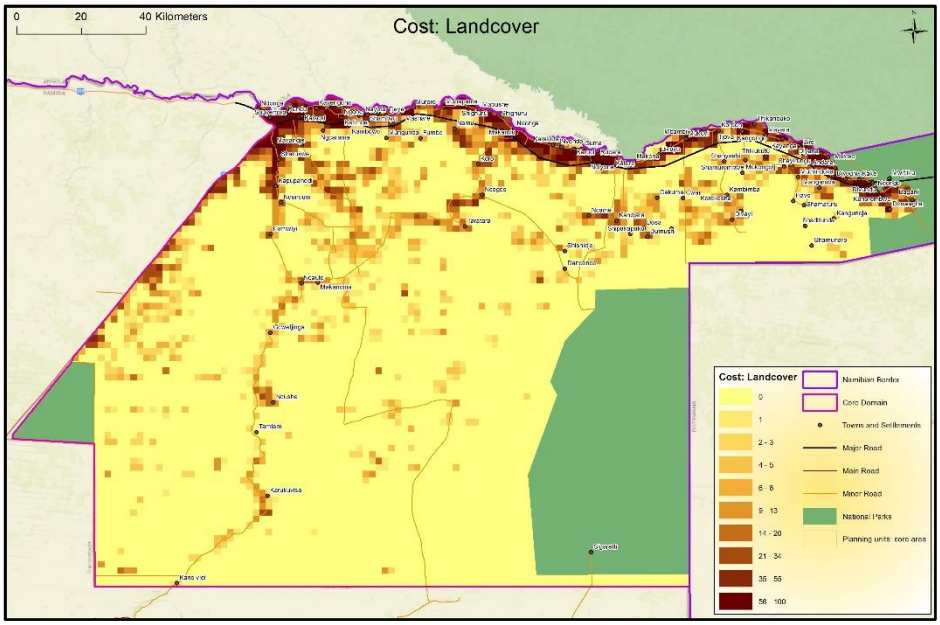
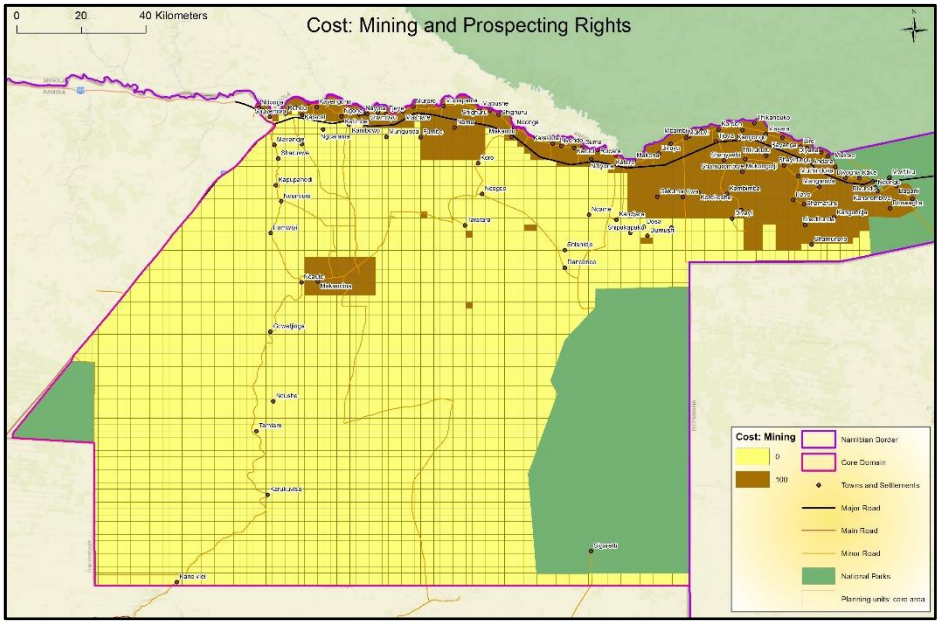
Kavango East Cost Layers	
	Figure 29d) Kavango East Cost Layer: Landcover
	Figure 29e) Kavango East Cost Layer: Mining and Prospecting Rights

Figure 29: The socio-economic cost layers for Kavango East: Buildings, dwellings, population density, landcover and mining & prospecting rights.

Description

Socio-economic and land use components were incorporated into the conservation planning process via a cost surface approach. The socio-economic cost layers for Zambezi and Kavango East (Figure 28 and Figure 29 respectively) consisted of available relevant socio-economic, landcover and land use data (Table 14). We examined landcover change, population density, dwelling density, villages, cattle density, deforestation, competing land rights, areas with mining and prospecting rights, and for Zambezi areas allocated to irrigation and transport in the land use plan (Ministry of Lands and Resettlement, 2015). As some layers were only available for Zambezi (i.e. the data derived from the Zambezi Land Use Plan, namely the transport and irrigation allocations; the data from aerial surveys for villages and cattle density; and the additional WWF mapping of deforestation), **the cost surface**

is not comparable between the two regions. This is the key reason why the results for the two regions should essentially be seen as two separate products. Notwithstanding, the available data for the Kavango East Region was still able to yield valuable results.

Overview of data sources and incorporation into planning

The individual costs surface elements were prepared as follows:

- Buildings: Data on buildings was sourced from Open Street Map. 53 898 larger building were identified in the planning domain. These were converted to points based on their centroids. The points were then converted to a 30m raster and summarised for each planning unit. The summed values were reclassified based on 20 geometric intervals, and then normalized to a 0-100 range. This gives a range from 0 (lowest building density) to 100 (highest density of buildings).
- Dwellings: Data on dwellings/households was sourced from Namibian census data for 2011. 94 629 dwellings/households were identified in the planning domain. These were summarised for each planning unit. The summed values were reclassified based on 20 geometric intervals, and then normalized to a 0-100 range. This gives a range from 0 (lowest dwelling density) to 100 (highest dwelling density).
- Population density: Population density data was sourced from Namibian census data for 2011. Values in population/km^2 were summarised for each planning unit. The summed values were reclassified based on 20 geometric intervals, and then normalized to a 0-100 range. This gives a range from 0 (lowest population density) to 100 (highest population density).
- Cattle density data: Data from the MEFT aerial surveys data (2013, 2015, 2019) were sourced showing cattle density across Zambezi. Similar to the approach used for other data, these values were summarised across the three surveys per planning unit. The summed values were reclassified based on 20 geometric intervals, and then normalized to a 0-100 range. This gives a range from 0 (lowest cattle density) to 100 (highest cattle density).
- Village/settlement data: Data from the MEFT aerial surveys data (2013, 2015, 2019) were sourced showing villages across Zambezi. Similar to the approach used for other data, these values were summarised across the three surveys per planning unit. The summed values were reclassified based on 20 geometric intervals, and then normalized to a 0-100 range. This gives a range from 0 (lowest village density) to 100 (highest village density).
- Mining and prospecting rights. Data on current mining exploration and mining rights, supplied by WWF was used to identify planning units with mining or exploration rights. These units were coded with a value of 100. Other planning units with no rights were coded as 0.
- Transport corridors. Areas zoned within transport corridors (which are also areas of significant development pressure) within the Zambezi Land Use Plan (Ministry of Lands and Resettlement, 2015) were coded with a value of 100. Other planning units not assigned to transport corridors were coded as 0.
- Irrigation Area. Areas zoned for irrigation development within the Zambezi Land Use Plan (Ministry of Lands and Resettlement, 2015) were coded with a value of 100. Other planning units not assigned to irrigation were coded as 0. Other agricultural development categories (e.g. livestock) were considered to be neutral in terms of cost, and were not used.
- Competing incompatible land use rights. Data on competing land use rights for Zambezi were sourced from WWF. The analysis focused on areas with approved non-compatible rights which were coded as 100. These high cost categories were used for activities such as residential, commercial, institutional (e.g. church, education) and crop rights. Unknown/unspecified rights were also included in this high cost category. Tourism and grazing were seen as low

cost (i.e. reasonably compatible or at least lower conflict activities for conservation) and were coded with a value of 10. This lower value was also used for areas with no allocated rights. The above values were converted to 30m pixels and an average value was calculated per planning unit. We also examined sites where rights were allocated to small properties, based on the assumption that if a conservation incompatible right was assigned to a small site, then it was highly likely that the whole site would be developed. To do this the sizes of properties with incompatible rights (i.e. excluding tourism and grazing) were divided into 10 geometric intervals, and allocated a score from 100 (for small sites – effectively of under 10ha - which were likely to be intensively used) to 10 (for the largest sites – effectively over 15,000 ha - which were less likely to be intensively used. The overall cost used in the analysis was a maximum value of the two above approaches (i.e. the non-compatible rights and the rights – size analysis).

- Transformed landcover classes (including commercial and dryland cultivation, mining, plantation, secondary and cleared forest, urban/ settlement). The landcover data for KAZA (2005) supplied by WWF was coded based on the compatibility with future conservation activity and remaining biodiversity value. Permanently or intensively transformed landcover classes were coded with a value of 100. These were mining, urban settlement, commercial cultivation, plantations and dryland cultivation. Degraded areas (i.e. secondary growth of previously cleared forest) were coded with a value of 25, and all natural areas were coded with 0m. An average score (of the coded 30m pixels) was calculated for each planning unit, giving a range from 0 (for a unit that was 100% natural) to 100 (for a unit that was 100% permanently impacted).
- Forest loss. Pixels with identified forest clearance during 1996, 2019 and 2021 in the Zambezi Region (Schultz, M., 2017) were coded with a value of 100. Pixels without recorded forest loss were coded with a value of 0. An average score (of the coded 30m pixels) was calculated for each planning unit, giving a range from 0 (for a unit that had no evidence of forest clearance) to 100 (for a unit that was 100% cleared).

The integration of the cost surface is detailed in the following section.

