Mapping Nature for People and Planet

in Uganda

ELSA Webtool Manual

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UNBC UNIVERSITY OF NORTHERN BRITISH COLUMBIA

GORDON AND BETTY MOORE FOUNDATION

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Summary

This user guide aims to help you to use the ELSA Online Webtool to identify your country's Essential Life Support Areas (ELSAs) based on your national policy priorities. The ELSA Webtool was developed through the Mapping Nature for People and Planet project in Uganda. Chapter 1 of this user guide provides background information on the ELSA process in Uganda. Chapter 2 describes how ELSA can contribute to the nation's priorities by creating an action map to show where nature-based actions can lead to optimal impacts across key policy commitments. Chapter 3 includes step-by-step instructions on how to operate the ELSA Webtool.

1. Introduction

1.1 Essential Life Support Areas (ELSAs)—What and Why

Background

Maintaining a healthy planet where people and ecosystems thrive requires reliable, timely, precise 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 Uganda, despite existing technical capacity and strong political will, the government faces similar challenges, including: lack of usable rainfall and climatic data, a need for identifying nature-based solutions that can lead to both economic and environmental outcomes, and a desire for actionable maps that can inform the implementation of the Third National Development Plan (NDPIII).

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 areas (ELSAs), 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 can include the protection, management, and/or restoration of ecosystems.

The partnership has created a scientific framework and decision support system to bring together national data in a central repository, to identify ELSAs 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 Uganda 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 ELSAs; 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 Uganda's private 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. The successful approaches developed in Uganda will inform the development of the ELSA project in six new pilot countries in 2021: Cambodia, Dominican Republic, Ecuador, Haiti, Nepal, and South Africa.

The Partnership

Working with Colombia, Costa Rica, Kazakhstan, Peru, and Uganda as the initial pilot countries (with plans to replicate in Cambodia, Dominican Republic, Ecuador, Haiti, Nepal, and South Africa in 2021), this work brings together a powerful coalition of governments, NGOs, research institutes, and intergovernmental organizations.

The Uganda case

In Uganda, the project is led by the United Nations Development Programme (UNDP), National Environment Management Authority (NEMA), University of Northern British Columbia (UNBC), National Geographic Society, and Impact Observatory, with funding from the Gordon and Betty Moore Foundation and the Global Environment Facility (GEF). Technical support is provided by the Pacific Marine Analysis and Research Association (PacMARA).

Participating institutions include: ENR Africa Center, Environmental Alert, Environmental Management for Livelihood Improvement, EnviroSpatio Consults Ltd., Green World Challenge, International Union for Conservation of Nature, Makerere University, Ministry of Agriculture, Animal, Industry and Fisheries of Uganda, Ministry of Water and Environment of Uganda, Ministry of Wildlife, Tourism and Antiquities of Uganda, National Agriculture Research Organisation, National Biodiversity Data Bank, National Environment Management Authority, National Forestry Authority, National Planning Authority, Total E&P Uganda Office, Uganda National Council for Science and Technology, Uganda Wildlife Authority, United Nations Environment Programme, United Nations Development Programme in Uganda, United Organisation for Batwa Development in Uganda, World Agroforestry, and Wildlife Conservation Society, among others.

Quick Resources on ELSA

Introduction to ELSA

- ELSA overview presentation: This 3-minute introductory video explains the basics of mapping Essential Life Support Areas.
- Monitoring ELSA using Dynamic World: 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.
- Concept note: a six-page document summarizing the key elements of ELSA in Uganda.
- ELSA infographic: This infographic provides an overview of the 10 steps of the ELSA process.
- 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 ELSA

- Training on Systematic Conservation Planning: This session offered by PacMARA to Ugandan 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 ELSA analysis. Further information is available from the prioritizr website and the prioritizr workshop manual.
- Data included in Uganda ELSA analysis (ENG): This presentation slides describes the pre-processing of the datasets included in the second ELSA map for Uganda.
- Development of Uganda's second ELSA map (Day 1 | Day 2): These recordings show the interactive co-creation of Uganda's second ELSA map.

ELSA in Uganda

- ELSA Uganda trailer: In this 5-minute video, Ugandan national authorities showcase the importance and opportunities that the ELSA project represents for the country.
- Workshops:
  - First workshop website
  - First workshop report
  - Second workshop website
  - Second workshop report
- Press releases & media related to ELSA in Uganda
  - NEMA: 1 | 2
  - UNDP Uganda: 1 | 2
  - UNDP Medium

ELSA in Other Countries

- Learning for Nature ELSA Community of Practice
- ELSA Costa Rica (ENG | ESP)
- ELSA Kazakhstan (EN)
- ELSA Peru (SP with English subtitles)
- ELSA Colombia (SP with English subtitles)

2. The Science of ELSA

2.1 Steps in the ELSA Process

In order to identify key nature-based actions that can support priority policy commitments in Uganda, the ELSA process includes four broad areas of work: (1) Identify priority policy commitments; (2) Collect national and global data to map these commitments; (3) Produce ELSA 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 ten steps. In Uganda, stakeholders worked together to execute the 10 steps of the ELSA process, with a continued focus on steps 9 and 10 on implementation and communication (Figure 1).

