Mapping Essential Life Support Action Areas

in South Africa

Science Brief

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forestry, fisheries & the environment
Department: Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

SANBI
Biodiversity for Life
South African National Biodiversity Institute

BIOFIN
The Biodiversity Finance Initiative

Impact Observatory

UNDP

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Executive Summary

This brief aims to provide a concise summary of the science behind the Essential Life Support Action Area (ELSAA) map and online webtool for South Africa. The ELSAA map and webtool have been developed through the Mapping Nature for People and Planet project in South Africa.

Chapter 1 of this science brief provides background information on the ELSAA process in South Africa. Chapter 2 describes the science behind ELSAA and elucidates how the process can contribute to the nation's priorities by creating an action map that shows where nature-based actions can lead to optimal impacts across key policy commitments. For further information using ELSAA webtool, please refer to the ELSAA Webtool User Guide.

1.Introduction: Essential Life Support Action Areas (ELSAAs)—what and why

Background

Maintaining a healthy planet where people and ecosystems thrive requires reliable, timely, decision-relevant information. While the number of global, biodiversity-based information sources grows daily, few are accessible and curated to meet the needs of policymakers at the national scale. A user needs assessment of 60 Parties to the Convention on Biological Diversity (CBD) conducted by the United Nations Development Programme (UNDP) in 2018 identified four significant barriers to integration of spatial data into national policy:

1. Spatial data is inaccessible,
2. Spatial data is unusable,
3. Spatial data is not nationally validated, and
4. Governments lack the capacity to use spatial data.

To put it simply, although earth observations are available that have potential to support implementation of the Sustainable Development Goals (SDGs), countries are not utilizing them. This 'data gap' takes a toll on national efforts to safeguard nature and related ecosystem services.

In South Africa, despite the existence of high technical capacity and quality data, the government faces similar challenges, including: siloed planning across sectors and variable access to spatial technology. In addition, spatial data capacity tends to be contained to a small community of practice.

The Endeavor: Mapping Nature for People and Planet

The Mapping Nature for People and Planet Partnership brings together scientists and policy experts to harness earth observations to deliver on national priorities. To do this, the partnership works closely with countries to identify their essential life support action areas (ELSAAs), defined as areas where nature-based actions can safeguard key biodiversity and ecosystem services.

Nature-based actions refer to land and sea management that address the biodiversity crisis, climate crisis, and promote sustainable development. These actions typically include the protection, management, and/or restoration of ecosystems, but can be adapted based on national context.

The partnership has created a scientific framework and decision support system to bring together national data in a central repository, to identify ELSAAs that show where nature-based actions should be taken based on national priorities, and to monitor the impact of these actions. Our theory of change is that map-based, credible, high-quality information combined with capacity building at the national level will drive shifts in policy implementation and reporting to deliver on the 2030 Agenda and the Rio Conventions.

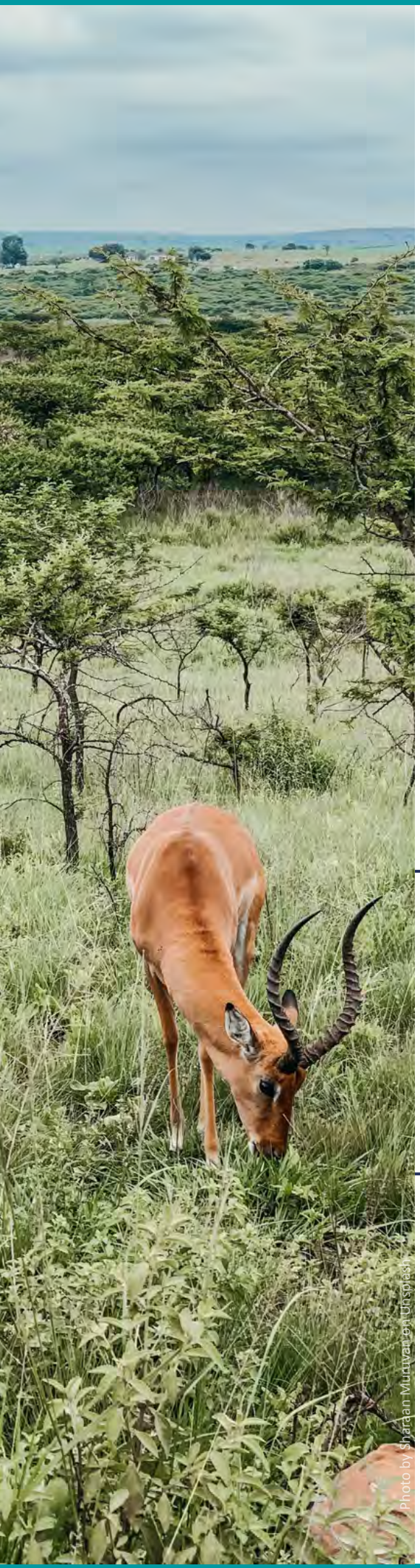
The project has supported South Africa to:

1. Consolidate national data to create a national repository of spatial data on biodiversity and ecosystem services;
2. Apply rigorous scientific methodology to create a systematic conservation planning tool to identify ELSAAs; and
3. Use earth observations to monitor and report on progress towards achieving the 2030 Agenda and other key international commitments.

Project outcomes will be added to South Africa's secure workspace on the UN Biodiversity Lab, an UN-supported platform that provides countries with access to the best global and national spatial data on biodiversity, ecosystem services, and sustainable development. To request access to South Africa's workspace, please contact Nokutula Mhene (nokutula.mhene@undp.org) and/or Carol Lefakane (C.Lefakane@sanbi.org.za). The successful approaches developed in South Africa will inform the further development of the project in other pilot countries.

The Partnership

Working with South Africa, Cambodia, Chile, Colombia, Costa Rica, the Dominican Republic, Haiti, Ecuador, Kazakhstan, Nepal, Peru, and Uganda as the 12 initial pilot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countries, this work brings together a powerful coalition of governments, NGOs, research institutes, and intergovernmental organizations.

The South Africa case:
In South Africa, the project is led by the United Nations Development Programme (UNDP), the South Africa Department of Forestry, Fisheries and the Environment (DFFE), the South African National Biodiversity Institute (SANBI) and the Biodiversity Finance Initiative, with funding from the Sustainable Markets Foundation. Technical support is provided by Impact Observatory.

Participating institutions include: South Africa's Department of Agriculture, Land Reform and Rural Development, the Department of Science and Innovation, the Council for Scientific and Industrial Research (CSIR), South African National Parks, the International Union for Conservation of Nature (IUCN), the United Nations Environment Programme (UNEP), national universities, and NGOs such as Endangered Wildlife Trust and Kruger to Canyons, among others.

Quick Resources on ELSA(A)

Note: In South Africa, the term Essential Life Support Action Areas (ELSAA) is used instead of Essential Life Support Areas (ELSA). This term was changed to better reflect the South African context and desire to emphasize implementation and action. However, in other countries and general materials, the term ELSA is maintained.

Introduction to ELSAA

- ELSA trailer: This 4-minute introductory video explains the basics of mapping ELSAs and tours the world to explore how different countries are applying the ELSA process.
- ELSA brochure: This 8-page polished publication provides an introduction to ELSA and how countries around the world are using the ELSAA process.
- Monitoring ELSAs using dynamic data: This 2-minute presentation introduces new high-resolution land use land cover data that can help to monitor progress towards a country's priority policy commitments.

- Project document: A 6-page document summarizing the key elements of ELSAA in South Africa.
- ELSA vision: This 8-minute video elucidates the foundation and goals of the ELSA methodology.
- ELSA recipe: This 12-minute video provides an overview of the 10 steps of the ELSA approach.