MARXAN Cost Layer

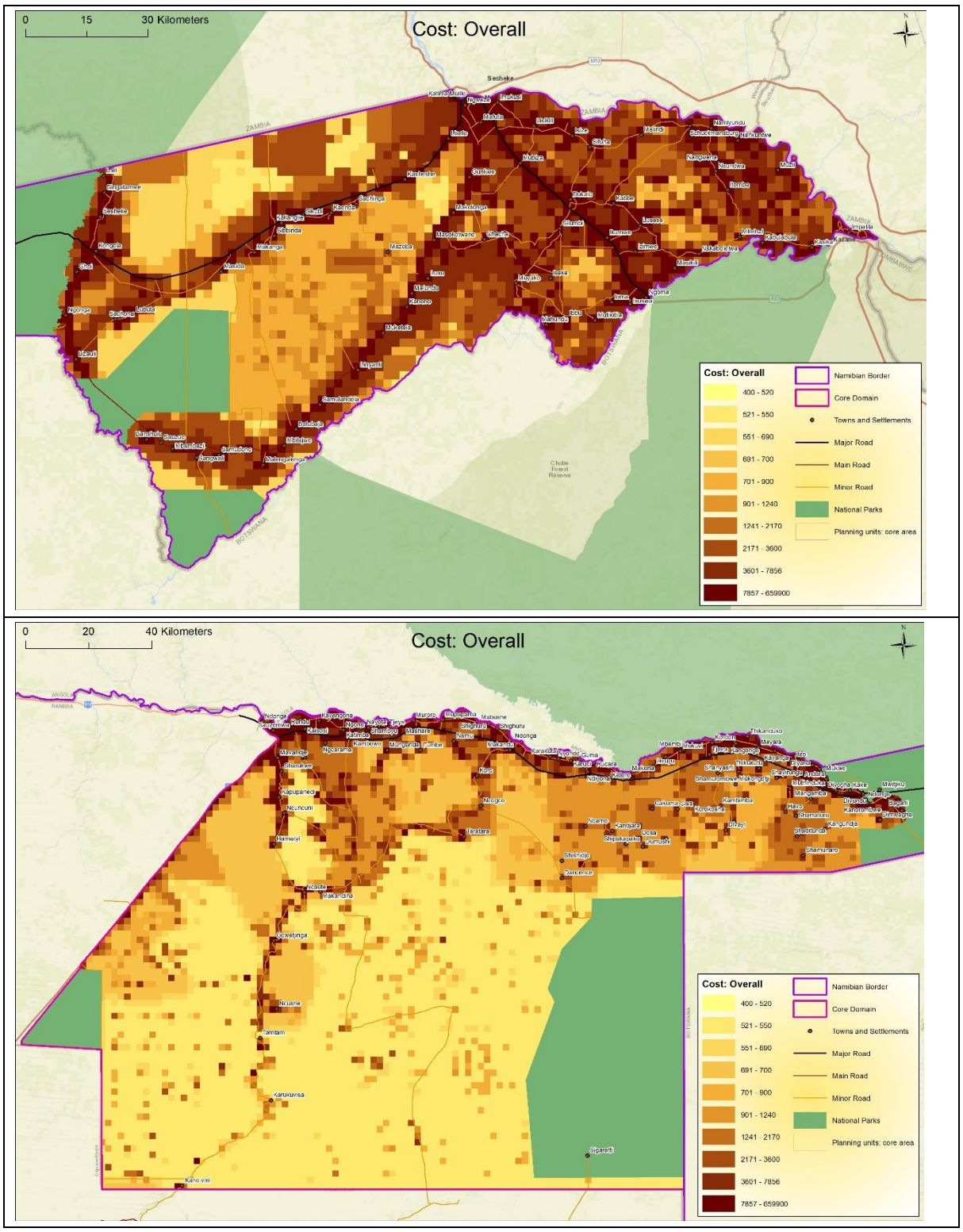


Figure 30: The overall cost surface layer used in the MARXAN analysis for the Zambezi Region (Top) and the Kavango East Region (Bottom).

Description

A cost surface was used in the MARXAN analysis in order to ensure an efficient solution and to avoid areas of high socio-economic cost, that are in poor ecological condition or that are used intensively by activities that are largely incompatible (at least at higher intensities) with maintaining areas in a natural or semi-natural state. We examined landcover change, population density, dwelling density, villages, cattle density, deforestation, competing land rights, areas with mining and prospecting rights, and for Zambezi areas allocated to irrigation and transport in the land use plan (Ministry of Lands and Resettlement, 2015). See the previous section for the detailed description of the underlying data layers used in the cost surface.

Overview of data sources and incorporation into planning

As described in the previous section, each of the input layers was scaled from 0-100. This allows layers to be easily combined. After some experimentation, the simplest method for combining the data was chosen, and an equal weighted sum was used.

The cost surface was built up of the following elements detailed in the "Cost Surface" Section:

- Area of the planning unit in hectares.
- *For Zambezi and Kavango:*
    - Impacted landcover classes.
    - Population density
    - Buildings
    - Dwellings
    - Mining and prospecting rights
- *Additional data for the Zambezi Region*:
    - Forest clearance
    - Areas allocated to transport corridors
    - Areas allocated to irrigation agriculture
    - Cattle density
    - Villages and settlements.
    - Competing land rights.

The final cost surfaces are shown in Figure 28 for Zambezi and Figure 29 for Kavango. As previously noted, although useful results were obtained for both regions, the **cost surface layers should not be directly compared**.

Spatial Scenarios

Scenarios

The MARXAN process attempts to meet targets for all the features (in this case ecological and sustainable use features) in areas that are in the best possible ecological condition (i.e. favouring good and fair condition sites before poor condition sites), in a configuration that minimizes cost and conflict with other users of the region (e.g. mining, cultivation, settlement and plantation), and that is spatially connected (i.e. favours selecting coherent areas of adjacent planning units rather than a disconnected scatter of selected planning units) because this is ecologically preferable.

In this way, the planning approach attempted to meet the core objective to *"identify priority conservation areas for an integrated conservation support plan for Zambezi and Kavango East Regions, including confirmation of priority corridors and specification of particular areas which need to be strategically held down for conservation in the long term*".

It is easy to assume that there is one single answer to a conservation planning problem, however this is not generally the case. There are numerous issues related to the overall objectives of the planning exercise (e.g. for Protected Area Expansion, land use controls or use in prioritising CBNRM support), the relative balance between different biodiversity features (e.g. different valid conservation planning processes could have emphases on corridors and connectivity, threatened species or hydrological processes), the relative ambition of the conservation actions (e.g. being defensive in securing rapidly receding options is as valid an objective as proactively conserving larger unfragmented areas for Protected Area expansion), and the level of willingness to incur socio-economic cost in securing conservation areas. It is also worth highlighting that the current planning process is an initial rapid systematic conservation plan rather than a definitive single blueprint.

Because of all the issues highlighted above, it is important that we explore a range of conservation planning scenarios. The scenarios approach that we have taken involves:

- Building a basic SCP framework that includes all relevant and available biodiversity data and socio-economic cost data.
- Using different target combinations to influence the relative balance between different elements:
    - **The level of land hungriness of conservation planning results.** High targets require larger portions of the landscape to meet them. High targets are also more likely to require areas with high socio-economic costs to achieve these targets, as well as being more likely to include areas that are not in natural ecological condition. We have used scenarios with low, moderate and high targets to explore these issues.
    - **The relative focus on landscape connectivity.** We have used scenarios with high and low targets for the biodiversity features focussed on landscape connectivity (e.g. corridors, areas used by mobile wildlife populations, areas providing connectivity between reserves).
    - **The relative focus on existing conservation corridors.** We used a scenario which did not include existing identified conservation corridors (e.g. those in the Zambezi land Use Plan). These corridors are available for selection, but are not favoured by setting specific targets for the corridor itself. This allows us to use the planning outcomes to evaluate the corridor network.
    - **The relative focus on existing conservancy zoning**. We used a scenario which did not include existing specified conservation focussed zones for the conservancies (i.e.

conservation, hunting, tourism and mixed use zones with a wildlife function). These areas are available for selection, but are not favoured by setting specific targets for these zones. This allows us to use the planning outcomes to evaluate the conservancy zoning.

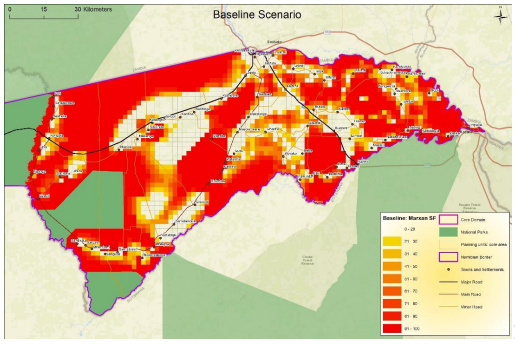
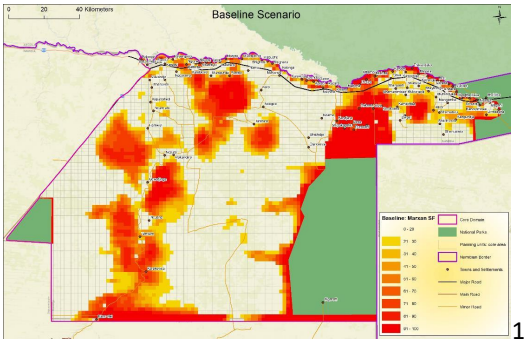
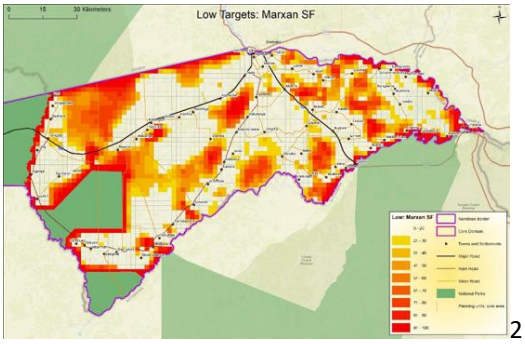
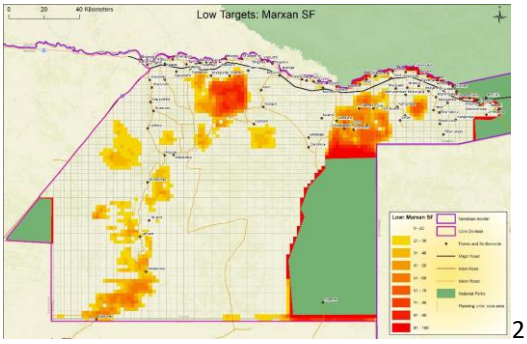
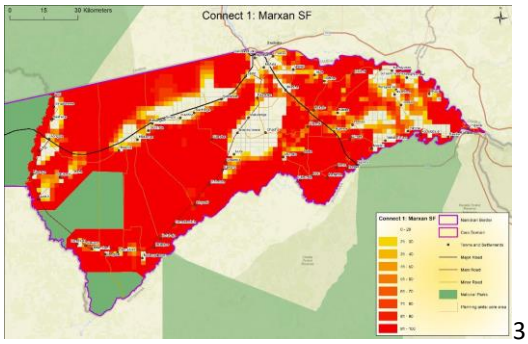
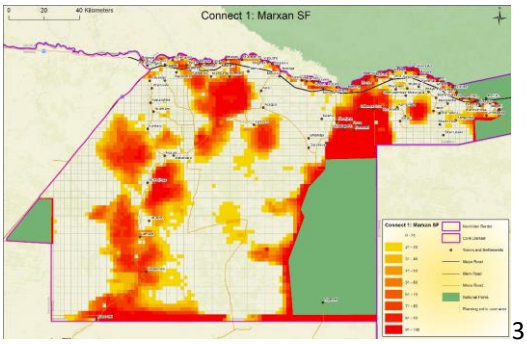
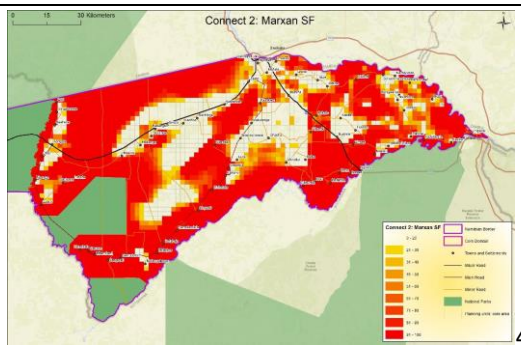
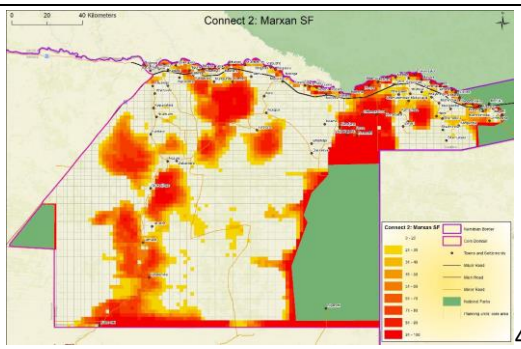
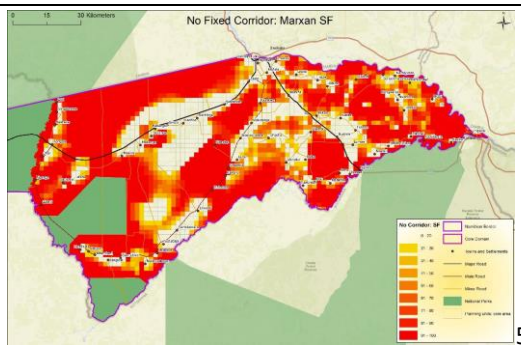
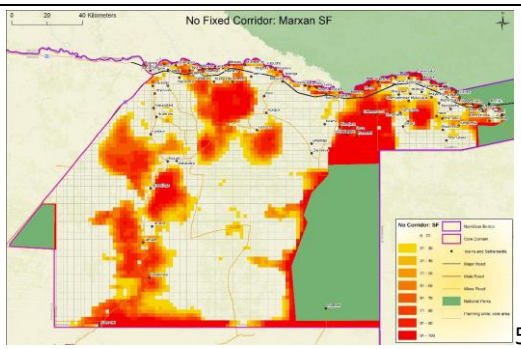
  - **The relative recognition of target achievements by existing protected areas**. Finally, we used a scenario where targets are increased to always require additional areas outside of the existing PA network. Effectively this scenario focusses on features that are outside of the current protected area network, even if they are relatively well secured within current PAs. For example, the target for a specific ecosystem type would be set at an **additional** 30% of the area of that type outside of existing PAs plus the full extent of the feature already within PAs, rather than the normal approach of targeting 30% of the area of that type across the entire planning domain. This results in targets effectively being much higher, and the conservation results being more land hungry.