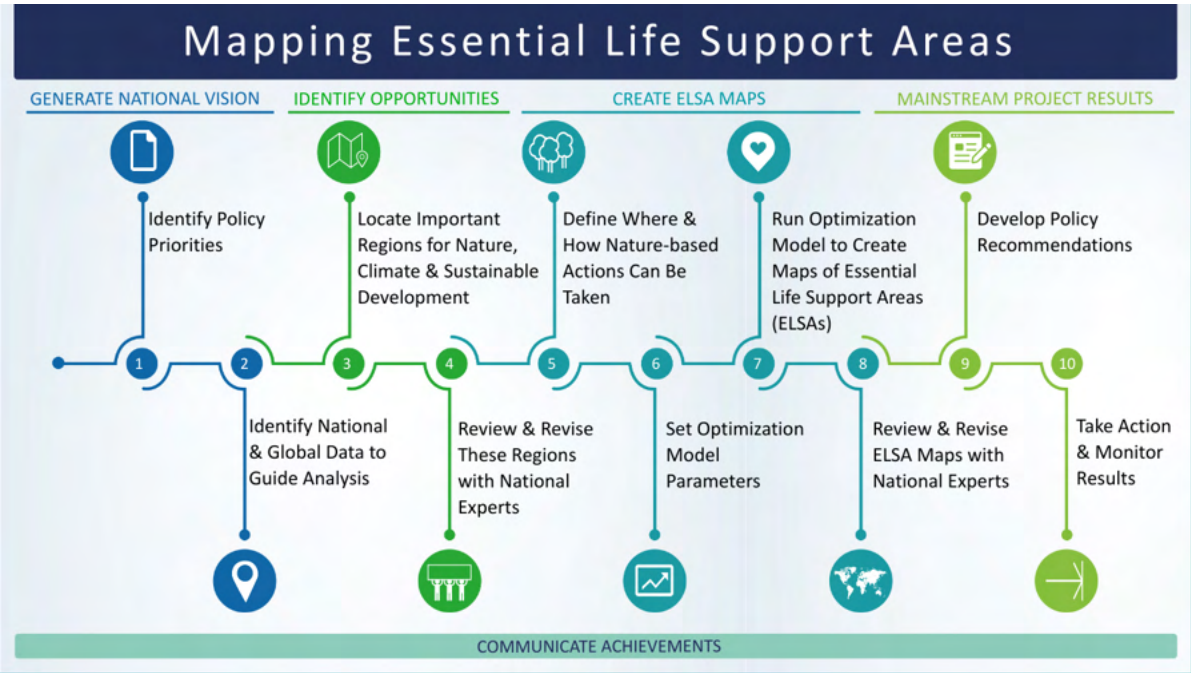


Figure 1. The ELSA process

2.2 How to Create an ELSA Map

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

ELSA 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 5). 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 ELSA 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 (targets) 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 ELSA analysis are actions to protect, manage, and restore natural ecosystems. The ELSA 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 ELSA analysis by setting the amount of land area the analysis can recommend for protection, restoration and management in order to contribute to the achievement of the 10 priority policy commitments.

The ELSA Policy Priorities in Uganda

In Uganda, thirteen priority policy commitments were initially identified in Uganda. They are shown in Figure 2. The selected targets span ecosystems and species diversity, green energy and climate actions, disaster risk reduction, agriculture and livestock, fisheries, and water resources.

Figure 2. Priority commitments identified through stakeholder consultation in Uganda.

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

The ELSA Nature-based Actions in Uganda

Uganda chose to focus their ELSA analysis on actions to protect, manage, and restore natural ecosystems. National stakeholders additionally highlighted that within these broad classes of nature-based solutions, there was high political will to support activities related to rehabilitation of land for human well-being.

The area-based targets for these actions were selected based on existing policy commitments and are summarized in Table 1. The area-based targets used in the analysis are higher than existing policy commitments. This enables the final ELSA map to indicatively suggest areas for action that can be discussed with local stakeholders rather than prescriptively determining a specific course of action.

Table 1. Nature-based actions and area-based targets used in the ELSA analysis

Action	National Definition of Action	Area-based Target	Origin of Target	Spatial Definition of Zone for Each Action	Spatial Constraints for Zone
Protection	The introduction of land use restrictions equivalent to those on protected areas supports the processes of the natural ecosystem and limits the exploitation of land resources by humans.	20% of national territory.	~5% more than the existing protected area coverage of 15.1%.	Areas that maintain intact natural ecosystems, including pristine and unique ecosystems, wildlife habitats, and important water sources.	• In Human Footprint < 14. • Not in water. • Not in farmland (30%). • Not in urban areas.
Management	Sustainable management methods used in agricultural areas, particularly cattle corridors and integration of trees into farmland. These management practices increase the content of organic matter in the soil, reduce erosion, reduce the waste of agricultural production resources, including fertilizers and pesticides, and increase the habitat structure (shrubs or trees).	10% of national territory.	Set to be ambitious based on national focus on restoration as a priority strategy for both human use (agriculture, rangelands) and biodiversity values.	Areas that are suitable for sustainable agriculture and cattle corridors, but which may be at risk of overuse.	• In Farmland (commercial or subsistence). • In Human Footprint <21. • Not in water. • Not in urban areas.
Restoration	Passive or active restoration of degraded fragile ecosystems including demarcation for natural regeneration for strict use or protection, reforestation and replanting of wetlands vegetation, demarcation of no-encroachment zones along lakes and rivers (buffer zones for the protection of water resources), re-afforestation and sustainable land management practices within hilly or mountainous areas. The country also places high priority on rehabilitation of land for human well-being (for agriculture or rangelands).	13% of national territory.	Set to be fairly ambitious due to national focus on sustainable management of cattle corridors.	Areas that are suitable for reforestation of wetland areas, development of buffer areas around water sources, reforestation in mountainous areas, and rehabilitation of land for agriculture or rangelands.	• IIn Forest Biome. • In Human Footprint <21. • Not in water. • Not in farmland. • Not in urban areas. • Not in fully stocked forest.

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 5).

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 conservation features. Depending on the complexity of the target, it might correspond to one or multiple conservation features. The analysis will ultimately seek to optimize outcomes across all conservation features. For example, when looking at a policy commitment for biodiversity, the core team might map this commitment through conservation features such as ecosystem connectivity and integrity, threatened species distribution, species richness, and Key Biodiversity Areas. These conservation features will be used in the analysis in combination with conservation features for commitments related to climate change, water security, food security, and sustainable livelihoods.

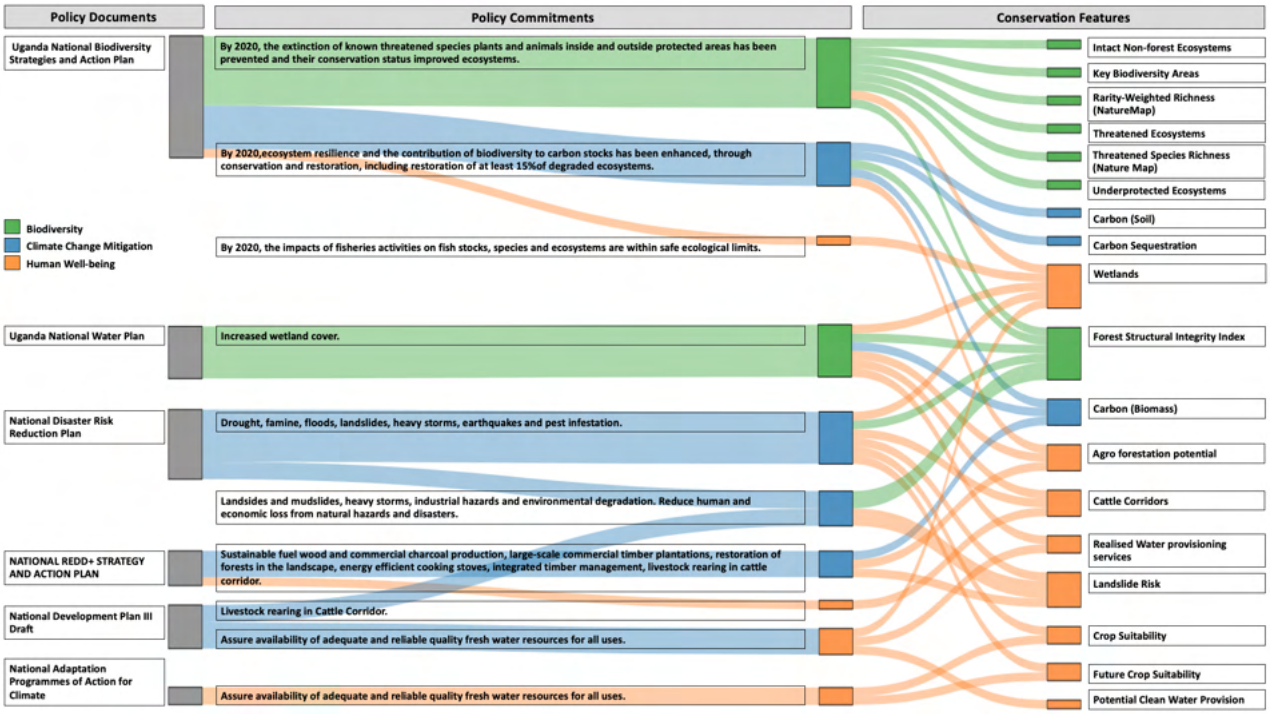
2. *Data to Map Zones.* Zones determine where each nature-based action can be implemented according to the land capacity and political zoning of the country. These zones are created based on "rules", or constraints, that help the algorithm to identify viable locations for each action. For example, zoning 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 ELSA analysis (Figure 1, Steps 3-8).