Science of ELSAA

- Training on Systematic Conservation Planning: This session offered by PacMARA to South Africa scientists and leaders introduces the fundamentals of the science behind ELSA, Systematic Conservation Planning.
- Training on prioritizr: This session offered by Richard Schuster, Carleton University, shows the details of the prioritizr R code that runs the ELSAA analysis. Further information is available from the prioritizr website and the prioritizr workshop manual.
- Data included in South Africa ELSAA analysis: This presentation slides describes the pre-processing of the datasets included in the second ELSAA map for South Africa.
- Development of South Africa's second ELSAA map (Day 1 | Day 2): These recordings show the interactive co-creation of South Africa's second ELSAA map.

ELSAA in South Africa

- South Africa solution video: In this 5-minute video, South Africa national authorities showcase the importance and opportunities that the ELSAA project represents for the country.
- Workshops:

1. First workshop website
2. First workshop report
3. Second workshop website
4. Second workshop report

ELSA in Other Countries

- Learning for Nature ELSA Community of Practice
- Costa Rica project overview and solution video
- Kazakhstan project overview and solution video
- Uganda project overview and solution video
- Colombia project overview and solution video
- Dominican Republic solution video
- Ecuador solution video
- Cambodia solution video

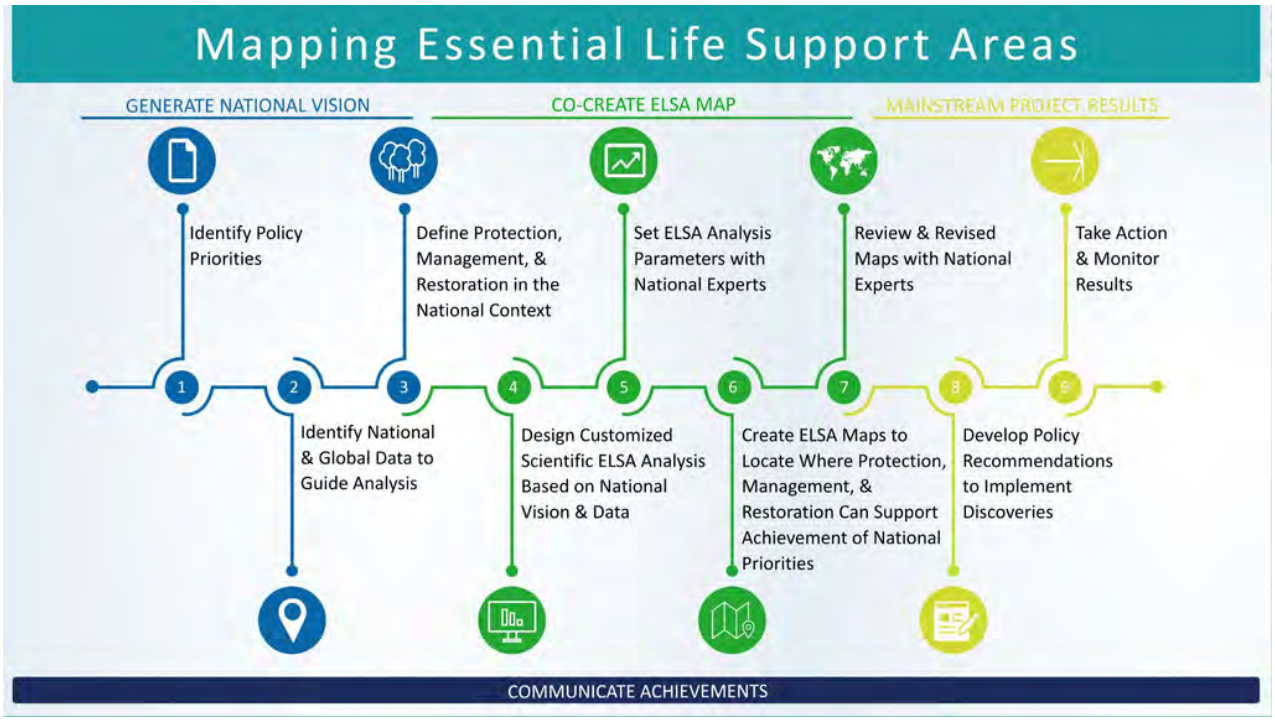
2.The Science of ELSAA

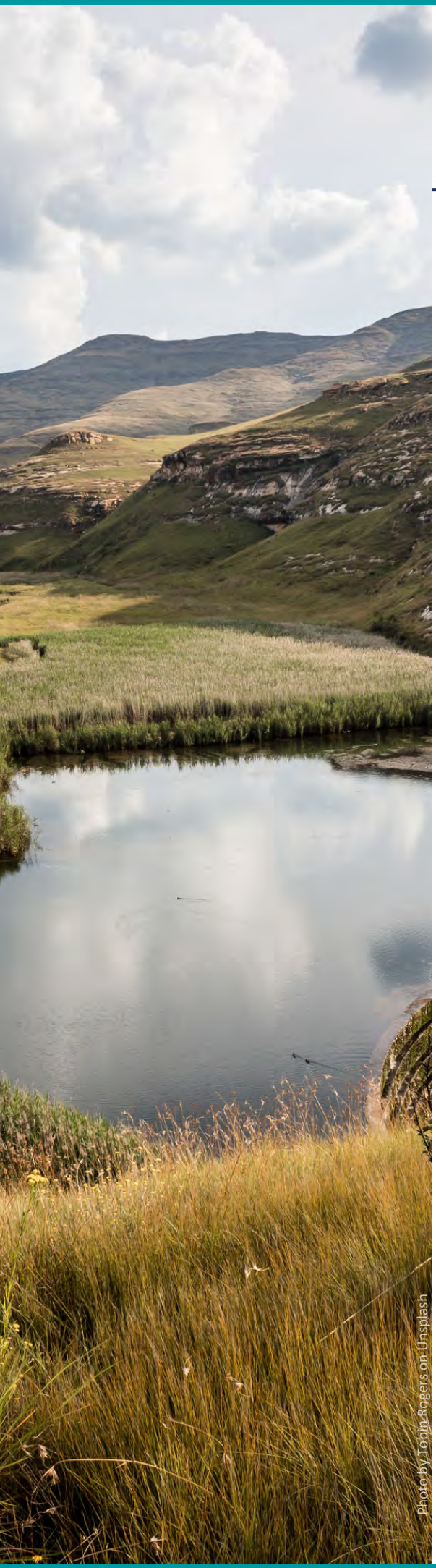
Overview of the ELSAA Process

In order to identify key nature-based actions that can support priority policy commitments in South Africa, the ELSAA process includes four broad areas of work: (1) Identify priority policy commitments; (2) Collect national and global data to map these commitments; (3) Produce ELSAA action maps, or 'maps of hope', that create a roadmap to achieve the key commitments; (4) Inform national decision making, implementation, and reporting.

These four areas of work are composed of nine steps, as well as an overarching focus on communication throughout the project. In South Africa, stakeholders worked together to execute the nine steps of the ELSAA process, with a continued focus on steps 8 and 9 on policy development and implementation & monitoring, as well as on communication (Figure 1).

FIGURE 1. THE ELSAA PROCESS

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Methods Used to Create the ELSAA Map

- The policy: How does each country identify its priority policy commitments?

ELSAA uses spatial data as a tool to identify where nature-based actions will have maximum impact for biodiversity, climate change, and sustainable development across a country's most critical policy commitments. To do this, the Mapping Nature for People and Planet partnership core team first identifies: (1) the most important nature-based policy commitments in each country (Figure 1, Step 1), and (2) the nature-based actions endorsed as policy solutions (Figure 1, Step 3). These are both determined through an extensive stakeholder engagement process.

1. Identification of nature-based policy commitments. First, the core team identifies up to ten central policy documents they would like to guide the ELSAA process. These documents might include the full scope of the country's priorities for biodiversity, climate change, and sustainable development, or a country might choose to focus on a particular project or plan or interest, such as water security. The core team then conducts a rapid policy analysis to identify the nature-based commitments (priority commitments) within these policies. Finally, during the first project workshop, the project core team works with a diverse group of national stakeholders to survey these nature-based commitments, determine which can be mapped using spatial data, and identify up to 10 that are most critical for the nation's strategic priorities.
2. Identification of nature-based actions. The nature-based actions used in the ELSAA analysis are actions to protect, restore, avoid loss, reduce pressures, and urban adapt. The ELSAA analysis will determine the best place for each of these actions to be implemented in order to support the achievement of the 10 priority policy commitments. Each nature-based action is defined in consultation with national stakeholders to provide a clear picture of how it is conceived and implemented in a given country.