- Undertaking a conservation planning process for each scenario. The specific targets used for each scenario are detailed in Table 4 on page 10. The primary result of each MARXAN analysis is a selection frequency surface (Figure 31), i.e., how often a planning unit is selected as part of an efficient solution out of a user-defined number of runs of the scenario. This value indicates the irreplaceability of features within a planning unit, and the output map is usually referred to as an **irreplaceability map or selection frequency map**. The MARXAN selection frequency map shows 9 selection frequency categories (with percentage values of 0% – 100%), ranging from low selection frequency, where a planning unit was selected for priority features less than 20% of the time, to high selection frequency where a planning unit was selected more than 90% of the time (Figure 31).
- The MARXAN analysis was then run for **seven conservation planning targets scenarios** for the Zambezi and Kavango East Regions (Figure 31). Although the biodiversity data and the socio-economic cost layers for Kavango East were data poor relative to Zambezi, one MARXAN analysis was run for both these regions together (i.e. the planning domain) and for each target scenario. The results would have been equivalent if two separate MARXAN analyses were conducted for each region. These were:
  - **Baseline Scenario**. Generally, targets of 30% aligned with the new post 2020 CBD goals (Nicholson et al., 2021) were used as the starting point with higher targets for identified high conservation value habitat types, special features (e.g. wetlands), special process areas (e.g. floodplains) and specific expertly mapped features (e.g. key wildlife linkages). Refer to Table 4 for targets.
  - **Low Target Scenario.** This option uses targets that are set at half of the baseline targets (see above). This scenario is fairly unambitious in terms of conservation scope, and incurs low socio-economic costs. Although this scenario is probably insufficient as a stand alone set of conservation priorities, the output is extremely useful in highlighting the most important areas of the landscape with biodiversity features which are very poorly represented in the current Protected Area network. In other words, the areas highlighted in this analysis are insufficient in themselves, but they are likely to be very high priority sites for conservation actions and hence are useful in scheduling conservation actions across the landscape. Refer to Table 4 for targets.
  - **Landscape Connectivity Scenario (One).** This scenario has a very strong focus on securing features required for landscape connectivity. Higher conservation targets for connectivity features (i.e. wildlife corridors, expert identified areas for linkages, and areas used by highly mobile key species). The high targets for connectivity

features imply that there this scenario will occur significant addition socio-economic cost in order to achieve landscape connectivity and hence is likely to push into some highly contested landscapes especially across some of the linear transport corridors. Refer to Table 4 for targets.

- **Landscape Connectivity Scenario (Two).** This scenario is much like the previous Landscape Connectivity Scenario and also has a very strong focus on securing features required for landscape connectivity. However, only moderately higher conservation targets are used for connectivity features (i.e. wildlife corridors, expert identified areas for linkages, and areas used by highly mobile key species). The consequence is that this scenario is less land hungry than the previous one and incurs much lower addition socio-economic cost in order to achieve landscape connectivity and will extend less into highly contested landscapes. Refer to Table 4 for targets.
- **No Zone Scenario.** This scenario does not assume conservancy conservation zones (i.e. conservation, hunting, tourism and mixed use zones with a wildlife function). These areas are available for selection, but are not favoured by setting specific targets for these zones. This allows us to use the planning outcomes to evaluate the sufficiency/effectiveness of conservancy zoning in achieving conservation outcomes.
- **No Fixed Corridors Scenario.** Target scenario does not strongly favour existing identified corridors i.e. does not lock in pre-identified wildlife corridors. We used a scenario which did not include existing identified conservation corridors (e.g. those in the Zambezi land Use Plan). These corridors are available for selection but are not favoured by setting specific targets for the corridor itself. This allows us to use the planning outcomes to evaluate the corridor network.
- **Outside Protected Areas (PA) Scenario.** This scenario strongly focusses on securing areas of biodiversity importance, even if the biodiversity features are already well represented in the existing Protected Area Network. The target portions are the same as those used for the baseline scenario but, but the contributions of existing PAs are excluded. By definition, this scenario will be more land hungry and have a higher socio-economic cost.

- The results of the seven scenarios for the two regions (Figure 31) were then evaluated in an expert workshop. A voting and consensus building exercise was undertaken which identified the favoured conservation scenario for each region. The results are covered in the next section.

Zambezi Region Scenarios 1 - 7	Kavango East Region Scenarios 1 - 7
 1	 1
 2	 2
 3	 3
 4	 4
 5	 5

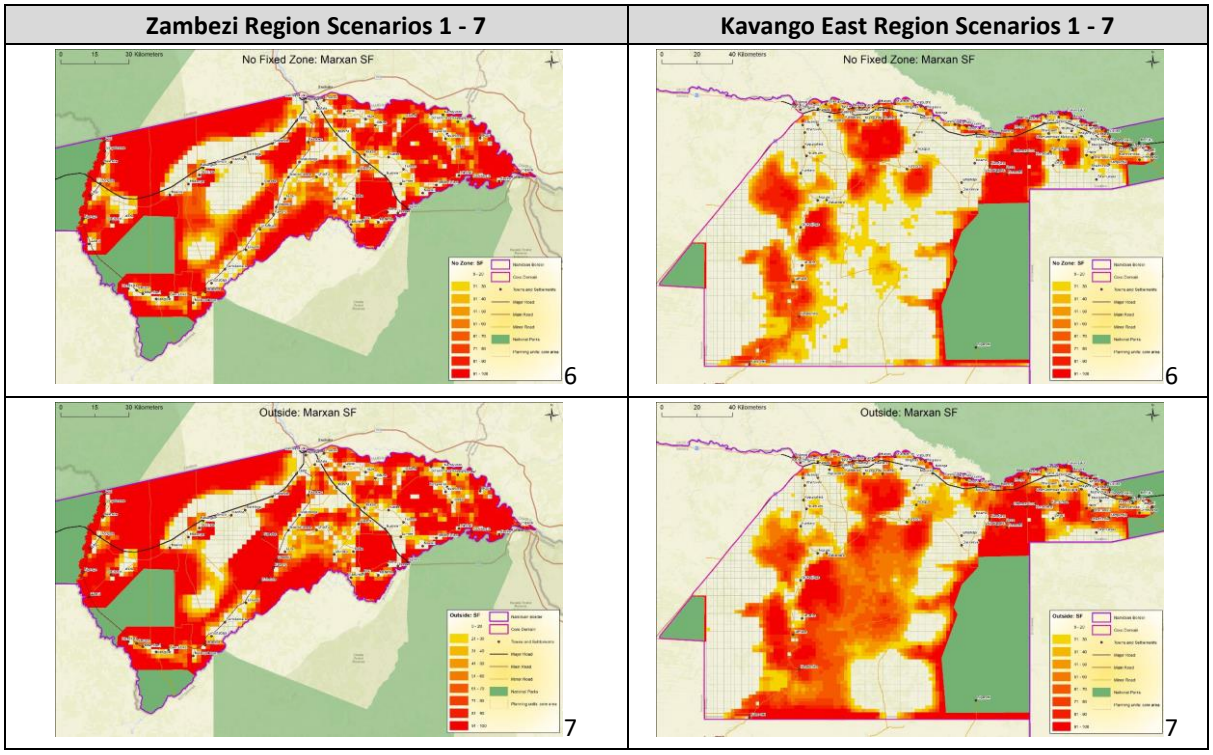


Figure 31: MARXAN Selection Frequency for the seven conservation planning scenarios derived for the Zambezi-Kavango East rapid systematic conservation plan.

Recommended Scenarios

During the expert workshop held with WWF to discuss and build consensus on favoured conservation planning scenarios, the **baseline scenario 1** was recommended for the final conservation prioritization plan for each of the regions (Figure 32).

Of the planning domain approximately 1,397,556 ha or 30,9% was in the highest selection frequency areas for this scenario. Refer to the section below for details and the spatial priorities defined for conservation action during the expert workshop.