Mapping of Priority Policy Targets in Uganda

Eighteen conservation features were identified that could serve as spatial proxies for the 10 of the 13 policy commitments selected by Uganda. Three of the commitments were removed from the analysis, in consultation with the national team, due to the lack of available spatial data to map them. The relationship between the policy commitments and conservation features is shown in Table 2.

Table 2: Relationship among policy documents, priority commitments, and conservation features selected for inclusion in the analysis.



The ELSA Nature-based Actions and Action Zones in Uganda

Uganda identified three nature-based actions that were critical to include in its ELSA map: protect, manage, and restore natural ecosystems. 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 maintain intact natural ecosystems, including pristine and unique ecosystems, wildlife habitats, and important water sources. This is mapped using four different spatial datasets, including farmlands, urban areas, open water (such as great lakes like Lake Victoria and Lake Albert), and human footprint index. The human footprint index was used to identify areas with very low human pressure (human footprint less than 14) that should be considered for protection. The datasets mapping farmlands, urban areas, and open water were used to exclude these areas from the zone as they are not good candidates for protection.

The **restoration** zone includes areas that are suitable for reforestation (degraded forest reserves and bare land) and re-generation/re-vegetation of degraded areas, development of buffer areas around water sources, reforestation in mountainous areas, and rehabilitation of land for agriculture or rangelands by increasing forest cover. In Uganda, this is mapped using six different spatial datasets. Datasets on forest biome and human footprint were used to identify areas for inclusion in the zone, with a threshold of human footprint less than 21 used to exclude areas that are highly modified and intensively used human settlements. As with the protection zone,

farmland, urban areas, and open water were excluded from the zone because they are not viable areas for restoration. In addition, fully stocked forest areas were excluded from the zone as these areas do not need restoration.

The **management** zone covers areas that are suitable for sustainable agriculture and livestock farming – especially the cattle corridors – but which may be at risk of overuse. For example, areas where overgrazing and overstocking may occur. This is mapped using five different spatial datasets. Datasets on farmland (both commercial and subsistence) and human footprint were used to identify areas for inclusion in the zone, with a threshold of human footprint less than 21 used to exclude areas that are highly modified and intensively used human settlements. Open water and urban areas were excluded from the management zone.

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

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

The ELSA analysis (Figure 1: Steps 3-8) for Uganda uses Systematic Conservation Planning (SCP) to identify where nature-based actions to protect, manage, and restore nature 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 terrestrial conservation that helps identify where nature-based actions can achieve maximum impact across multiple priorities in a given study area, region of interest, or country.

The value of using SCP to run the ELSA analysis is two-fold. First, it assesses all conservation 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 ELSA analysis also offers the option to create a map focused only on the targets related to the three themes -- biodiversity, climate change, and human well-being -- in order to provide customized maps to support action within specific sectors. Second, the ELSA analysis enables diverse stakeholder groups to weigh the relative importance of the various conservation 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 ELSA analysis and the ELSA Webtool. Find their general definitions and their specific definitions for your country in Annex 3. Two elements of this analysis are critical to understand: weights and impacts.

1. *Weights:* Weights enable users to set relative priorities across the conservation features associated with their policy commitments. Weighing is implemented in the ELSA webtool on

a scale of zero to five. For example, if Uganda assigns greater importance to carbon sequestration than food security, the maps will reflect both, but prioritize areas most important for carbon sequestration over those important to food security.

2. *Impacts:* An impact score is given to determine how each nature-based action contributes to achieving each conservation feature. This impact score is determined by the ELSA science team based on the specific actions and conservation features in each country. For instance, only sustainable management contributes to achieving policy commitments related to agricultural production, as this is the only zone that is compatible with food production.

After stakeholder engagement to determine the relative weight of each conservation feature, the ELSA 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 conservation features. In order 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 conservation feature can be accomplished by implementing the actions documented in the ELSA map, relative to what is possible under a targeted planning scenario. A score of 100% means that the conservation feature has been represented as well in the ELSA map (which represents all conservation features) as if it were to be planned for in isolation.

In cases where the ELSA map accomplishes less of a given feature than the more targeted scenario, stakeholders can revise the weighting to ensure better outcomes for a given conservation feature. The ability to change weighting for each conservation feature in the ELSA webtool enables an iterative approach to developing the ELSA map, where stakeholders can revise weighting to better deliver across all conservation features. Likewise, the weighting can be revised over time as the relative importance of the ten priority commitments shift in the country. Overall, the ELSA analysis provides Uganda 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.

The ELSA Analysis in Uganda

The ELSA maps of Uganda below show areas that should be prioritized for protection, management, and restoration in order to most effectively deliver across the ten policy commitments associated with biodiversity, climate change mitigation, and human well-being.
The 'ELSA' map demonstrates where actions can most effectively achieve the greatest impact across all conservation features. The other three maps focus only on the features related to the given themes -- biodiversity, climate change mitigation, and human well-being -- in order to provide customized maps to support action within specific sectors.