In addition, an area-based target for each nature-based action is identified based on existing policy commitments. These area-based targets provide a key input into the ELSAA analysis by setting the amount of land area the analysis can recommend for protection, restoration, loss avoidance, pressures reduction, and urban adaptation in order to contribute to the achievement of the 10 priority policy commitments.

The ELSAA Policy Priorities in South Africa

In South Africa, ten priority policy commitments were initially identified. They are shown in Figure 2. The selected policy commitments span water security, ecological infrastructure, invasive alien species, ecosystems conservation and restoration, climate change mitigation and adaptation, and jobs in the wildlife sector.

For more information on baselines and indicators associated with each policy commitment, please see this google sheet.

FIGURE 2. PRIORITY COMMITMENTS IDENTIFIED THROUGH STAKEHOLDER CONSULTATION IN SOUTH AFRICA.

The ELSAA Nature-based Actions in South Africa

South Africa chose to focus their ELSAA analysis on five nature-based actions: protect, avoid loss, restore, reduce pressures, and urban adaptation. Although the ELSAA analysis in other pilot countries typically focuses on three nature-based actions (protect, manage, restore), national stakeholders highlighted that in the case of South Africa, it was highly important to further differentiate the actions to align with existing national policy frameworks and implementation efforts. The details of each class of action are explored below.
The area-based targets used in the analysis for each of these actions are based on existing policy commitments. The final definitions and area-based targets are summarized in Table 1.

- The data: How does each country identify relevant spatial data for the ELSA analysis?

Based on the outcomes of the policy process, the core team works together to identify the best global and national data that can: (1) serve as a proxy for the priority policy commitments (Figure 1, Step 2) and (2) constrain the zones where each nature-based action can take place in the country (Figure 1, Step 3).

1.Data to Map Priority Policy Commitments. The core team evaluates each of the policy commitments to identify spatial datasets that can serve as a 'proxy' by mapping the commitment in the analysis. These spatial proxy data sets are known as planning features. Depending on the complexity of the commitment, it might correspond to one or multiple planning features. The analysis will ultimately seek to optimize outcomes across all planning features.

For example, when looking at a policy commitment for biodiversity, the core team might map this commitment through planning features such as ecosystem connectivity and integrity, threatened species distribution, species richness, and Key Biodiversity Areas.

These planning features will be used in the analysis in combination with planning features for commitments related to climate change, water security, food security, and sustainable livelihoods.

2.Data to Map Zones. Zones determine where each nature-based action can be implemented according to the land capacity and political zoning of the country. These zones are created based on "rules", or constraints, that help the algorithm to identify viable locations for each action. For example, zoning constraints might tell the algorithm that protection can take place in areas where ecosystem quality is high, human pressure is low, and government zoning allows the allocation of a protected area.

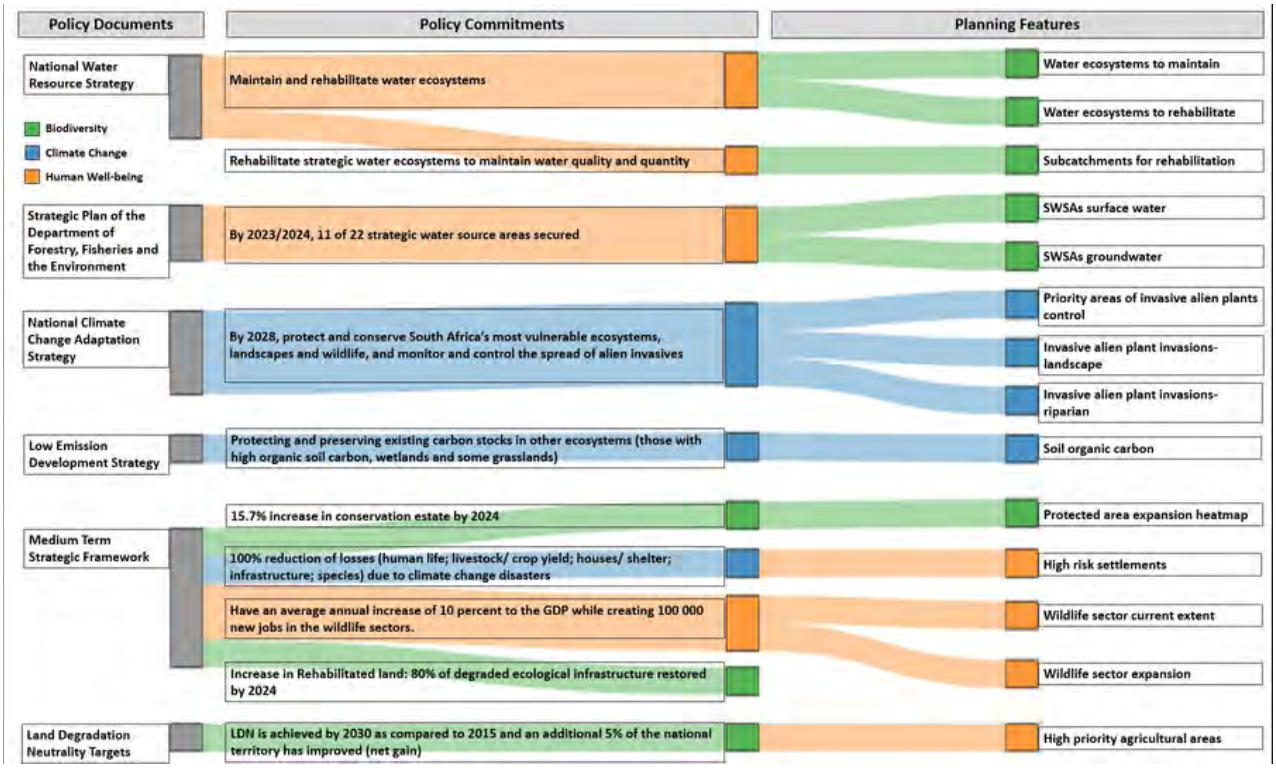
Together, these data provide the key inputs needed to run the ELSAA analysis (Figure 1, Steps 4-7).

Mapping of Priority Policy Commitments in South Africa

During the data collection process, the project team organized more than 15 meetings with core groups of national experts to identify the best data available for the 10 policy commitments. The team obtained data permissions, organized, and processed 59 national data layers and 1 global layer identified through these expert consultations. This resulted in the use of 14 individual layers and the development of 7 composite layers. Overall, 21 layers were included in the final data stack, including one planning unit layer, 14 planning feature layers, 5 zone layers, and one layer as lock-in constraints.

The 14 planning features identified through this process serve as spatial proxies for the ten policy commitments selected by South Africa. The relationship between the policy commitments and planning features is shown in Figure 3.

FIGURE 3: RELATIONSHIP AMONG POLICY DOCUMENTS, PRIORITY COMMITMENTS, AND PLANNING FEATURES SELECTED FOR INCLUSION IN THE ANALYSIS.



Mapping of Nature-based Action Zones in South Africa

South Africa identified five nature-based actions that were critical to include in its ELSAA map: protect, avoid loss, restore, reduce pressures and urban adapt. To determine where each of these actions can take place, the core team identified simple “rules”, or constraints that could be used with existing spatial data to map the zones where each action could occur on a map.

Based on the national definitions for each action identified in Table 1, the protection zone includes areas that are managed mainly for biodiversity conservation aiming to maintain or improve the state of biodiversity and ecological functions in order to support the benefits and opportunities people derive from nature. This zone is mapped considering all natural areas and bare soil in South Africa.

The avoid loss zone covers areas where the loss of natural or semi-natural ecosystems must be avoided in order to retain priority biodiversity assets and ecological infrastructure. This includes all CBAs not covered by the rest 4 ELSAAA actions after the prioritizr optimization.