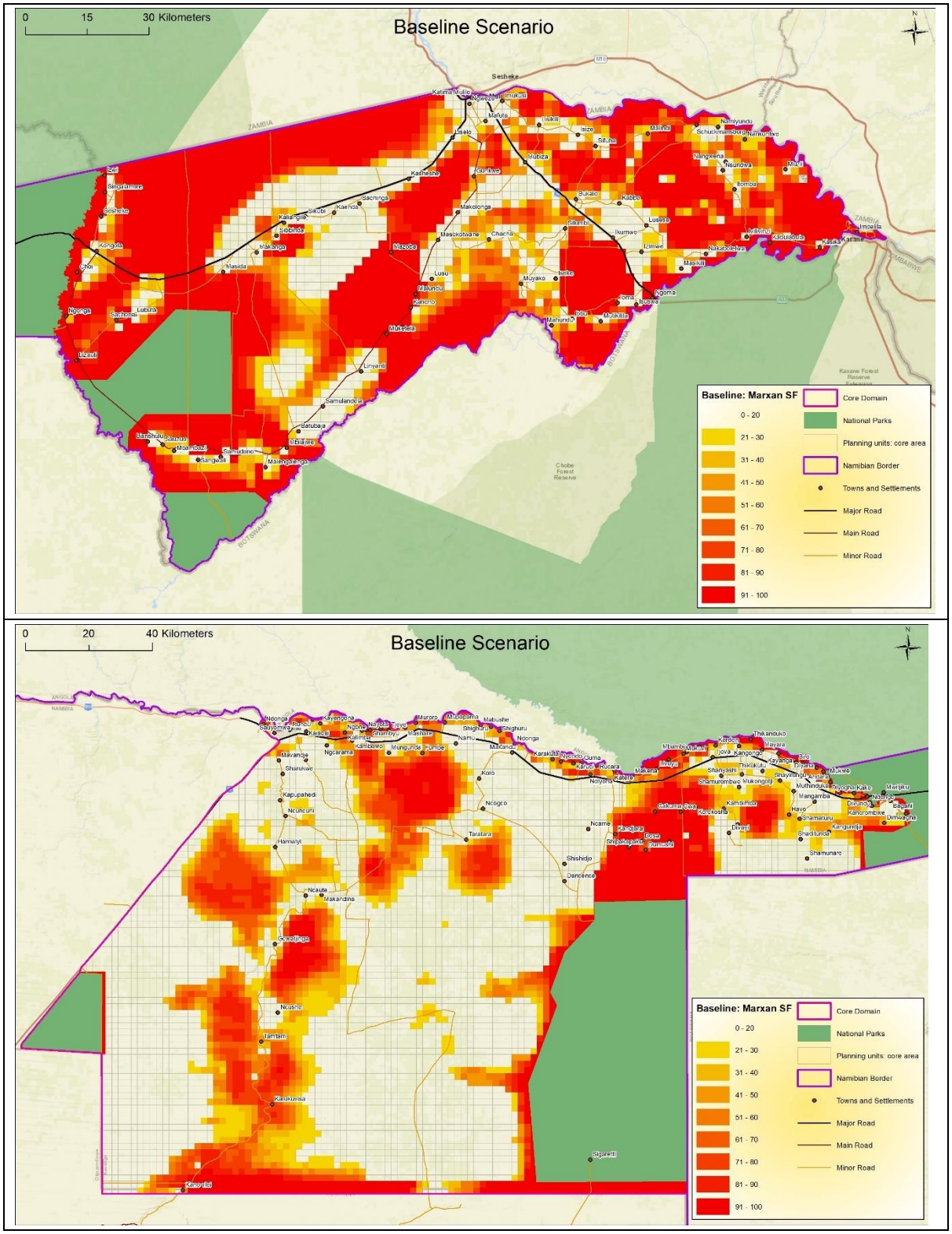


Figure 32: MARXAN Selection Frequency for the recommended baseline scenario 1 derived for the Zambezi-Kavango East rapid systematic conservation plan.

Spatial Priorities Results

Overall Priorities

Once site irreplaceability values for MARXAN were obtained for the favoured **baseline scenario 1**, a set of summary Conservation Priority Areas was developed (see below). These Conservation Priority Areas aid in understanding the spatial prioritization, are useful for describing selected areas, and are easier to include in implementation plans. **These were manually divided into two categories:**

Conservation Priority Area	Definition
Highest Conservation Priority Areas	• These areas are highlighted as the most important for immediate conservation actions. • They are generally less fragmented and have overall higher irreplaceability values. • These areas are most important for overall landscape linkages, and loss of these areas would result in a significant decrease in landscape connectivity. • They were identified as the most important conservation areas in the expert workshop.
Additional Conservation Priority Areas	• These are additional areas of conservation importance; but may be of lower significance. • They are often slightly more fragmented and have lower irreplaceability values. • In some cases, these areas are less connected with the rest of the priority areas network (i.e. they are important, but the remainder of the network is not dependent on them). • Alternatively, these were areas identified in the expert workshop as possibly having significant implementation constraints.

Key aspects of the prioritization

The areas were categorized based on a range of considerations:

- **Irreplaceability.** The baseline MARXAN results were a primary input into the identification of different landscape priorities. To do this, the most frequently selected planning units (generally areas with an irreplaceability value of over 60%, but with some expert adjustment of boundaries to avoid fragmented areas) were selected. "Highest Conservation Priority Areas" generally have the highest irreplaceability scores, "Additional Conservation Priority Areas" either have slightly lower scores or have a range of values, and areas outside of any priority category have low or no irreplaceability values.
- **Expert workshop inputs.** The combined expert views, mapped during an expert workshop, were a key informant of the split into "Highest Conservation Priority Areas", "Additional Conservation Priority Areas" and remaining areas of low priority or practicality for conservation (See Figure 33 and Figure 34). The expert group interactively categorized areas into 'Priority', 'Not a Priority', 'Corridor', 'Possible' and 'Not Realistic'.

- **Alignment with planning instruments and opportunities.** Where possible, we aligned with conservation compatible zones in the underlying land use plan (e.g. in the Land Use Plan in the Zambezi region) and conservancy conservation zones).
- **Landscape linkages.** Critical areas for landscape connectivity were generally assigned to the "Highest Conservation Priority Areas" category while high value, but less connected sites, were more likely to be "Additional Conservation Priority Areas".
- **Social and economic costs.** High selection frequency areas with high social and economic costs, which reflect high population densities or landscape transformation (e.g. agricultural fields), tended to be placed in the "Additional Conservation Priority Areas". Conservation actions in these areas will be difficult or expensive.
- **Defining boundaries of areas.** An expert mapping approach was used to define boundaries between different areas. For convenience areas were split into manageable sections. We used from the workshop, and where possible aligned with existing conservancies (especially the conservation zones within these conservancies) and corridors. Some manual smoothing/mapping of boundaries was done to improve alignments and connectivity.

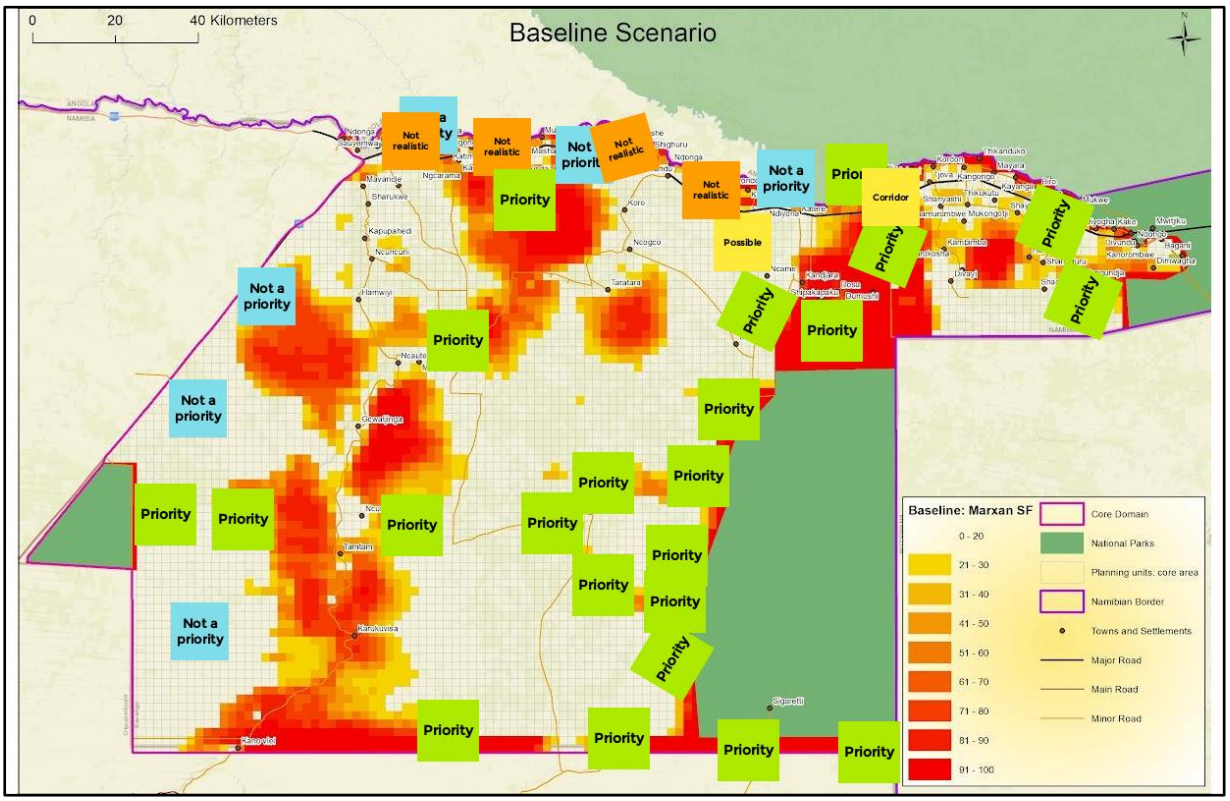


Figure 33: Expert workshop prioritization of initial MARXAN results for Kavango East (with expert views categorised as 'Priority', 'Not a Priority', 'Corridor', 'Possible' and 'Not Realistic').