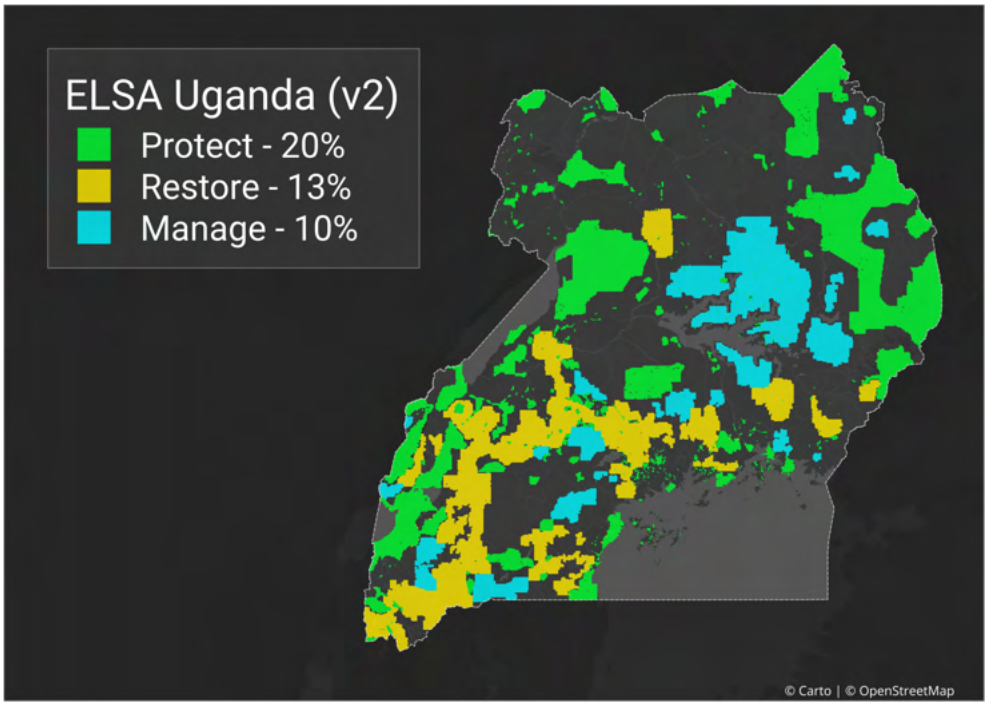


Figure 3. The second ELSA map for Uganda

The technology: How is the ELSA analysis run?

The ELSA 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 ELSA 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 is found.

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

2.3 Implementation of the ELSA Map

Contribution of ELSA to policy development in areas of strategic importance

The ELSA 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 ELSA map for implementation in Uganda, see our policy brief on applications of the ELSA process.

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

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

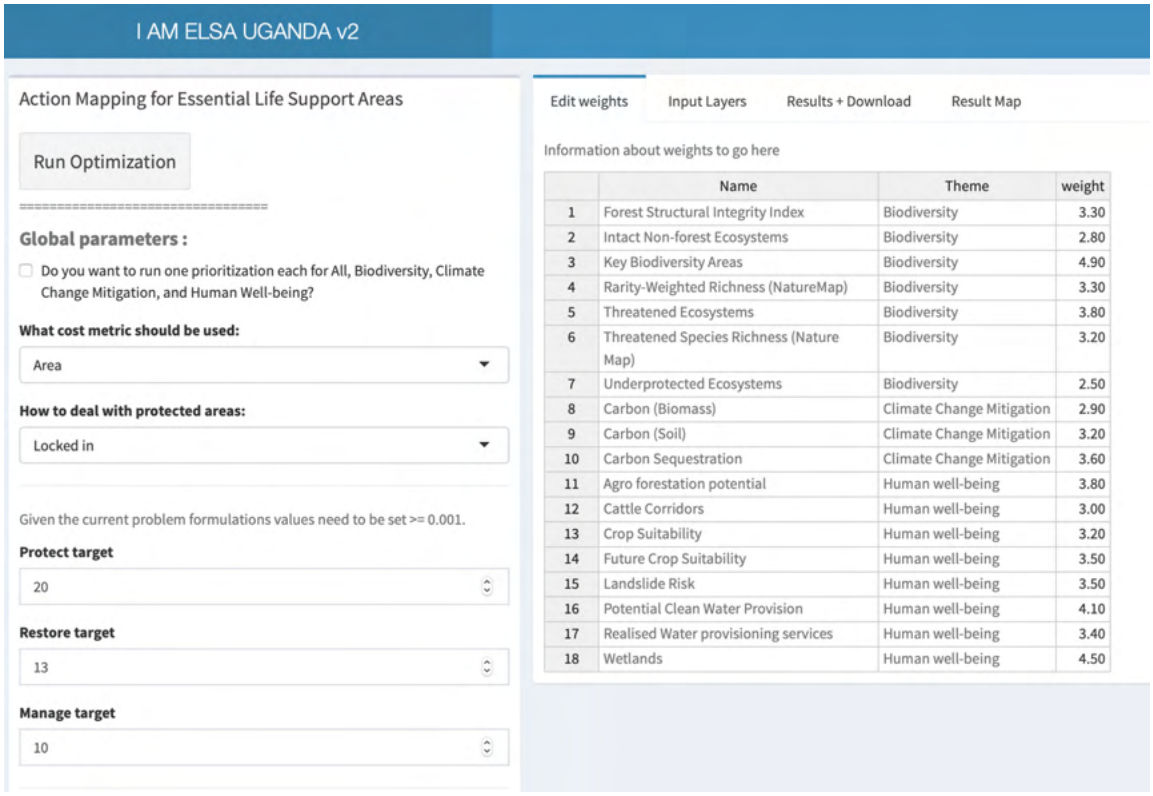
- Target 1 on land and seas under spatial planning;
- Target 2 on protecting and conserving at least 30 percent of the planet;
- Target 5 on controlling and managing invasive species;
- Target 7 on increasing contributions to climate change mitigation, adaptation, and disaster risk reduction from nature-based 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.

3. The ELSA Webtool

3.1 What Purpose Does the ELSA Webtool Serve?

The ELSA webtool is an interactive online webpage designed by Dr. Oscar Venter at University of Northern British Columbia and Dr. Richard Schuster at Carleton University. It generates ELSA maps based on the country's targets for nature, climate change, and sustainable development, automating steps 3, 6, and 7 in the ELSA process (Figure 1). The webtool is easy to use for people who are not spatial data experts, with no coding or modelling skills required.

The webtool runs optimizations quickly (typically in less than one minute). It can therefore be used to generate and refine conservation plans in real-time during stakeholder meetings, and contribute to a more transparent, inclusive, and defensible decision-making process.



	Name	Theme	weight
1	Forest Structural Integrity Index	Biodiversity	3.30
2	Intact Non-forest Ecosystems	Biodiversity	2.80
3	Key Biodiversity Areas	Biodiversity	4.90
4	Rarity-Weighted Richness (NatureMap)	Biodiversity	3.30
5	Threatened Ecosystems	Biodiversity	3.80
6	Threatened Species Richness (Nature Map)	Biodiversity	3.20
7	Underprotected Ecosystems	Biodiversity	2.50
8	Carbon (Biomass)	Climate Change Mitigation	2.90
9	Carbon (Soil)	Climate Change Mitigation	3.20
10	Carbon Sequestration	Climate Change Mitigation	3.60
11	Agro forestation potential	Human well-being	3.80
12	Cattle Corridors	Human well-being	3.00
13	Crop Suitability	Human well-being	3.20
14	Future Crop Suitability	Human well-being	3.50
15	Landslide Risk	Human well-being	3.50
16	Potential Clean Water Provision	Human well-being	4.10
17	Realised Water provisioning services	Human well-being	3.40
18	Wetlands	Human well-being	4.50

Figure 4. The interface of the ELSA webtool-Uganda

3.2 Functions of the Online Webtool

The ELSA webtool for Uganda is hosted by the UN International Computing Centre (UNICC) and is available online here. The ELSA webtool has been created specifically for Uganda and can be used for several key functions.