The restoration zone includes areas where ecosystems must be rehabilitated (at least) to the degree to which they function sufficiently well to deliver ecosystem services. This may involve the removal of biomass, for example from invasive plant species, structural/engineering intervention in aquatic (freshwater/wetland) ecosystems, and change in land use from intensive/commercial land uses to lower impact land uses.

In South Africa, this is mapped using spatial datasets covering gully, erosion areas, secondary natural areas, fallow, cropland, plantation and mine areas.

The reduce pressures zone covers areas where intensity of use of natural resources must be reduced and managed for sustainable use, and unsustainable practices and/or degradation must be remedied. This is mapped using secondary natural area post 1990, fallow, cropland and plantation areas in South Africa.

The urban adapt zone includes urban areas and adjacent areas where ecosystem-based adaptation should be undertaken to reduce vulnerability to disasters associated with climate change, including wildfires, flooding and drought. This is mapped using the built-up areas in South Africa.

The constraints used in South Africa to spatially define where each of these actions can occur is summarized in Table 1.

TABLE 1. NATURE-BASED ACTIONS AND AREA-BASED TARGETS USED IN THE ELSAA ANALYSIS

Action	National Definition of Action	Area-based Target	Origin of Target	Spatial Definition of Zone for Each Action	Spatial Constraints for Zone
PROTECT	Areas that are, or should be, formally protected by law and managed mainly for biodiversity conservation. A management authority and a management plan focused on maintaining or improving the state of biodiversity and ecological functions must be in place, supporting the benefits and opportunities people derive from nature. This will entail restrictions on certain land uses.	15,7% of national territory	Medium-Term Strategic Framework.Policy Target #5: 15.7% increase in conservation estate by 2024.	This zone includes all-natural areas and bare ground in South Africa.	All-natural areas and bare ground identified in the national land cover in 2020 (SANLC 2020).
AVOID LOSS	Areas where the loss of natural or semi-natural ecosystems, and their associated species, must be avoided in order to retain priority biodiversity assets and ecological infrastructure.	29.62% of national territory	This target was not pre-set. It was calculated after the prioritizr optimization as all Critical Biodiversity Areas not covered by the other four ELSAAA actions.	All CBAs not covered by the four other ELSAAA actions after the prioritizr optimization	No spatial constraints applied before optimization

RESTORE	Areas where ecosystems must be rehabilitated (at least) to the degree to which they function sufficiently well to deliver ecosystem services. This implies passive or active restoration of ecosystems, where the loss of natural functioning (damage to an ecosystem) must be reversed and may require an improvement in the structure of the habitat and increase or decrease of vegetative cover, as ecologically appropriate. This may involve: • The removal of biomass, for example from invasive plant species. • Structural/ engineering intervention in aquatic (freshwater/wetland) ecosystems. For degraded wetland ecosystems, active structural/engineering interventions may be required. • Change in land use from intensive/commercial land uses to lower impact land uses.	7.5% of national territory	Land Degradation Neutrality Targets: LDN is achieved by 2030 as compared to 2015 and an additional 5% of the national territory has improved (net gain), and included a summed area-based targets of the following: • Rehabilitate and sustainably manage 1,809,767 hectares of forest by 2030 • Rehabilitate and sustainably manage 1,349,714 ha of fynbos by 2030 • Rehabilitate and sustainably manage 83,621 ha of thicket by 2030 • Rehabilitate and sustainably manage 2,436,170 ha of grassland by 2030 • Rehabilitate and sustainably manage 2,646,069 ha of savanna (<5m) by 2030 • Rehabilitate and sustainably manage 149,877 ha of Succulent Karoo by 2030 • Rehabilitate and sustainably manage 528,632 of Nama Karoo by 2030 • Rehabilitate and sustainably manage 75,525 ha of desert by 2030 • Rehabilitate 61,900 ha of wetlands by 2030	This zone includes all-natural areas and bare ground in South Africa.	All-natural areas and bare ground identified in the national land cover in 2020 (SANLC 2020).
REDUCE PRESSURES	Areas where the cumulative or historic loss of natural ecosystems must be mitigated; areas where intensity of use of natural resources must be reduced and managed for sustainable use, and unsustainable practices and/or degradation must be remedied.	8.2% of national territory	10 million hectares by 2030 of private owned, communal and reform land improved and developed for conservation and commercial game ranching (Phakisa 2030).	Secondary natural area post 1990, fallow, cropland and plantation areas in South Africa.	Combined secondary natural area post 1990, fallow, cropland and plantation areas. Above categories were identified in the national land cover in 2020 (SANLC 2020) and the secondary natural classes developed for SANBI's "Habitat Modification" datasets (Skowno et al. 2021)

URBAN ADAPT	Areas where ecosystem-based adaptation should be undertaken in urban environments, or in the ecological infrastructure in adjacent or upstream areas on which they rely, to reduce vulnerability to disasters associated with climate change, including wildfires, flooding and drought.	0.29% of national territory	Land Degradation Neutrality Targets: Rehabilitate 350,000 ha of artificial areas by 2030.	The built-up areas in South Africa	Built-up areas identified in the national land cover in 2020 (SANLC 2020)

- **The analysis: How can Systematic Conservation Planning help us to see where nature-based actions will be most effective to meet national priorities?**

The ELSAA analysis (Figure 1: Steps 4-7) for South Africa uses Systematic Conservation Planning (SCP) to identify where nature-based actions to protect, avoid loss, restore, reduce pressures, and urban adapt can lead to the best outcomes across the ten policy commitments identified through stakeholder consultations (Margules & Pressey 2000). SCP is a peer-reviewed, gold-standard approach for conservation that helps identify where nature-based actions can achieve maximum impact across multiple, often competing, priorities in a given study area, region of interest, or country.

The value of using SCP to run the ELSAA analysis is two-fold. First, it assesses all planning features that map the ten priority commitments at once, enabling capitalization on synergies to determine where actions can most effectively achieve the greatest impact across all policy commitments. The ELSAA analysis also offers the option to create separate maps focused only on the commitments related to the three themes -- biodiversity and ecological infrastructure, climate change, and human well-being -- in order to provide customized maps to support action within specific sectors. Second, the ELSAA analysis enables diverse stakeholder groups to weight the relative importance and their confidence in the various planning features associated with the priority policy commitments, view tradeoffs that result from conflicting priorities, and foster dialogue around cross-sectoral collaboration and implementation.

Several key terms from SCP are used in the ELSAA analysis and the ELSAA Webtool. Find their general definitions and their specific definitions for your country in Annex 1. Two elements of this analysis are critical to understand: weights and impacts.

- Weights: The aim of the weighting process is to determine the relative importance of some features over the other features. For example, if the total weight of carbon sequestration layer is higher than food security layer, the maps will reflect both, but prioritize areas most important for carbon sequestration over those important to food security.

National stakeholders set weights for each feature layer according to two criteria: 1) importance of that layer in relation to other layers and the policy targets they represent; and 2) confidence in the data layer. For importance, stakeholders gave each data layer a score from zero to ten, where zero excluded the layer from the analysis and ten indicated extremely high importance. For confidence, stakeholders gave one of three scores: 0 (no confidence), 0.5 (uncertain or partial confidence), or 1 (reasonable confidence). I.e., There is no 'high confidence' score. The final weight for a data layer = I * C, where I is the importance score, C is the confidence score.

A brief example to demonstrate how this works in practice: if stakeholders assigned high importance to carbon sequestration and had high confidence in the data, it would be weighted as one of the most important features in the analysis. However, if stakeholders assigned high importance to carbon sequestration but has zero confidence in the data, it would be excluded from the analysis.

- Impacts: An impact score is given to determine how each nature-based action (zone) contributes to achieving each planning feature. This impact score is determined by the ELSAA science team based on the specific actions and planning features in the country. For instance, the potential areas for protected areas expansion consisted of critical and key biodiversity areas, and threatened species habitat. When setting impact scores for the feature of protected areas expansion heatmap, a '1.0' impact was given to protect and avoid loss to indicate high level of contribution, while a '0' impact score was assigned to urban adapt as no direct contribution. Similar with the feature of high-risk settlements, urban adapt actions will largely contribute to the risk migration and adaptation, thus a high impact score of "1.0" was assigned.