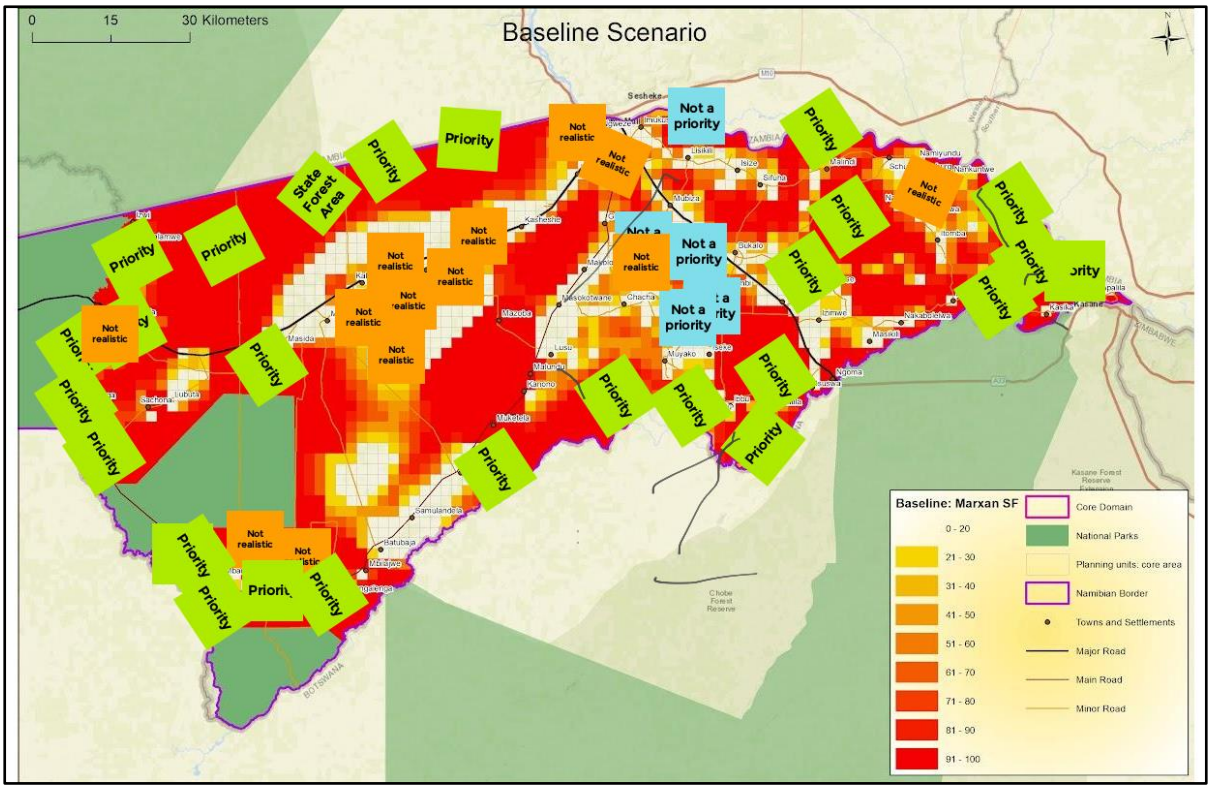


Figure 34: Expert workshop prioritization of initial MARXAN results for Zambezi (with expert views categorised as 'Priority', 'Not a Priority', 'Corridor', 'Possible' and 'Not Realistic').

Priorities – Whole Region

Overall, within the Zambezi-Kavango East SCP planning domain (4,523,176 ha), the **"Highest Conservation Priority Areas"** represent 30.9% (or 1,397,556 ha), whereas 6.4% (or 287,980 ha) were identified as "**Additional Conservation Priority Areas"** (Table 15). National Parks account for 25.6% (or 1,158,395 ha) and areas outside of the conservation priorities are 37.1% (or 1,679,245 ha) of the entire landscape.

Table 15: Summary table of planning unit categories, with Conservation Priority Areas, for the Zambezi-Kavango East SCP recommended baseline scenario 1.

Spatial Planning Category	Extent (ha)	Percent of Domain (%)
Recommended Baseline Scenario 1 – Zambezi-Kavango East Regions		
National Parks	1,158,395	25,6%
Highest Conservation Priority Areas	1,397,556	30,9%
Additional Conservation Priority Areas	287,980	6,4%
Other (outside the above conservation priority areas)	1,679,245	37,1%
Total Area of Planning Domain	**4,523,176**	**100,0%**

Conservation Priority Areas – Zambezi Region

The conservation priority areas for the Zambezi Region are presented in Figure 35, with a summary of the spatial planning categories in Table 16.

The **"Highest Conservation Priority Areas"** cover 36.4% (or 524,303 ha) of the Zambezi planning domain (1,442,167 ha), while 9% of the area (or 130,324 ha) was identified as "**Additional Conservation Priority Areas"**. National Parks account for 27.8% (or 400,905 ha), while the remaining areas outside of the conservation priorities are 26.8% (or 386,635 ha) of the Zambezi Region.

Table 16**:** Summary table of planning unit categories and Conservation Priority Areas for the Zambezi Region's recommended baseline scenario 1.

Spatial Planning Category	Extent (ha)	Percent of Domain (%)
Recommended Baseline Scenario 1 – Zambezi Region		
National Park	400,905	27.8%
Highest Conservation Priority Areas	524,303	36.4%
Additional Conservation Priority Areas	130,324	9.0%
Other (outside the above conservation priority areas)	386,635	26.8%
Total Area of Planning Domain	**1,442,167**	**100.0%**

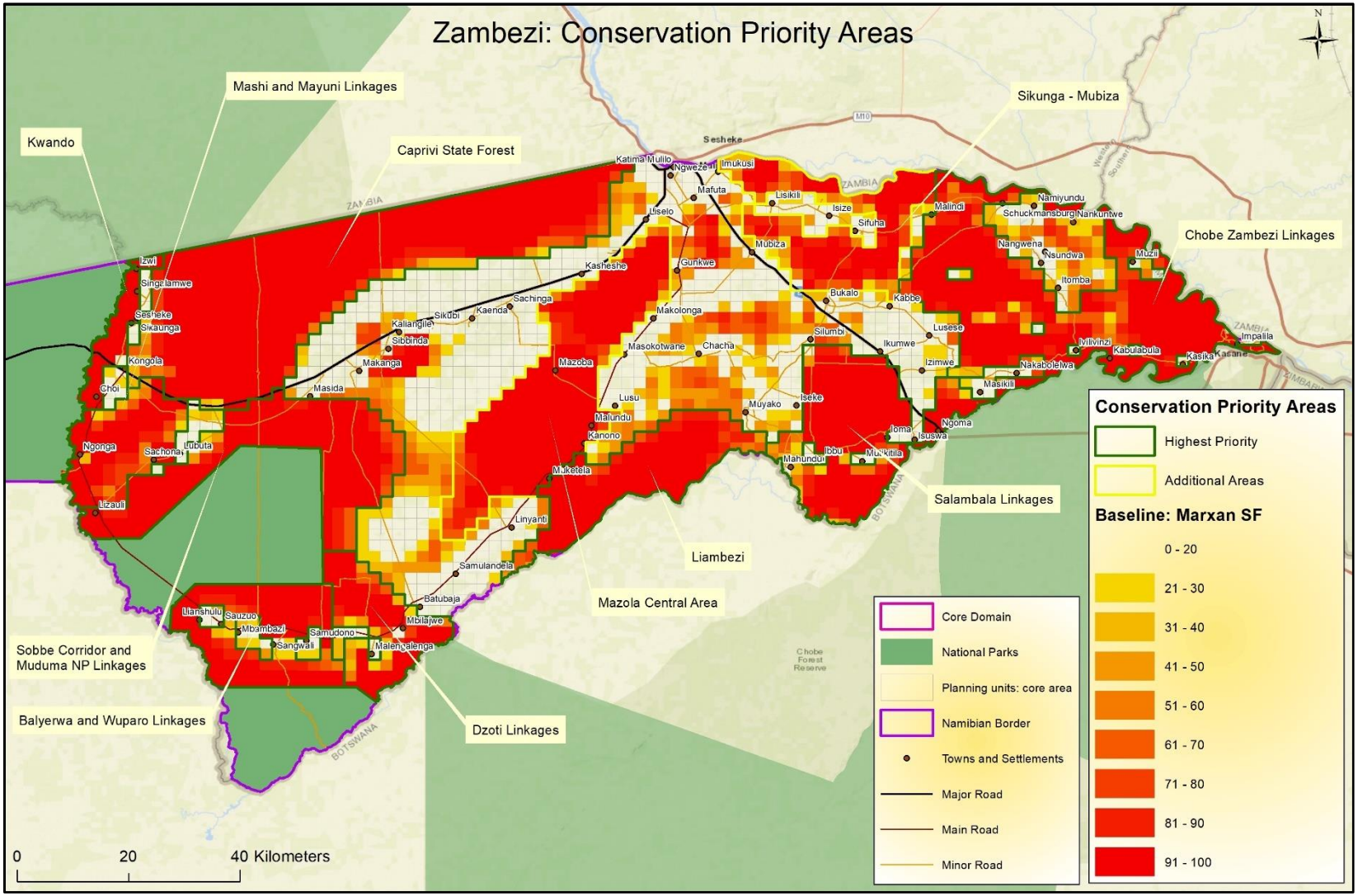


Figure 35: Descriptive map depicting the Zambezi-Kavango East rapid Systematic Conservation Planning (SCP) Conservation Priority Areas for the recommended baseline scenario 1 in the Zambezi Region.

Table 17 below presents a description of the spatial planning categories and Conservation Priority Areas in the Zambezi Region, with summary statistics (extent and proportion), for the Zambezi-Kavango East conservation prioritization plan.

The **"Highest Conservation Priority Areas"** provide critical linkages between the National Parks, the Caprivi / Zambezi State Forest and along major rivers and floodplains, especially Zambezi-Chobe Floodplains, Lake Liambezi, and along the Kwando River. The Mudumu and Nkasa Rupara are the two National Parks in the Zambezi Region that are provided key landscape linkages north to south through Sobbe Corridor and Balyerwa and Wuparo corridors, along the Kwando River. West-east priority linkages are derived through the hydrological process corridors. Mazola Central Area and Sikunga – Mubiza are the "**Additional Conservation Priority Areas"**.

Table 17: Summary of Zambezi Region's Conservation Priority Area descriptions identified in the SCP with the extent (ha) and proportion of the planning domain (%) for the recommended baseline scenario.

Category	Area Description	Area (ha)	Area (%)
National Park		**400,905**	**27.8%**
	Mudumu, Nkasa Rupara & Bwabwata (Kwando Core Area) National Parks	400,905	27.8%
Highest Conservation Priority Areas		**524,303**	**36.4%**
	Balyerwa and Wuparo Linkages	38,765	2.7%
	Caprivi / Zambezi State Forest	148,807	10.3%
	Chobe - Zambezi Linkages	105,604	7.3%
	Dzoti Linkages	29,149	2.0%
	Kwando	11,177	0.8%
	Liambezi	42,521	2.9%
	Mashi and Mayuni Linkages	30,531	2.1%
	Salambala Linkages	56,895	3.9%
	Sobbe Corridor and Mudumu NP Linkages	60,854	4.2%
Additional Conservation Priority Areas		**130,324**	**9.0%**
	Mazola Central Area	82,400	5.7%
	Sikunga - Mubiza	47,924	3.3%
Outside of PA or Priority Area		**386,635**	**26.8%**
	Outside of PA or Priority Area	386,635	26.8%
	Grand Total	**1,442,167**	**100.0%**

<u>Additional conservation issues for the Zambezi Region:</u>

- The finalization and full implementation of the Caprivi /Zambezi Forest Reserve is a priority.
- The key linkages are south (Sobbe Corridor) and west from the Caprivi /Zambezi Forest Reserve.
- Potential additional linkages and conservancies need to be explored in the far east (Zambezi – Chobe Linkages).

Corridor Review - Zambezi Region

A key task of the planning process was to review the landscape corridors for Zambezi. We examined both the broader scale corridors embedded in the Zambezi Land Use plan (Ministry of Lands and Resettlement, 2015), and the recently identified more specific corridor nodes (Ministry of Environment, Forestry and Tourism, 2021; WWF, 2020).