What stakeholders in Uganda can use the ELSA Webtool to accomplish:

- Choose to lock-in or lock-out Protected Areas.
- Change the percentage of national territory that can be allocated to each nature-based action zone (protect, restore, and manage).
- Edit weights of each conservation feature.
- Run the optimization.
- View and download the ELSA map and summary results.

All of these parameters can be adjusted in real-time to enable a group of stakeholders to co-create an ELSA map.

What stakeholders in Uganda cannot use ELSA Webtool to accomplish:

- Customize zoning constraints.
- Upload additional data layers for inclusion in the model either as conservation features or as zoning constraints.
- Add extra lock-in features.

All of these parameters are hard-coded into the backend of the ELSA webtool by the science team based on input from the core project team. They cannot at this time be modified by individual users.

3.3 Cost Metric

The cost metric shows how much it will cost, in terms of land area or conflict with human footprint (e.g., opportunity cost), to implement each nature-based action. On the left panel, you can choose the cost metric you want to use in the analysis. Selecting 'area' as the cost metric assumes that all Planning Units have the same cost (meaning there is no differentiation in cost). The 'area' cost metric is the only setting available for the ELSA analysis.

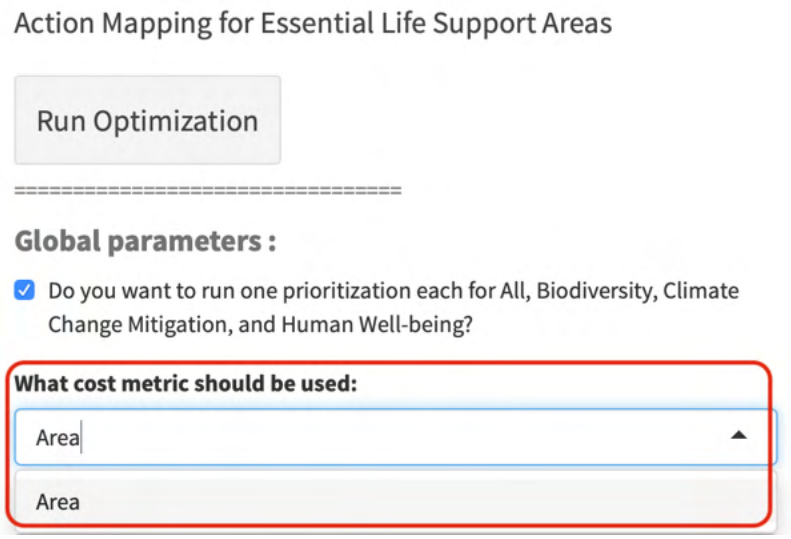


Figure 5. Select the cost metric

3.4 Lock-in Features

The lock-in features apply to existing protected areas, which can include contracts to protect, manage or restore natural systems. Locking-in these areas ensures they are included in the ELSA areas during the optimization.

Steps

Lock-in Protected Areas:

- Select "Locked in" if you want to force the analysis to include (lock-in) existing protected areas within the 'protect' action. In addition to showing existing protected areas, the resulting map will also show where new protected areas should be placed.
- Select "Available" if you want to independently assess the optimal location for protected areas in your country based on the ELSA analysis.

Currently for Uganda, the protected area estate covers 15.2% of the country. Therefore, selecting "lock in protected areas" requires that you allocate at least 15.2% of national territory under the 'protected target' (see 3.5).

3.5 Targets

This part of the ELSA webtool enables you to set area-based targets for protection, restoration, and management. The targets can also be understood as the percentage of terrestrial land that can be allocated to each action within the country. The default values in the ELSA Webtool are derived from existing policy commitments and/or priorities in Uganda (see Chapter 2).

Steps

1. Set any value >=0.001 for the protection, management, and restoration targets. The sum of the value all targets can be less than but should not exceed 100.
    a. Currently, about 15.2% of Uganda is protected. Therefore, if you select 'lock-in protected areas' (3.4), the protect target here must be at least 15.2%.

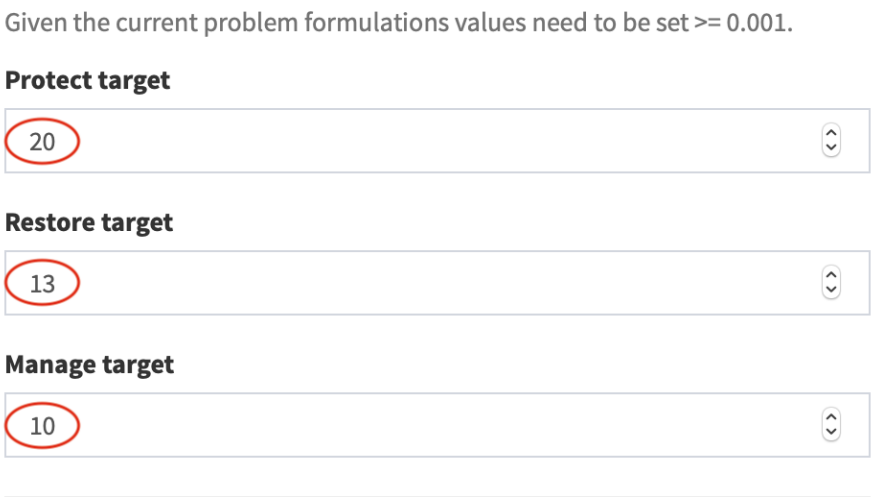


Figure 6. Target setting

3.6 Boundary Penalty Factor

The boundary penalty is used to promote spatial cohesion when prioritizing land use zones. It helps to avoid a 'salt and pepper' map with actions assigned to very small areas scattered across the landscape. The boundary penalty can be 0 or higher. The higher the value, the more likely to create an ELSA map that has larger contiguous zones for each action, making it more implementable. To create Uganda's second ELSA map, the global science team used a boundary penalty factor of 8e-06.

Steps

1. To set the boundary penalty, start with a very small number e.g., 0.00001.
2. Iteratively increase the number by an order of magnitude (e.g., 0.00001 -> 0.0001 -> 0.001), reducing the rate of increase as you near solutions that lead to your desired level of clumping.