After stakeholder engagement to determine the relative weight of each planning feature, the ELSAA webtool will create a map that shows where the country should take each nature-based action in order to optimize impacts across all of the planning features. In the case of South Africa, after the optimization is run, the avoid loss zone is automatically identified by the ELSAA webtool by mapping all Critical Biodiversity Areas not covered by the other four ELSAAA actions.

To verify that the optimization has produced results that are satisfactory for the country, the webtool will also output an Excel file that documents the degree to which each planning feature can be represented by implementing the actions documented in the ELSAA map, relative to what is possible under a targeted planning scenario. A score of 100% means that the planning feature has been represented as well in the ELSAA map (which optimizes for all planning features) as in a more directed planning scenario that only focuses on the theme (biodiversity and ecological infrastructure, climate change, or human well-being) to which that feature belongs.

In cases where the ELSAA map represents substantially less of a given feature than the more targeted scenario (typically identified as 80% or less), stakeholders can revise the weighting to ensure better outcomes for a given planning feature. The ability to change weighting for each planning feature in the ELSAA webtool enables an iterative approach to developing the ELSAA map, where stakeholders can revise weighting to better deliver across all planning features and measure the results using the downloaded table. The weighting can also be revised over time as the relative importance of the ten priority commitments shift in the country. For more information on iterating the analysis, please see the ELSAA webtool manual.

Overall, the ELSAA analysis provides South Africa with an outcome-orientated map to implement nature-based solutions that will contribute to the achievement of the ten priority policy commitments and support the country to achieve adaptive sustainable management of natural ecosystems.

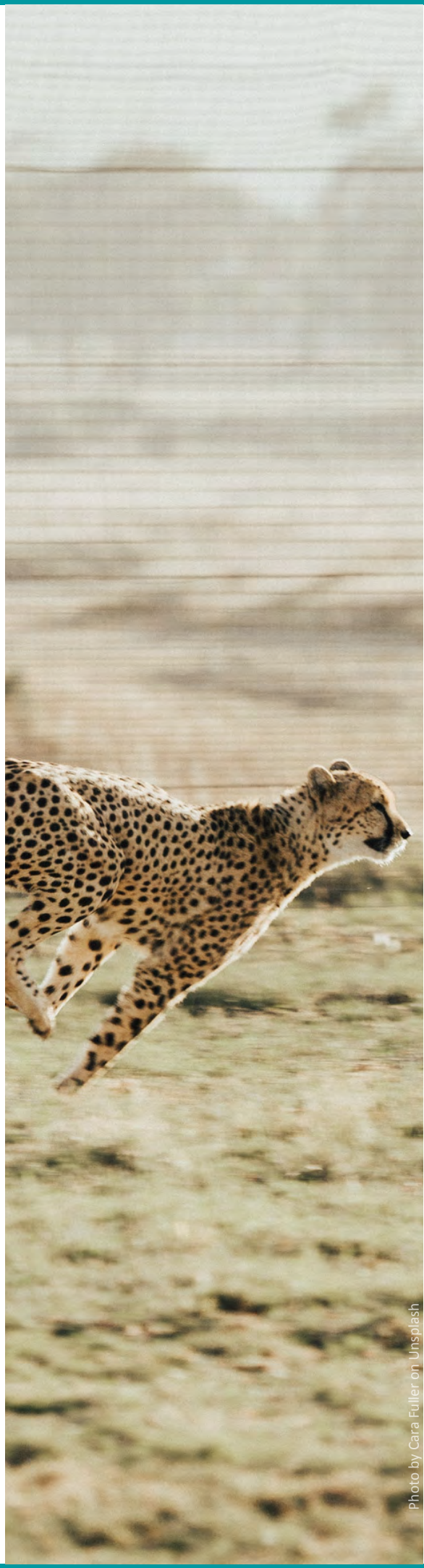


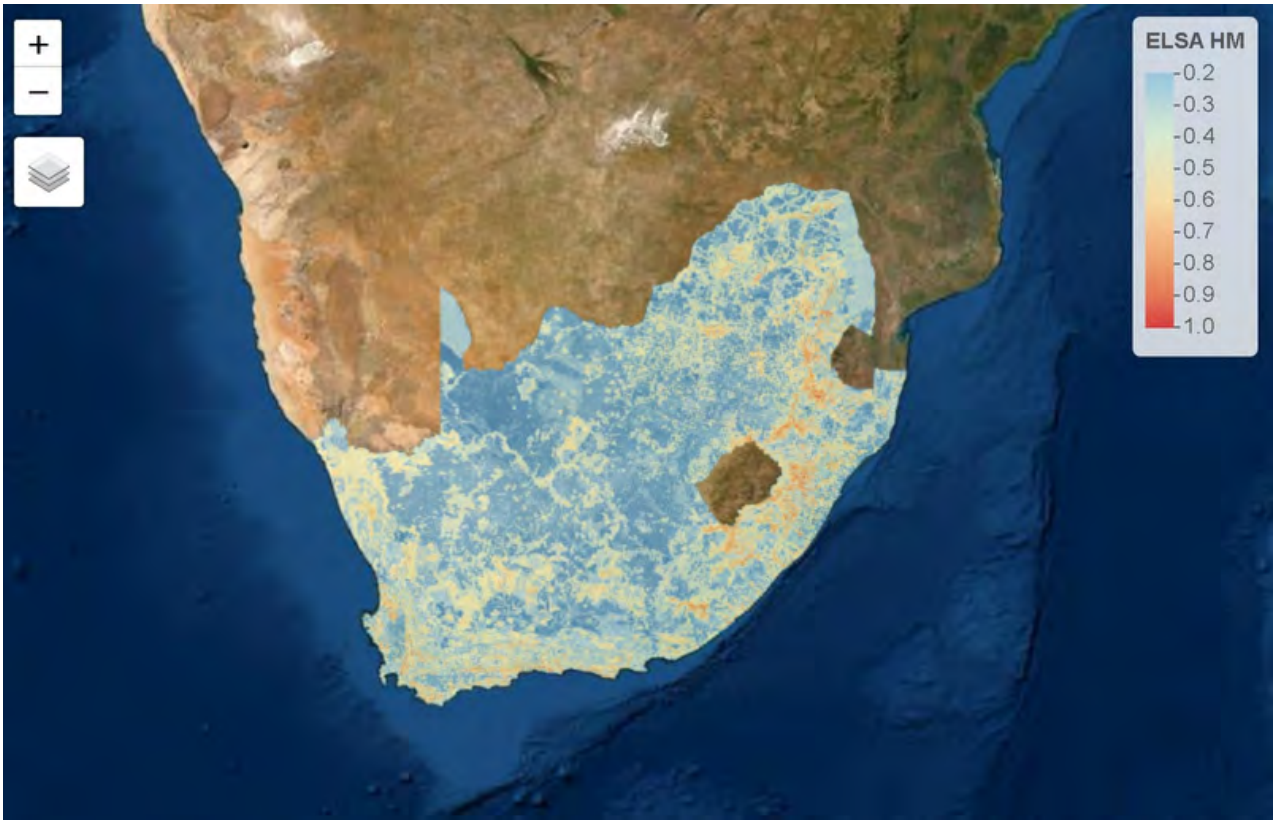
Photo by Cara Fuller on Unsplash

The ELSAA Analysis & Results for South Africa

The first ELSAA products for South Africa are heatmaps of ecological values across the country. The heatmaps identify the distribution of ecological values that support South Africa's ten priority commitments. The heatmaps are the result of the intersection of the planning features and their respective weights. The higher the value on a range from zero to one, the more features of high weight overlap. The heatmaps thus show overall areas of importance for biodiversity and ecological infrastructure, climate change, and human well-being in South Africa. The first map shows the distribution of biodiversity and ecological infrastructure values, the second of values relating to climate change and the third map the values supporting human well-being. These maps show some areas of coincidence or overlap in areas of warm colours or high values, but also some differences. The fourth and final map shows the distribution of all these values combined. For more information on accessing these different heat maps, please see the ELSAA webtool manual.