Three approaches were used:

- **Expert evaluation:** Corridors were evaluated by experts in the November 2021 workshop. Corridors were split into priority sections ("Priority"), areas that are "Not a Priority" and sections that were not considered to be realistic ("Not Realistic") (Figure 36).
- **MARXAN irreplaceability and priority areas:** The corridors were mapped/overlaid on the results of the MARXAN analysis, which identified "Highest Conservation Priority Areas" and "Additional Conservation Priority Areas" (Figure 37 and Figure 38).
- **Costs benefit-analysis:** The costs (from the MARXAN cost surface) and benefits (irreplaceability and priority areas) for planning units within the corridors were evaluated (Figure 38). Planning units were divided into four categories depicting various combinations of high or low costs and benefits. Planning units which overlapped corridors (but were outside of Protected Areas) were evaluated. The final baseline cost per planning unit (See Cost Surface: Socio-economic and land use cost features Section) was used as a summary measure of socio-economic costs. Planning units were ranked from lowest to highest costs and those above the median cost score (i.e. the top quantile) were considered to be "High Cost" and those below the median cost (i.e. the bottom quantile) were considered to be "Low Cost". Similarly, the irreplaceability scores from the baseline scenario analysis (See Scenarios Section) were used as a measure of biodiversity benefit. Again, these were ranked this time from highest to lowest, and planning units with above the median score were considered "High" benefit; and units below the median score were "Low" Benefit. In addition, any planning units that were within the identified Conservation Priority Areas were considered to be "High" benefit.

Corridor Results

The following six corridor sections were consistently important in the MARXAN analyses and are "Highest Conservation Priority Areas" (from west to east) (Figure 37 and Figure 38):

- Mashi and Mayuni Linkages
- Kwando
- Sobbe Corridor and Mudumu NP Linkages
- Balyerwa and Wuparo Linkages
- Dzoti Linkages
- Salambala Linkages

The following two sections were consistently of lower benefit and feasibility for corridor purposes. They were and were therefore considered "Not a Priority" or "Not Realistic"; and do not fall within the Conservation Priority Areas (Figure 36 and Figure 38):

- The large north-south corridor running through Sibbinda; and then southwards to Samulandela.
- The smaller north-south corridor running through the Silumbi- Mubiza section, in the east.

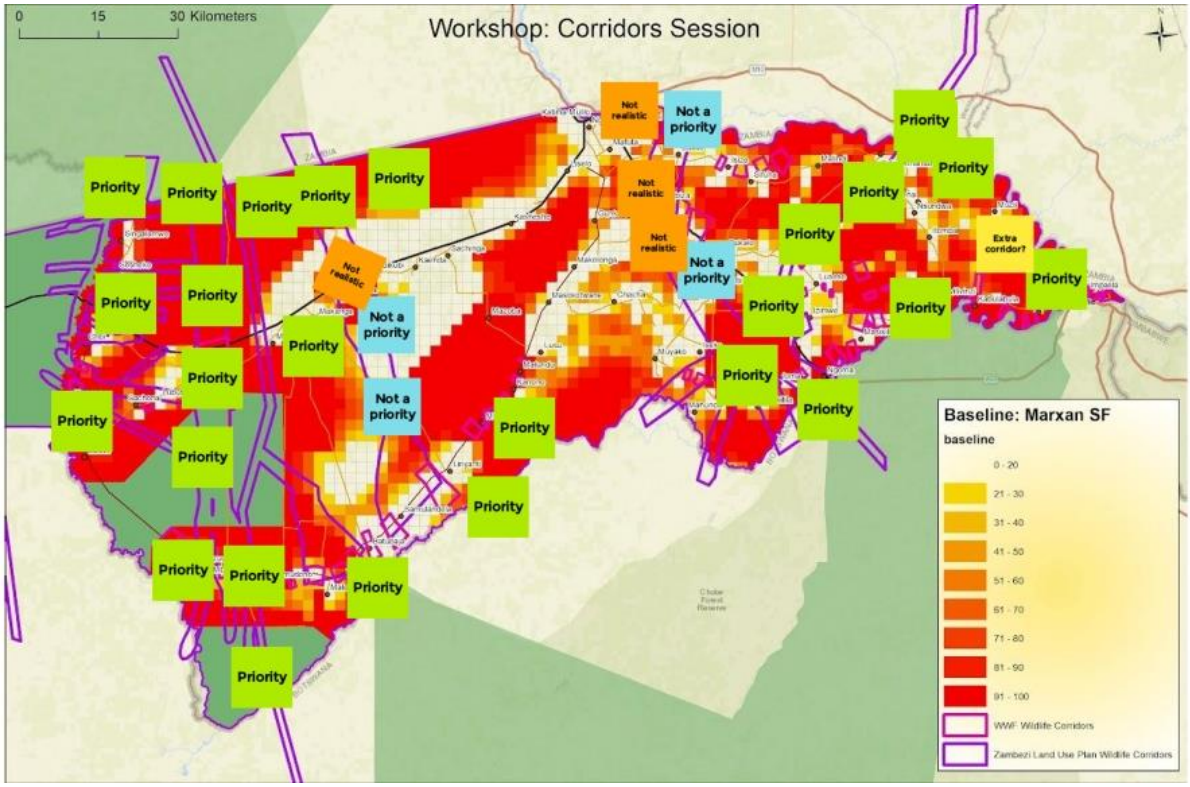


Figure 36: Results of the workshop expert evaluation of corridors. Corridors were split into priority sections ("Priority"), areas that are not a priority ("Not a Priority") and sections that were not considered to be realistic ("Not Realistic").

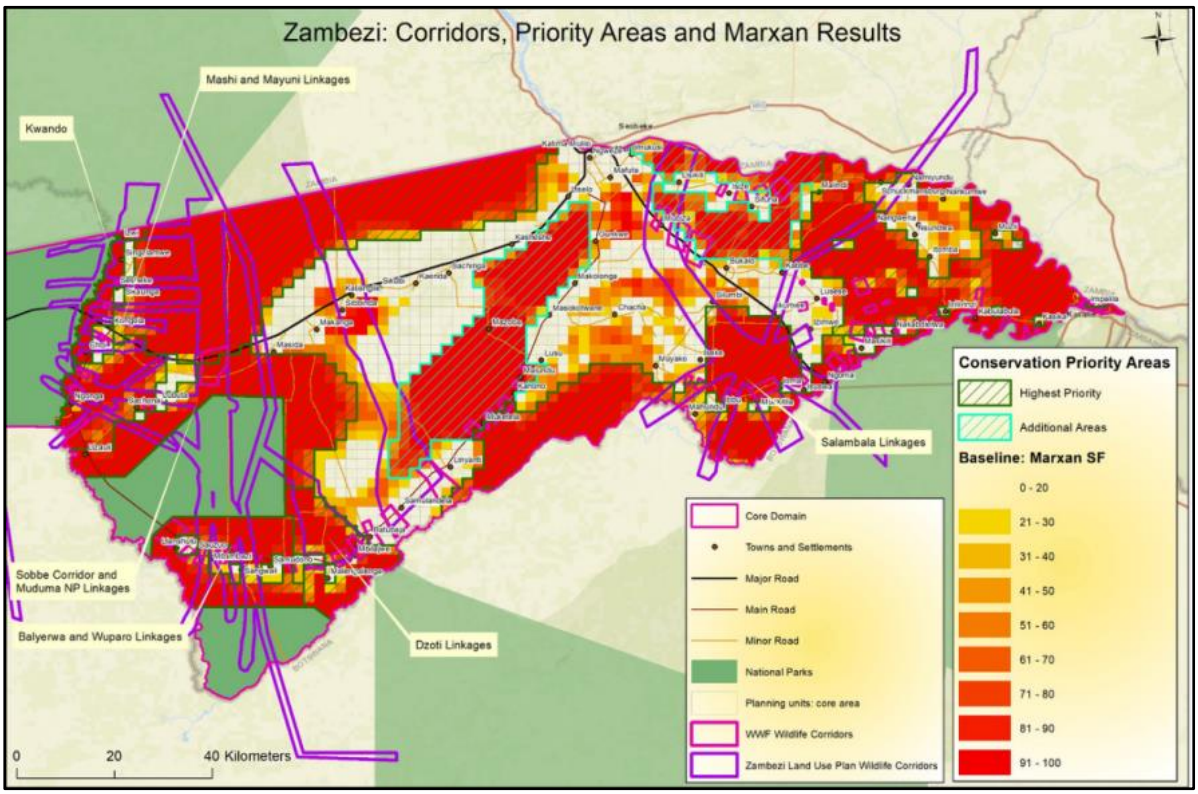


Figure 37: Map showing corridors in relation to the identified "Highest Conservation Priority Areas", "Additional Conservation Priority Areas" and the MARXAN selection frequency. For clarity, only the priority areas which are relevant for corridors are annotated.

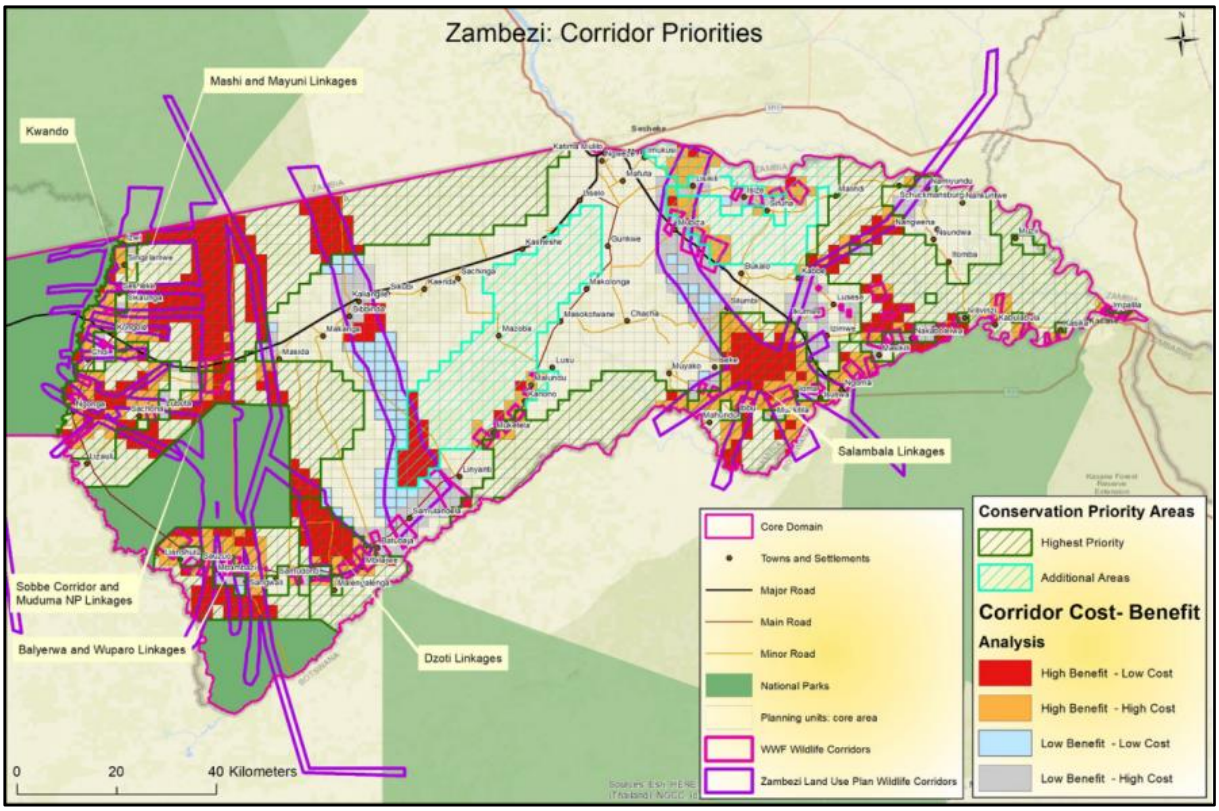


Figure 38: Evaluation of the existing corridor network for Zambezi. The costs (from the MARXAN cost surface) and benefits (irreplaceability and priority areas) for planning units within the corridors were evaluated. Planning units were divided into four categories of various combinations of high or low costs and benefits. Conservation Priority Areas with specific importance (based on this analysis) are annotated.