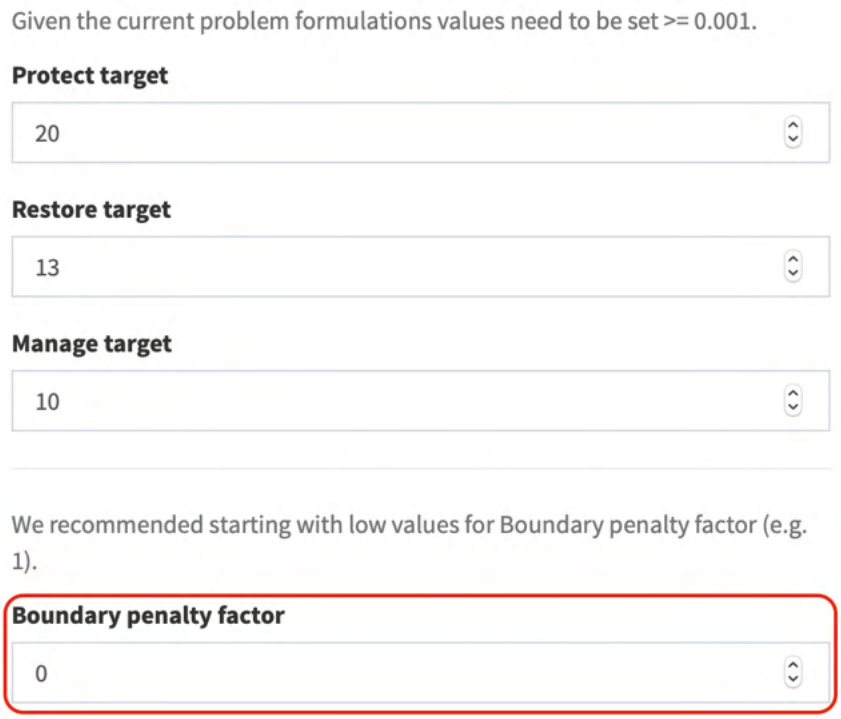


Figure 7. Boundary penalty factor setting

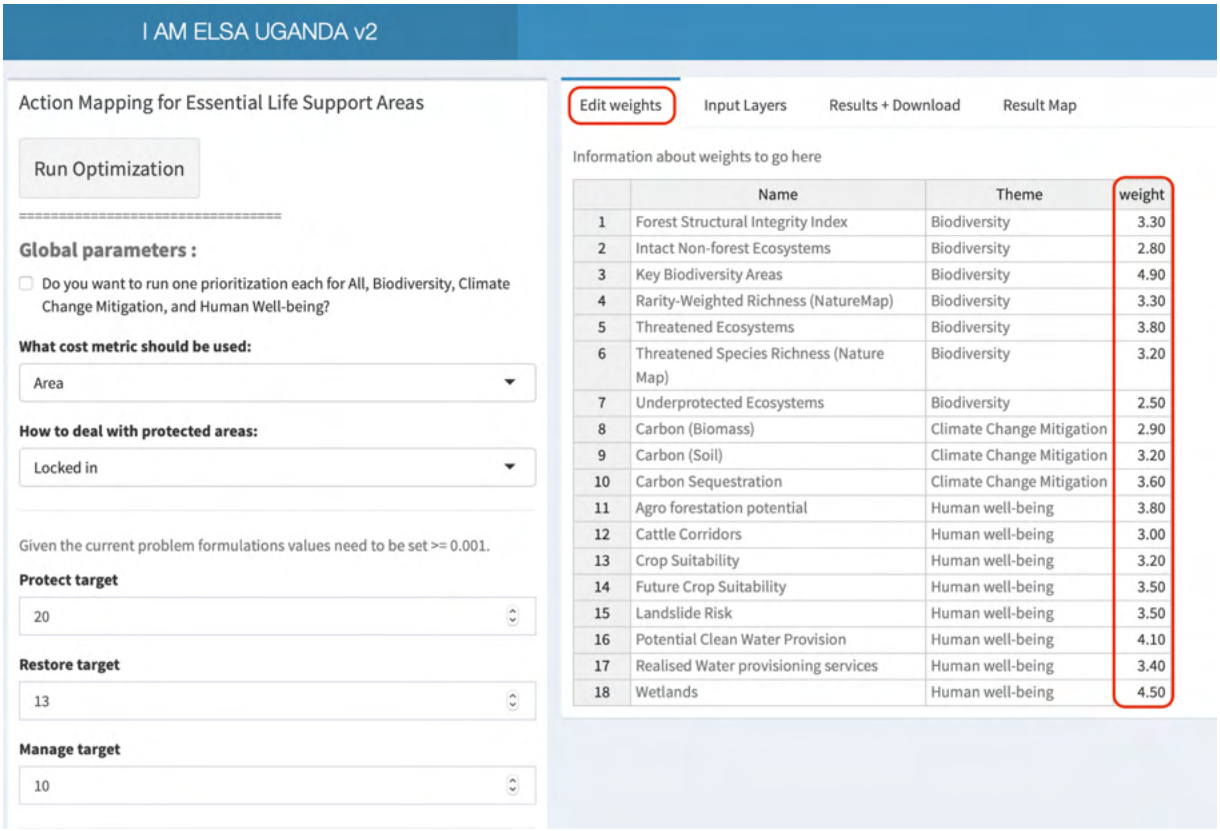
3.7 Edit Weights of Features

To run the optimization analysis, stakeholders need to decide the comparative importance of each of the conservation features that map the priority policy commitments for Uganda. This is accomplished through weighting. For example, if key biodiversity areas are considered as highly important, higher weight should be given to this feature (>3).

The default weights in the tool weights are based on inputs from a diverse group of policymakers, experts and other stakeholders in your country.

Steps

1. Enter a weight for each conservation feature. We recommend a scale from 0-5 as the following based on the priority level of each conservation feature:
   - 0 – not important / do not consider
   - 1.0 – low importance
   - 3.0 – average importance
   - 5.0 – highest importance



	Name	Theme	weight
1	Forest Structural Integrity Index	Biodiversity	3.30
2	Intact Non-forest Ecosystems	Biodiversity	2.80
3	Key Biodiversity Areas	Biodiversity	4.90
4	Rarity-Weighted Richness (NatureMap)	Biodiversity	3.30
5	Threatened Ecosystems	Biodiversity	3.80
6	Threatened Species Richness (Nature Map)	Biodiversity	3.20
7	Underprotected Ecosystems	Biodiversity	2.50
8	Carbon (Biomass)	Climate Change Mitigation	2.90
9	Carbon (Soil)	Climate Change Mitigation	3.20
10	Carbon Sequestration	Climate Change Mitigation	3.60
11	Agro forestation potential	Human well-being	3.80
12	Cattle Corridors	Human well-being	3.00
13	Crop Suitability	Human well-being	3.20
14	Future Crop Suitability	Human well-being	3.50
15	Landslide Risk	Human well-being	3.50
16	Potential Clean Water Provision	Human well-being	4.10
17	Realised Water provisioning services	Human well-being	3.40
18	Wetlands	Human well-being	4.50

Figure 8. Weight setting

3.8 View the Input Layers

By clicking the 'input layers', users can view the maps for the 18 conservation features included in the ELSA analysis.

Steps

1. Check the box for each input layer you would like to visualize.
2. Uncheck the box to remove the input layer from the view.