By looking at the heat maps before the action maps, data experts can view the combined planning feature data, and determine if the patterns are aligned with their expectations and personal knowledge of the region. However, these maps don't yet indicate the best places to take action to contribute to the achievement of the ten priority policy commitments.

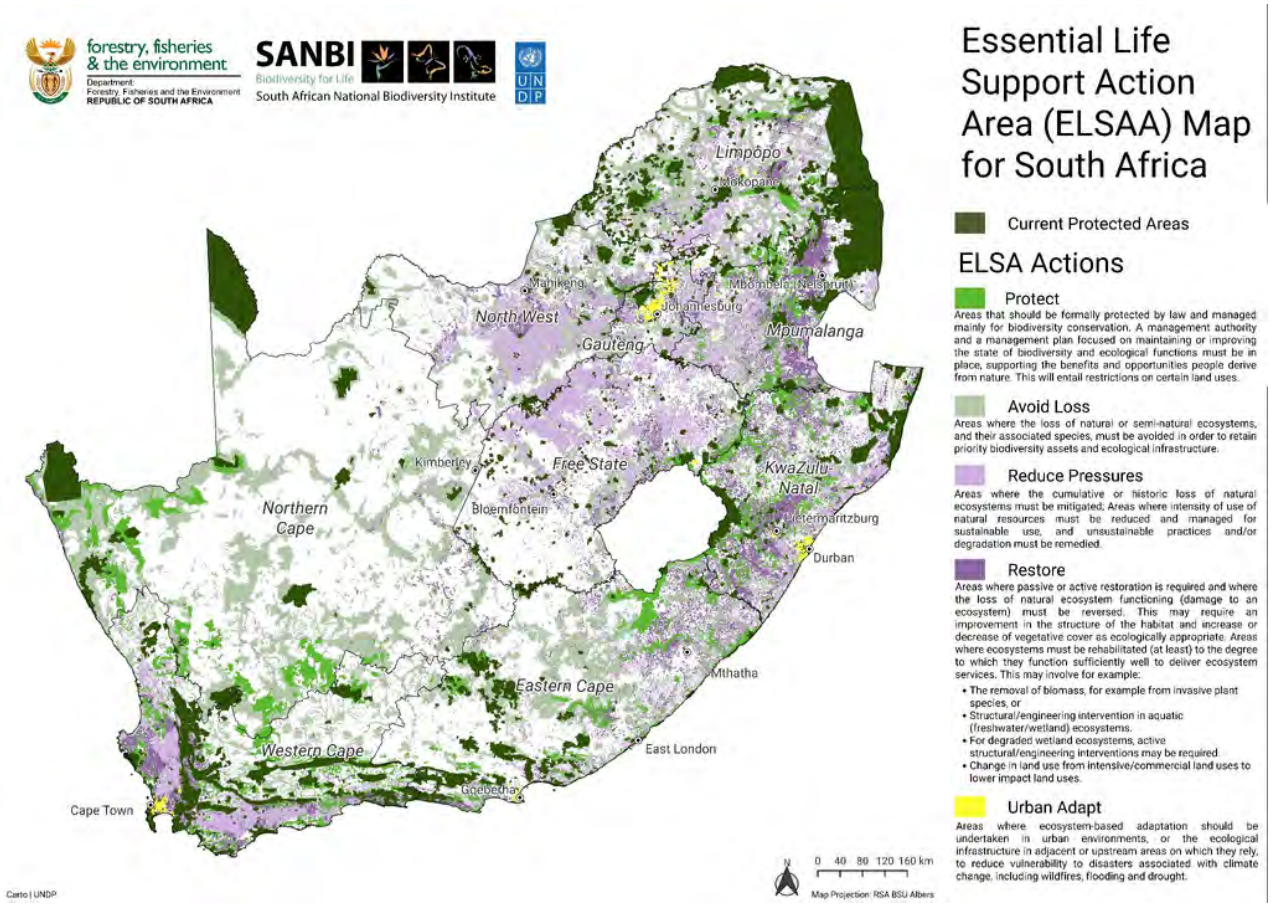
FIGURE 4: ELSAA HEATMAP -- AREAS IMPORTANT FOR BIODIVERSITY AND ECOLOGICAL INFRASTRUCTURE, CLIMATE CHANGE, AND HUMAN WELL-BEING.



The second ELSAA product for South Africa is the ELSAA action map. This results from the ELSAA optimization analysis. It shows areas that should be prioritized for protect, avoid loss, restore, reduce pressures and urban adapt in order to most efficiently deliver across the ten policy commitments associated with biodiversity and ecological infrastructure, climate change, and human well-being.

The ELSAA action map, developed and validated by stakeholders in South Africa, demonstrates where actions can most effectively achieve the greatest impact across all planning features. Two versions of the map are available: a filtered version and an unfiltered version (Figure 5). The term 'filtered' refers to an ELSAA map that is produced using a higher boundary penalty factor (BPF) that results in areas being selected that are both larger and more contiguous. These larger and more contiguous areas closely resemble typical protected area networks, which consider logistical and management considerations (costs) in their creation and implementation, costs which are often more efficient when implemented across a smaller number of larger areas. Further, large, more contiguous areas can often protect important landscape level connectivity and processes. The term 'unfiltered' refers to an ELSAA map that captures the most optimal outputs (at the pixel level) of the ELSAA analysis and shows small areas where nature-based actions would produce optimal outcomes for the ten priority commitments.

FIGURE 5. THE ELSAA MAP FOR SOUTH AFRICA.



- **The technology: How is the ELSAA analysis run?**

The ELSAA analysis uses the prioritizr software library (In the R programming language) as a decision support tool to run SCP analyses (Hanson et al. 2021). The prioritizr package implements integer linear programming (ILP) techniques to provide a flexible interface for building and solving conservation planning problems (Beyer et al. 2016). It supports a broad range of objectives, constraints, and penalties that can be used to custom-tailor conservation planning problems to the specific needs of a conservation planning exercise.

There are also other decision support tools like Marxan and Zonation that can be used to run SCP analyses. The ELSAA project uses prioritizr because it can solve large problems (>1 million cells) faster than other approaches, allowing real-time analysis with stakeholders, and it guarantees that the optimal solution can be found.

Remember, regardless which decision support tool you use, they are designed to help you make decisions—they can't make decisions for you.

Implementation of the ELSAA Map

Contribution of ELSAA to policy development in areas of strategic importance

The ELSAA process provides an opportunity to generate integrated landscape analyses to support policy development for environmental, agricultural and land management challenges.

For more information on use of the ELSAA map for implementation in South Africa, see our discussion document on applications of the ELSAA process.

Photo by CLARA METIVIER BEUKES on Unsplash

Supporting development and implementation of post-2020 Global Biodiversity Framework of the Convention on Biological Diversity

The ELSAA approach can also guide the development, implementation, and monitoring of progress for the post-2020 Global Biodiversity Framework in South Africa. In particular, ELSAA can support national processes around the following targets of the draft framework;

- Target 1 on land and seas under spatial planning;
- Target 2 on protecting and conserving at least 30 percent of the planet;
- Target 3 on restoration;
- Target 7 on increasing contributions to climate change mitigation, adaptation, and disaster risk reduction from nature-based solutions;
- Target 9 on supporting the productivity, sustainability and resilience of biodiversity in agricultural and other managed ecosystems; and
- Target 10 on ensuring that nature-based solutions contribute to regulation of air quality and water provision for human well-being.