Conservation Priority Areas – Kavango East Region

The Conservation Priority Areas for the Kavango East Region are presented in Figure 39, with a summary of the spatial planning categories in Table 18.

The **"Highest Conservation Priority Areas"** cover 28.3% (or 873,253 ha) of the Kavango East planning domain (3,081,010 ha), while 5.1% (or 157,656 ha) are **"Additional Conservation Priority Areas"**. National Parks account for 24.6% (or 757,490 ha), with 42% (or 1,292,610 ha) being outside of these areas.

Table 18: Summary table of Conservation Priority Areas for the Kavango East Region.

Spatial Planning Category	Extent (ha)	Percent of Domain (%)
Recommended Baseline Scenario 1 – Kavango East Region		
National Park	757,490	24.6%
Highest Conservation Priority Areas	873,253	28.3%
Additional Conservation Priority Areas	157,656	5.1%
Other (outside the above conservation priority areas)	1,292,610	42.0%
Total Area of Planning Domain	**3,081,010**	**100.0%**

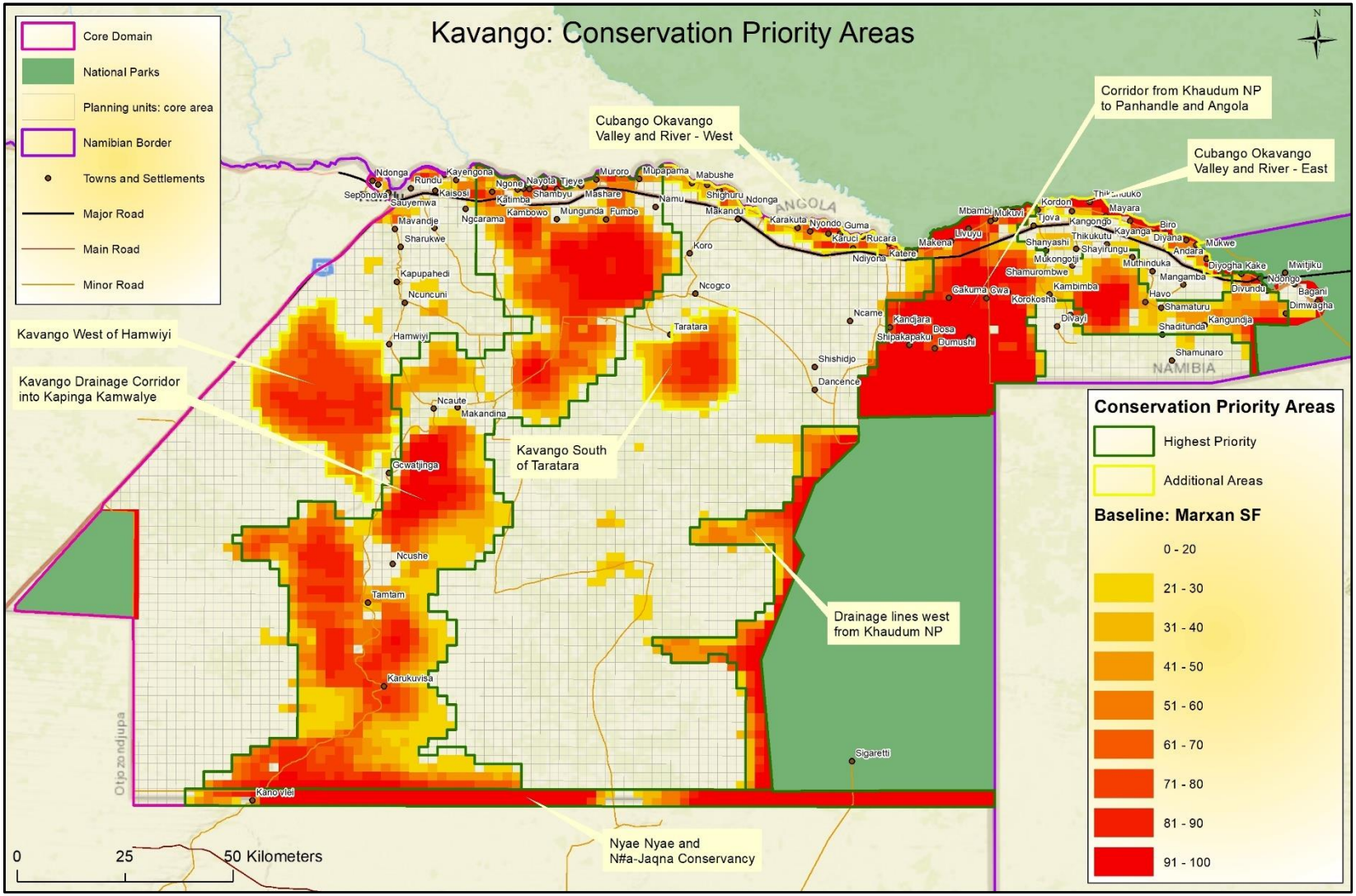


Figure 39. Descriptive map depicting the Zambezi-Kavango East rapid Systematic Conservation Planning (SCP) Conservation Priority Areas for the recommended baseline scenario in the Kavango East Region.

Table 19 below presents a description of the spatial planning categories and Conservation Priority Areas in the Kavango East Region, with summary statistics (extent and proportion), for the Zambezi-Kavango East conservation prioritization plan.

The **"Highest Conservation Priority Areas"** provide critical linkages between the National Parks and along major rivers and floodplains. The Omataka River drainage system to Kapinga Kamwalye, is especially important, a main north-south tributary of the Cubango (Kavango) River. Khaudum and Bwabwata National Parks are connected through the Khaudum-Nga Corridor. This corridor also provides critical landscape linkages to the Zambezi Region and the neighbouring KAZA TFCA countries.

The Kavango Taratara and Hamwiyi, including the Cubango Okavango Valley and River sub-catchments represent the "**Additional Conservation Priority Areas"**, providing east-west linkages. These Conservation Priority Areas represent important hydrological process corridors, forest habitat and wildlife habitat range for the threatened African Wild Dog (Figure 11a).

Table 19: Summary of Kavango East Region's Conservation Priority Area descriptions identified in the SCP with the extent (ha) and proportion of the planning domain (%) for the recommended baseline scenario.

Category	Area Description	Area (ha)	Area (%)
National Park		**757,490**	**24.6%**
	Khaudum, Bwabwata, Popa & Mangetti National Parks	757,490	24.6%
Highest Conservation Priority Areas		**873,253**	**28.3%**
	Corridor from Khaudum NP to Panhandle and Angola	202,360	6.6%
	Drainage lines west from Khaudum NP	69,046	2.2%
	Kavango Drainage Corridor into Kapinga Kamwalye	533,475	17.3%
	Nyae Nyae and N#a-Jaqna Conservancy	68,372	2.2%
Additional Conservation Priority Areas		**157,656**	**5.1%**
	Cubango Okavango valley and river - East	13,229	0.4%
	Cubango Okavango valley and river - West	18,827	0.6%
	Kavango South of Taratara	40,000	1.3%
	Kavango West of Hamwiyi	85,600	2.8%
Outside of PA or Priority Area		**1,292,610**	**42.0%**
	Outside of PA or Priority Area	1,292,610	42.0%
	Grand Total	**3,081,010**	**100,0%**

<u>Additional conservation issues for the Kavango East Region:</u>

- Extend the KAZA boundary to Kavango West.
- The importance of the Mangetti National Park linkage to the east needs to be examined, as well as possibly to the north. The current analysis suggests that it is not a priority. Workshop feedback indicates that conservation actions in this area may also be unrealistic. Nevertheless, the options (including potential conservancies) should be investigated.
- In the south of the region, the options for support and promotion of the Nyae Nyae People's Park should be explored.

- Key issues for Khaudum National Park are: (i) removal of the veterinary fence on the eastern boundary with Botswana (to allow for predator and elephant migrations), and (ii) to explore options for allowing buffalo in the park.
- There are important areas along the Cubango Okavango Valley and River. However, the consensus is that these areas are either not a priority or are, realistically, not achievable.

Alignment opportunities between Community Based Natural Resource Management (CBNRM) and Spatial Priorities

A key objective for WWF Namibia is to identify Conservation Priority Areas that align with Community Based Natural Resource Management (CBNRM) areas. This would enable the prioritization of support to existing and emerging CBNRM situated in these spatial priorities.

To achieve this, the MARXAN irreplaceability values (for the baseline scenario) (Figure 32), were mapped against the existing and emerging CBNRM areas (Figure 40 and Figure 41).

The existing CBNRM areas consist of the following conservation land use categories:

- Twenty-two (22) registered conservancies in the Zambezi-Kavango East region. These include 15 conservancies in Zambezi, five conservancies in Kavango East and the northern portions of two conservancies of Namibia's Otjozondjupa Region (i.e. at the southern end of Kavango East).
- The conservation zones of these registered conservancies, which are comprised of:
    - Exclusive Wildlife: All Wildlife Utilization
    - Exclusive Wildlife: No Disturbance
    - Exclusive Wildlife: Tourism Only (No Hunting)
    - Exclusive Wildlife: Trophy Hunting Only
    - Multiple Use: Hunting Priority
    - Multiple Use: Tourism Priority
- The proposed Caprivi / Zambezi State Forest.
- Communal Forest Areas.

It is important to note that these categories are not exclusive and are often forest areas and conservancies overlap.

Results of the assessment

Alignment opportunities between Community Based Natural Resource Management (CBNRM) and Spatial Priorities are presented in Figure 40 and Figure 41. Overall, the CBNRM focus areas are well aligned with the identified Conservation Priority Areas. The key priorities for the Zambezi and Kavango East regions are outlined below.