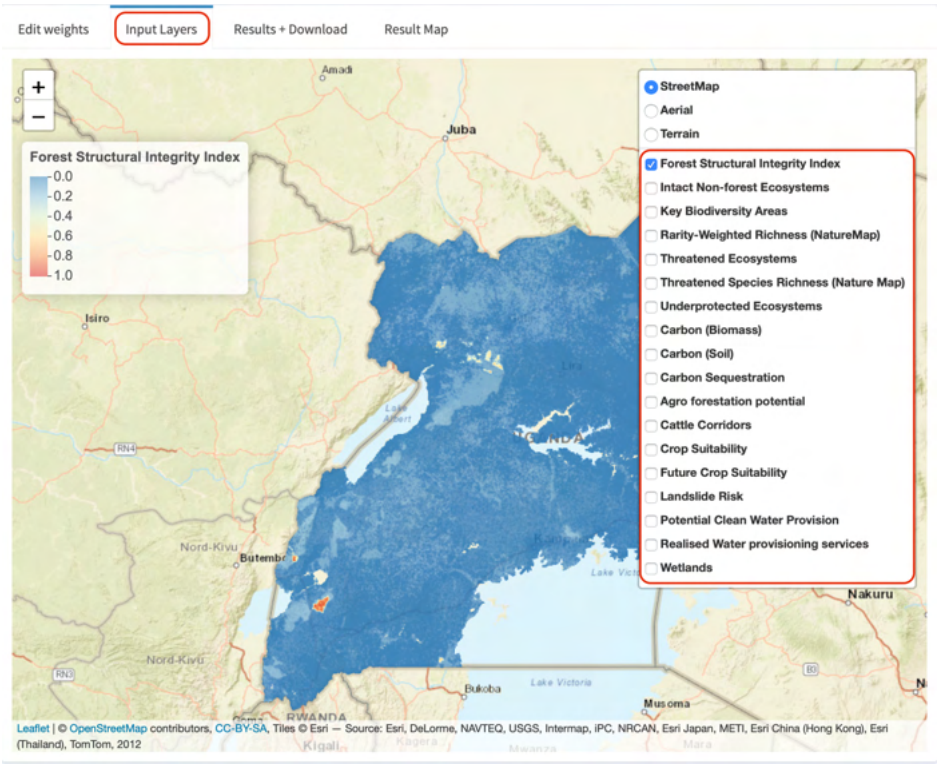


Figure 9. View the input layers

3.9 View the Heat Maps

Before running the optimization, when clicking the 'result map' on the right panel, you can find four heat map (HM) layers. The heat maps identify locations important for Uganda's ten priority commitments. They are the result of the intersection of the conservation features and their respective weights. The higher the value on a range from zero to one, the more features of high weight overlap. They thus can be identified as hotspots for biodiversity, climate change mitigation, and human well-being.

The heatmaps can be toggled, to view the all features (ELSA) heat map, which displays all features together, and maps showing only features within specific themes (biodiversity, climate change mitigation, human well-being). Important areas are shown in warm colors, with red indicating the most important.

By looking at the heat maps before the action maps, data experts can view the combined conservation feature data, and determine if the patterns are aligned with their expectations and personal knowledge of the region. To aid in this process, users can toggle between the heat maps and underlying satellite images and road maps, which helps orient the heat maps in the landscape. There are four types of heatmaps on Uganda's webtool:

Table 4. Types of heat maps on Uganda's webtool

Name	Description
All_HM	The ELSA heat map. This heat map shows the intersection of all conservation features to indicatively show areas of importance based on ALL national priority policy commitments.
Biodiversity_HM	TThe biodiversity heat map. This heatmap shows the intersection of conservation features for biodiversity to indicatively show areas of importance for biodiversity based on national priority policy commitments.
Climate Change Mitigation_HM	The climate change mitigation heat map. This heat map shows the intersection of conservation features for climate change mitigation to indicatively show areas of importance for climate change mitigation based on national priority policy commitments.
Human_well-being_HM	The human well-being heat map. This heat map shows the intersection of conservation features for human well-being to indicatively show areas of importance for human well-being based on national priority policy commitments.

Steps

1. Click on the 'results' tab in the right panel.
2. Toggle between the four heat maps to review the information before you run the optimization.
3. Experiment with switching between 'aerial' and 'terrain' views.

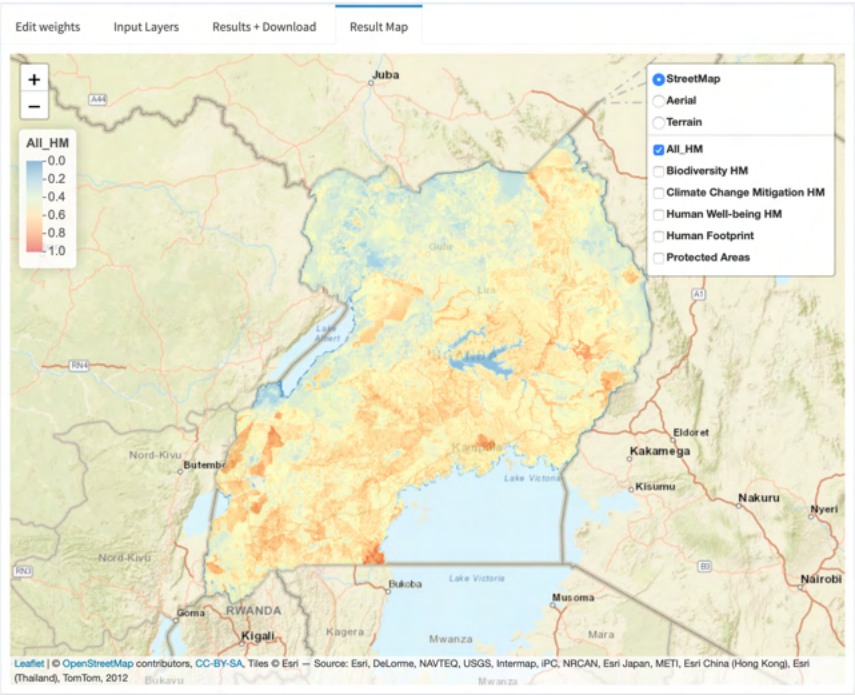


Figure 10. ELSA Heatmap of all features

3.10 Run Optimization

After you have customized the parameters listed above and reviewed the heat maps, you are ready to run the optimization analysis!

Steps

1. Click the 'run optimization' button. It may take up to 1-2 minutes to run the analysis. You should see a progress bar that documents the analysis status. Do not re-click on 'run optimization' while the analysis is already running.
2. The analysis will create four maps, one where the map of nature-based actions is optimized to deliver benefits across all conservation features (ELSA), one optimized for biodiversity, one optimized for climate change mitigation, and one optimized for human well-being.
3. Every time you change any parameters, click 'run optimization' again to run the model to refresh your result report and map.