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Annex 1: Key Terms Used in the ELSAA Process

TERM	DEFINITION	APPLICATION IN SOUTH AFRICA
Boundary penalty factor (BPF)	Penalty given to solutions based on the total exterior boundary or edge of zones. By penalizing high edge length solutions, this BPF can be used to promote spatial cohesion or clumping in ELSAA areas.	A boundary penalty of 10 was applied to produce the second ELSAA map for South Africa. This score was selected to create a scientifically rigorous but actionable map that promotes protection, management, and restoration over contiguous areas.
Area-based target (budget)	The maximum land area (expressed as % of total country land area) that can be allocated to a 'zone'.	Protect: 15.7% Restore: 7.5% Reduce pressures: 8.2% Urban adapt: 0.29% Avoid loss: not pre-determined
Planning feature	An element of biodiversity or ecosystem service selected as a focus for conservation planning or action. This can include ecological classifications, habitat types, species, physical features, processes or any element that can be measured in a planning unit. In the ELSAA process, each priority commitment for a country may correspond to one or multiple planning features depending on its complexity.	The ELSAA webtool for South Africa includes 14 features that map the ten priority policy commitments (Figure 3).
Decision support software	A computer-based application that uses information on possible actions and constraints on these actions in order to aid the process of decision-making in pursuit of a stated objective.	For the ELSAA project in South Africa, prioritizr is used as the decision support software.
Geographic Information System (GIS)	A computer-based system consisting of hardware and software required for the capture, storage, management, analysis and presentation of geographic (spatial) data.	The ELSAA webtool uses GIS software to present spatial data to users. No GIS expertise is required to use it.
Constraint	A rule that must be met during the optimization as it creates a network of zones. The primary constraints are that the budget (land area dedicated to each ELSAA action) must not be exceeded, and that each zone can only occur within specified planning units (e.g., protection zone may only be possible in planning units that are not agricultural or urban land covers)	Please see Table 1 for more details.

Impacts	The degree to which a specific zone contributes to the status of a specific planning feature. Values typically range from '0' (no contribution) to '1.5' (an increase of 50% from current condition).	The impact score for the effect of protect, avoid loss, restore, reduce pressures and urban adapt on each of the planning features for South Africa was determined through a rigorous scientific process.
Maximum coverage problem	The objective of the maximal coverage problem is to maximize protection of features subject to the constraint that the resources expended do not exceed a fixed cost.	The ELSAA process in South Africa uses a maximum coverage problem formulation.
Minimum set problem	The objective of the minimum-set problem is to minimize resources expended, subject to the constraint that all features meet their conservation target.	Not applicable for the ELSAA process.
Planning Units	Planning units are the building blocks of a reserve system. A study area is divided into planning units that are smaller geographic parcels of regular or irregular shapes. Examples include squares, hexagons, cadastral parcels and hydrological units.	Coordinate Reference System: Alberts (and snapped with South Africa's Basic Spatial Unit) Resolution or pixel size: 1km x 1km
Representation	In Systematic Conservation Planning, a representative system captures a full range of planning features (species, ecosystems, and ecosystem services) occurring within the planning region, not just iconic species.	In the ELSAA South Africa analysis, representation is used to measure how well the ELSAA areas capture or represent planning features relative to a more directed planning approach focused only on biodiversity and ecological infrastructure, climate change, or human well-being.
Systematic conservation planning (SCP)	Formal method for identifying potential areas for conservation management that will most efficiently achieve a specific set of objectives, commonly some minimum representation of biodiversity. The process involves a clear and structured approach to priority setting, and is now the standard for both terrestrial and marine conservation. The effectiveness of systematic conservation planning stems from its ability to make the best use of limited fiscal resources towards achieving conservation goals and do so in a manner that is defensible, accountable, and transparently recognises the requirements of different resource users.	SCP is the science that enables the identification of ELSAAs in South Africa.

User interface	The means by which people interact with a particular software application. A Graphical User Interface (GUI) presents information in a user-friendly way using graphics, menus and icons. The ELSAA Webtool is a GUI that provides stakeholders with the ability to directly run the ELSAA analysis themselves.	The ELSAA Webtool is a GUI that provides stakeholders with the ability to run the prioritizr ELSAA analysis themselves.
Weights	Weights enable users to set relative priorities within their priority policy outcomes. Values typically range for '0' (no importance) to '5' (extremely high importance)	The default weights for the South Africa ELSAA analysis were collaboratively developed through two stakeholder engagement sessions. Stakeholders can modify these weights through the ELSAA webtool based on changed priorities.
Zones/Actions	A land use zone, equivalent to a nature-based action, that serves to improve specific planning features. Zones are determined byconstraints that define where an action absolutely can or cannot occur. For example, these hard constraints limit protection to intact areas (e.g., low human footprint values) and protection/restoration to areas that are moderately impacted by human activity, but not fully human dominated (e.g., low to mid human footprint values).	In South Africa, the ELSAA analysis zoning maps five different actions: protect, avoid loss, restore, reduce pressures, urban adapt. Data used for zoning constraints is based on the land cover of South Africa in the year 2020 (SANLC 2020) with simplified classes to level 4, and the secondary nature classes developed for SANBI's Habitat Modification datasets (Skowno et al., 2021).

Annex 2: Data layers used in ELSAA South Africa

GROUPS	LABEL-THEME	LABEL-NAME	DATA SOURCE (INSTITUTE)	REFERENCE
Features	Biodiversity and Ecological Infrastracture	Water ecosystems to maintain	SANBI; NBA 2018; Nancy Job & Adwoa Awuah	Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K. 2018. South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 October 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa. CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847Also:http://bgis.sanbi.org/SpatialDataset/Detail/3699
		Water ecosystems to rehabilitate	SANBI; NBA 2018; Nancy Job & Adwoa Awuah	Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K. 2018. South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 October 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa. CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847Also:http://bgis.sanbi.org/SpatialDataset/Detail/3699
		Subcatchments for rehabilitation	GP created based on FEPA, SWSA & NBA2018 River data	
		SWSAs surface water	SANBI; Mervyn Lotter (MTPA on behalf of SANBI's EI4WS project)	Lötter, M.C. & Le Maitre, D. (2021) Fine-scale delineation of Strategic Water Source Areas for surface water in South Africa using Empirical Bayesian Kriging Regression Prediction: Technical report. Prepared for the South African National Biodiversity Institute (SANBI), Pretoria. 33 pages.

		SWSAs groundwater	WRC; David Le Maitre	Le Maitre, D.C., Seyler, H., Holland, M., Smith-Adao, L., Nel, J.A., Maherry, A. and Witthüser. K. (2018) Identification, Delineation and Importance of the Strategic Water Source Areas of South Africa, Lesotho and Swaziland for Surface Water and Groundwater. Report No. TT 754/1/18 Water Research Commission, Pretoria.
		Protected area expansion heatmap	SANBI: Tsamelo MalebuSANParks: Fahiema DanielsSANBI: Dr. Andrew SkownoSANBI: Dr. Andrew SkownoSANBI: Lize von StadenSANBI: Dewidine Van Der ColffStephen Holness (consultant)	Holness, S. and Stewart, W. 2020. Technical Support for Systematic Biodiversity Planning Projects, including Key Biodiversity Areas (KBAs) Identification: Final Report. South African National Biodiversity Institute and BirdLife South Africa: Pretoria, South Africa.Report Reference Code: SANBI KBA Assessment - Final Reporthttps://www.sanbi.org/biodiversity/building-knowledge/biodiversity-monitoring-assessment/key-biodiversity-areas-in-south-africa/Skowno, A.L., Raimondo, D.C., Poole, C.J., Fizzotti, B. & Slingsby, J.A. (eds.). 2019. South African National Biodiversity Assessment 2018 Technical Report Volume 1: Terrestrial Realm. South African National Biodiversity Institute, Pretoria. http://hdl.handle.net/20.500.12143/6370 http://bgis.sanbi.org/Projects/Detail/222Van Der Colff, D. and von Staden, L. 2019. Summary of Species Assessments Terrestrial and Inland Aquatic Technical Report Species Section 2018. South African National Biodiversity Institute (SANBI): Pretoria, South Africa.http://hdl.handle.net/20.500.12143/6720 Van Der Colff, D. and von Staden, L. 2019. Summary of Species Assessments Terrestrial and Inland Aquatic Technical Report Species Section 2018. South African National Biodiversity Institute (SANBI): Pretoria, South Africa.http://hdl.handle.net/20.500.12143/6720 Holness, S. (2008) SANBI Ecosystem-based Adaptation layer. Unpublished GIS dataset prepared for South African National Biodiversity Institute and Department of Environmental Affairs, Pretoria. See also Driver et al. 2012 NBA.