Main priorities for Community Based Natural Resource Management (CBNRM) highlighted for the Zambezi Region

- It is critical to complete the Caprivi /Zambezi State Forest declaration process and ensure that related conservation initiatives are optimized.
- The existing registered conservancies are generally very strongly aligned with conservation priorities. It is unclear, but to some extent only of academic interest whether this alignment is because the conservancies were located in the highest value (or best remaining) wildlife areas, or because the conservancies have allowed this value to persist or even improve. Either way, continued investment in these areas is clearly a priority. Ten of the conservancies fall in the highest value areas, namely: Sobbe, Kwandu, Balyerwa, Mayuni, Wuparu, Bamunu, Salambala, Kasika, Impalila and Dzoti. While three, namely Sikunga, Lusese and Nakabolelwa, are partially in marginally lower priority areas.
- The conservation zones of existing registered conservancies (e.g. Sobbe, Kwandu, Salambala) are very well aligned with the conservation priorities highlighted in the MARXAN analysis.
- The emerging conservancies are generally in lower priority areas than the existing conservancies. Mbara, Mahachani, Siluka and Mulisi are all in areas of lower overall selection frequency. This suggests that it may be a higher priority to optimize or fully implement the existing conservancies rather than focussing on emerging conservancies.

Main priorities for Community Based Natural Resource Management (CBNRM) for the Kavango East Region

- Although the existing conservancy network is more limited than in Zambezi, the conservancies are strongly aligned with the Conservation Priority Areas. Support for conservation activities and optimal outcomes from these conservancies is therefore a clear priority. The existing conservancy network overlapping high selection frequency areas includes:
    - Clustered in the west, the Kapinga, Kamwalye and (to a lesser extent) the Joseph Mbambangandu conservancies are core to the main Kavango Drainage Corridor priority area.
    - The George Mukoya and Muduva Nyangana conservancies consolidate the corridor north from Khaudum National Park.
    - In the south, the northern portions of Nyae Nyae and N=/=a Jaqna provide an important west-east linkage across the region.
    - In the east, although “isolated” from the George Mukoya and Muduva Nyangana conservancies, the Shamungwa Conservancy falls within “Highest Conservation Priority Areas” that links to Bwabwata National Park.
- The conservation zones of the existing conservancies are fairly limited. Most conservation zones are situated north of Khaudum National Park and in the small portions of the Nyae Nyae and N=/=a Jaqna conservancies, which only just fall within Kavango East. Where possible, strengthening of the conservation objectives, activities and zoning of existing conservancies should be supported.
- Nhoma is the only emerging conservancy in the area. It completes the west-east linkage in the far south of the region between the Nyae Nyae and N=/=a Jaqna conservancies.
- Existing communal forests are in some identified “Highest Conservation Priority Areas” and “Additional Conservation Priority Areas”. Potential for supporting CBNRM activities should be explored in the communal forest located within the Kavango Drainage Corridor priority area, as well as the “Additional Conservation Priority Areas” west of Hamwiyi (Kavango West) and in Taratara (Kavango South).

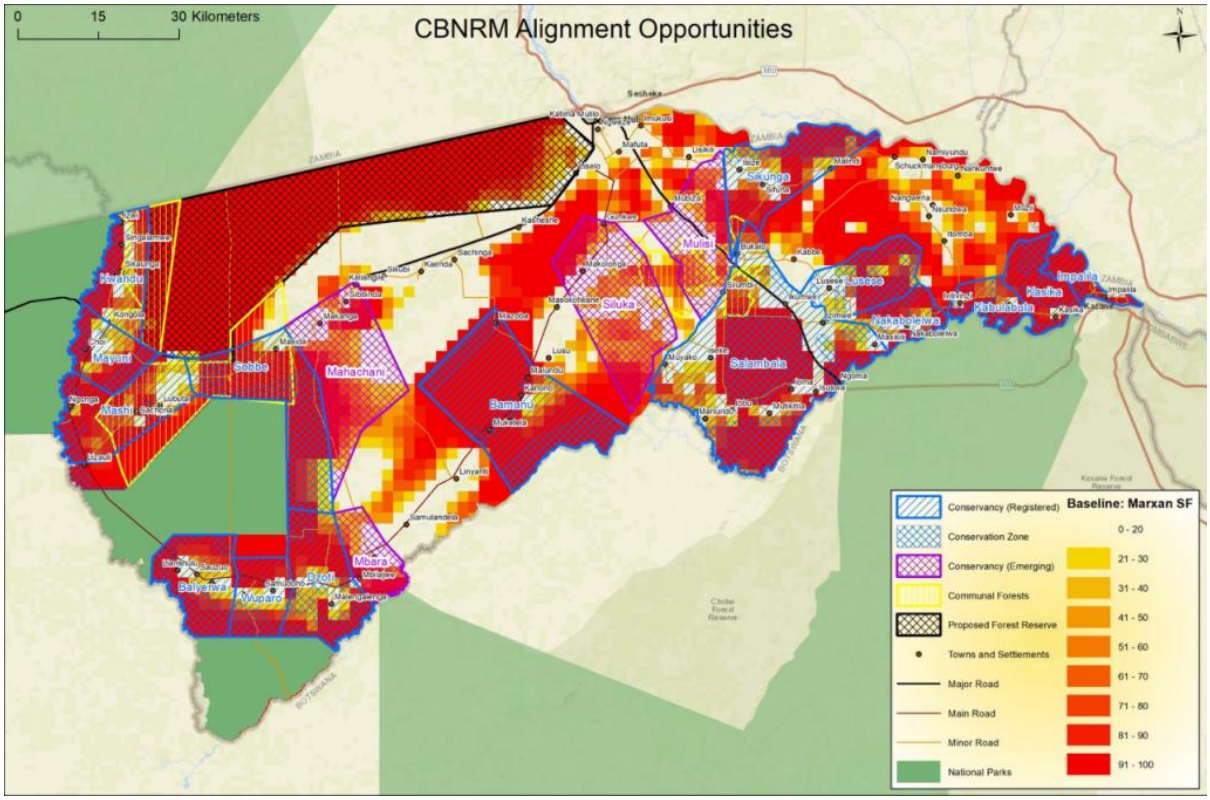


Figure 40: CBNRM alignment opportunities with the baseline scenario's MARXAN selection frequency values in the Zambezi Region, Namibia.

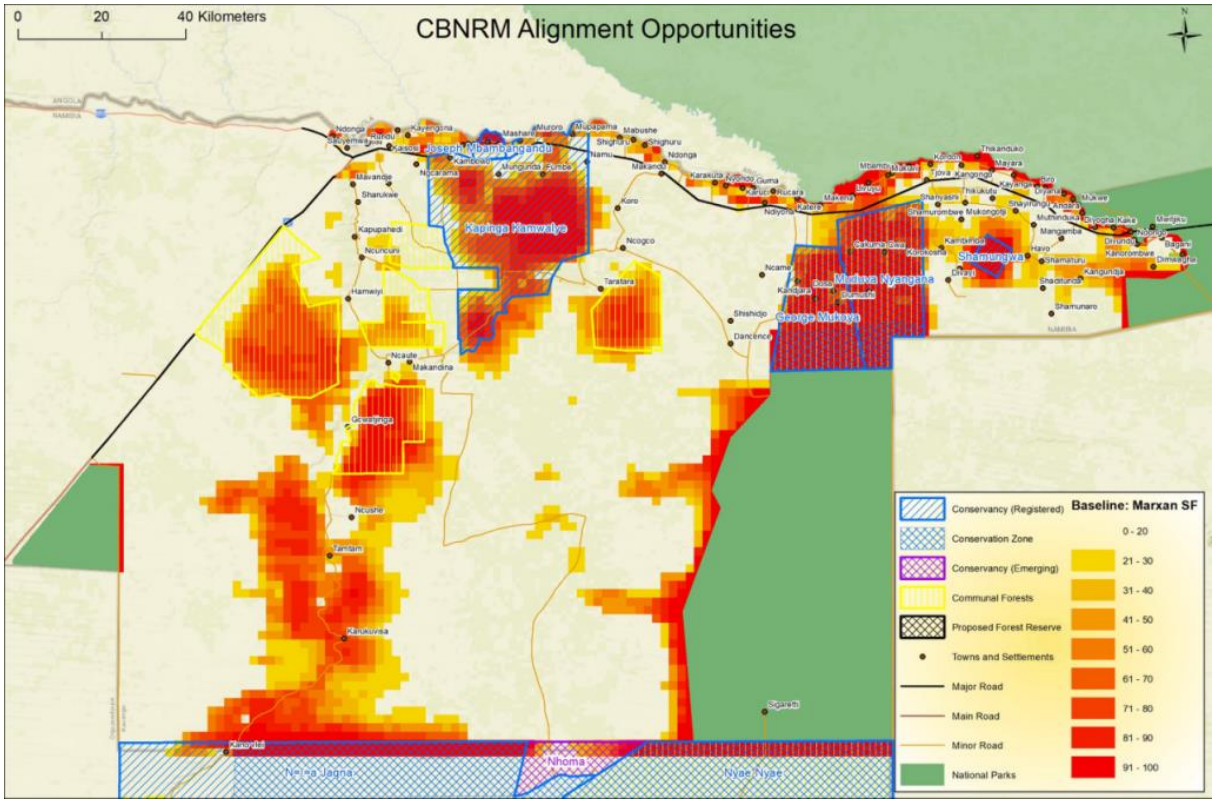


Figure 41: CBNRM alignment opportunities with the baseline scenario's MARXAN selection frequency values in the Kavango East Region, Namibia.

Conclusion

The Zambezi and Kavango East Regions of Namibia provide a critical network of wildlife corridors linking Namibia to its neighbouring KAZA TFCA countries, Angola, Botswana, Zambia and Zimbabwe.

Consequently, this rapid systematic conservation plan for Zambezi and Kavango East was needed to identify priority conservation areas for a regional specific integrated conservation support plan. MARXAN systematic conservation planning software was run for seven conservation planning target scenarios. Expert input was used to select the **baseline scenario 1** as the final conservation prioritization plan. A set of summary Conservation Priority Areas was then developed, consisting of "Highest Conservation Priority Areas" and "Additional Conservation Priority Areas".

The Zambezi Region has nine "Highest Conservation Priority Areas", stretching across 36,4% of this region, with six of these representing critical wildlife corridors, namely: Mashi and Mayuni Linkages, Kwando, Sobbe Corridor and Mudumu NP Linkages, Balyerwa and Wuparo Linkages, Dzoti Linkages and Salambala Linkages. Two "Additional Conservation Priority Areas" were identified, namely the Mazola Central Area and Sikunga – Mubiza, which together represent 9% of the Zambezi Region.

The Kavango East Region has four "Highest Conservation Priority Areas", covering 28,3% of this region, effectively providing two north-south corridor linkages and a buffer to Khaudum NP and its associated drainage systems. Four "Additional Conservation Priority Areas" provide east-west linkages and comprise 5.1% of the Kavango East Region.

The Conservation Priority Areas align well with a number of existing Community Based Natural Resource Management (CBNRM) areas in the Zambezi-Kavango East planning domain. In the Zambezi Region, it is recommended that, rather than focussing on emerging conservancies, it may be a higher priority to optimally implement and support existing conservancies. Completing the declaration process for the Caprivi /Zambezi State Forest is also critical. In the Kavango East Region, supporting conservancies is also a clear priority. In addition, it is recommended that the support of CBNRM activities should be explored in the communal forest located within the Kavango Drainage Corridor priority area, as well as the "Additional Conservation Priority Areas" west of Hamwiyi and at Taratara.

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