	Climate Change	Priority areas of invasive alien plants control	DFFE/NRM; Andrew Wannenburgh& Le Maitre et al., 2012	Le Maitre, D.C., Forsyth, G.G. and O'Farrell, P. (2012). Development of generic species- and area-based prioritization models for use by Working for Water in prioritizing alien plant control operations in South Africa. Report number CSIR/NRE/ECO/ER/2012/0028/B, CSIR, Stellenbosch.https://www.arcgis.com/home/item.html?id=227cf316bed84a17be1bdea0d97044eb
		Invasive alien plant invasions-landscape	DFFE/NRM; Andrew Wannenburgh& Kotze et al., 2010	Kotzé, JDF., Beukes, BH., Van den Berg, EC., and Newby, TS., 2010. National Invasive Alien Plant Survey. Report Number: GW/A/2010/21. Agricultural Research Council: Institute for Soil, Climate and Water, Pretoria.https://www.researchgate.net/publication/343267750_National_Invasive_Alien_Plant_Surveyhttps://www.arcgis.com/home/item.html?id=227cf316bed84a17be1bdea0d97044eb
		Invasive alien plant invasions-riparian	DFFE/NRM; Andrew Wannenburgh& Kotze et al., 2010	Kotzé, JDF., Beukes, BH., Van den Berg, EC., and Newby, TS., 2010. National Invasive Alien Plant Survey. Report Number: GW/A/2010/21. Agricultural Research Council: Institute for Soil, Climate and Water, Pretoria.https://www.researchgate.net/publication/343267750_National_Invasive_Alien_Plant_Surveyhttps://www.arcgis.com/home/item.html?id=227cf316bed84a17be1bdea0d97044eb
		Soil organic carbon	DFFE 2020 (in SAEON data catalogue)Venter et al., 2020	https://catalogue.saeon.ac.za/records/feb336ce-8bba-47bc-9250-b5ad97a33e84"https://doi.org/10.1016/j.scitotenv.2021.145384Venter, Zander S, Hawkins, Heidi-Jayne, Cramer, Michael D, & Mills, Anthony J. (2020). Soil organic carbon stocks and trends (1984-2019) predicted at 30m spatial resolution for topsoil in natural areas of South Africa (Version 01) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.4384692"
	Human Well Being	High priority agricultural areas	Department of Agriculture, Land Reform & Rural Development (DALRRD); Anneliza Collett	Department of Agriculture, Land Reform and Rural Development, 2021. High potential agricultural areas, 2021 – Spatial data layer, per each province in South Africa. 2021. Pretoria.

		High risk settlements	Council for Scientific and Industrial Research (CSIR);Chantel LudickGeo-Information ScientistInclusive Smart Settlements and Regions	Le Roux, A., Van Niekerk, W., Arnold, K., Pieterse, A., Ludick, C., Forsyth, G., Le Maitre, D., Lötter, D., du Plessis, P. & Mans, G. 2019. Green Book Risk Profile Tool. Pretoria: CSIR. Available at: https://riskprofiles.greenbook.co.za/.
		Wildlife sector current extent	SANBI: Matthew Child & Norma Malatji	Malatji, N., Nelwamondo, P., Child, M., and Selier, J. 2021. SANBI Working Lands Version 2. Unpublished GIS dataset prepared for "Digitizing working lands of South Africa" Project. South African National Biodiversity Institute: Pretoria, South Africa.
		Wildlife sector expansion	"DFFE & EWT: Environmental Screening Tool(EWT: Dr. Dominic Henry)""DFFE & EWT: Environmental Screening Tool(EWT: Dr. Dominic Henry)"See below re: NDR & grazing capacity layersSee below re: NDR & grazing capacity layers"Department of Environmental Affairs; Ezemvelo KZN Wildlife; CapeNature(KZN Wildlife; Boyd Escott)""DEFF, 2019EbA Mapping report; Dr. Philip Desmet"UN Biodiversity Lab"Department of Agriculture, Land Reform &Rural Development (DALRRD); Anneliza Collett""Department of Agriculture, Land Reform &Rural Development (DALRRD); Anneliza Collett"DFFE; Dr. Zakariyyaa Oumar	See below re: NDR & grazing capacity layersSee below re: NDR & grazing capacity layersBirss, C., Rushworth, I., Collins, N.B., Peinke, D. & Buijs, D. 2015. Inferred Natural distribution ranges of large mammals in South Africa, Version 1. Unpublished GIS coverage."Department of Environment, Forestry and Fisheries (DEFF), 2019. Ecosystem based adaptation Action Plan and Priority Areas Mapping report. Pretoria, South Africa.https://www.sanbi.org/wp-content/uploads/2020/10/Action-Plan-Priority-Maps-Full-Report-Digital-High-res.pdf"https://map.unbiodiversitylab.org/earth?basemap=grayscale&coordinates=20,0,2&layers=accessibility-to-cities-2015_100South Africa (Republic) 2018. Long-term grazing capacity for South Africa: Data layer. Government Gazette Vol.638, No.41870. 31 August 2018. Regulation 10 of the Conservation of Agricultural Resources Act (CARA): Act 43 of 1983. Pretoria. Government Printing Works.Department of Agriculture, Forestry and Fisheries, 2017. National land capability evaluation raster data layer, 2017. Pretoria."Department of Environmental Affairs, 2020. Refinement and Mapping of Biodiversity Economy Nodes. Mapping report and vector data layer, 2020. Pretoria, South Africa."

Lock-in	Biodiversity	Protected areas	SANBI; Sediqa Khatieb	
Zones		Protect zone	SANLC 2020 & Habitat Modification datasets - SANBI: Dr. Andrew Skowno	Skowno AL, Jewitt D, Slingsby JA. Rates and patterns of habitat loss across South Africa's vegetationbiomes. S Afr J Sci. 2021;117(1/2), Art. #8182. https://doi.org/10.17159/sajs.2021/81822
		Avoid zone	CBAs data - SANBI: Tsamelo Malebu	National CBA_082021
		Rehabilitate zone	RSA_Gullies - Department of Agriculture, Land Reform &Rural Development (DALRRD) and the Agricultural Research Council (ARC); Anneliza Collett SANLC 2020 & Habitat Modification datasets - SANBI: Dr. Andrew Skowno	Mararakanye, N. & Le Roux, J.J. 2011. Manual Digitizing of Gully Erosion in South Africa Using High Resolution SPOT 5 Satellite Imagery at 1: 10 000 Scale. Department of Agriculture, Forestry and Fisheries, Directorate Land Use and Soil Management, Pretoria. Skowno AL, Jewitt D, Slingsby JA. Rates and patterns of habitat loss across South Africa's vegetationbiomes. S Afr J Sci. 2021;117(1/2), Art. #8182. https://doi.org/10.17159/sajs.2021/81822
		Mitigate zone	SANLC 2020 & Habitat Modification datasets - SANBI: Dr. Andrew Skowno	Skowno AL, Jewitt D, Slingsby JA. Rates and patterns of habitat loss across South Africa's vegetationbiomes. S Afr J Sci. 2021;117(1/2), Art. #8182. https://doi.org/10.17159/sajs.2021/81822
		Urban PAMR zone	SANLC 2020 & Habitat Modification datasets - SANBI: Dr. Andrew Skowno	Skowno AL, Jewitt D, Slingsby JA. Rates and patterns of habitat loss across South Africa's vegetationbiomes. S Afr J Sci. 2021;117(1/2), Art. #8182. https://doi.org/10.17159/sajs.2021/81822

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