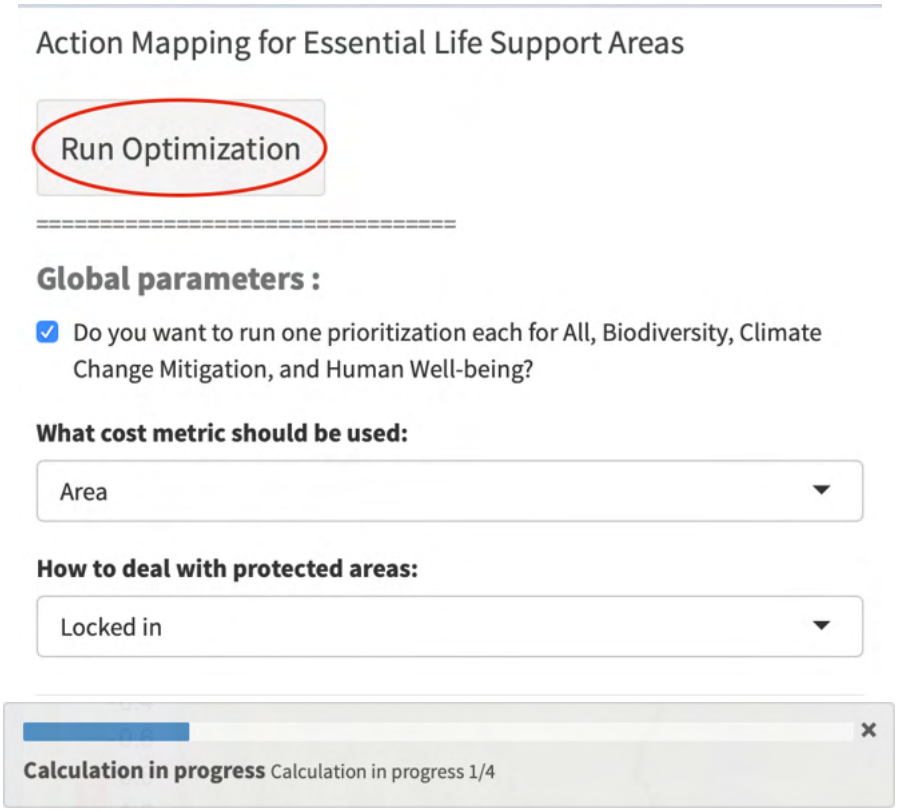


Figure 11. Optimization

3.11 Analyze Synergies and Tradeoffs

After running an iteration of the analysis, you can view the results and assess whether the parameters you selected led to an acceptable outcome.

Steps

1. Go to the 'Results + Download' tab, scroll down, and click 'download summary table'. This will download an excel file of the results.
2. Review the results.
   - Column A provides the name of the conservation feature.
   - Column B documents the theme it is associated with.
   - Columns C-F give these outcomes across the four planning scenarios
     - ELSA, which includes weights all conservation features;
     - Biodiversity conservation features weighted only;
     - Climate change mitigation conservation features weighted only, and
     - Human well-being conservation features weighted only.
   - Column G shows the weight used in the analysis.
3. For features where the feature representation under ELSA (cell values in columns C) , shows a substantial decline (~20%) relative to the highest representation possible (column D-F), it is advised to consider returning to the weights in the tool and increasing the weight for that feature so it is better represented within ELSA areas.

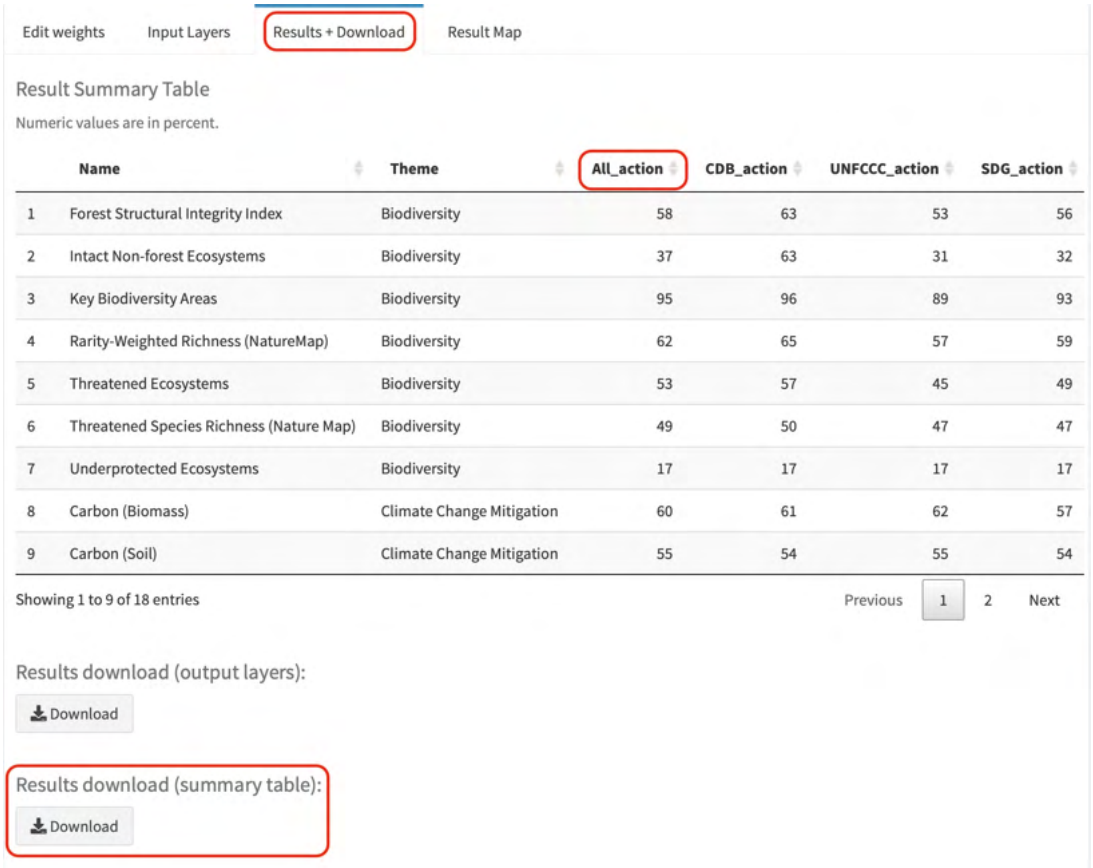


Figure 12. Download Summary Table

3.12 View and Download Maps

After running the optimization, you will be able to view and download eight maps (including four heat maps and four action maps) for your country based on the results of the ELSA analysis (Figure 13). These can be used for communication and implementation purposes.

Table 5. ELSA maps available for download from the ELSA webtool

Name	Description
All_action	The ELSA action map. This shows where action should be taken to protect, manage, and restore nature to best achieve all conservation features.
Biodiversity_action	The biodiversity action map. This shows where action should be taken to protect, manage, and restore nature to best achieve the conservation features for biodiversity.
Climate_change_mitigation_action	The climate change mitigation action map. This shows where action should be taken to protect, manage, and restore nature to best achieve the conservation features for climate change mitigation.
Human_well-being_action	The human well-being action map. This shows where action should be taken to protect, manage, and restore nature to best achieve the conservation features for human well-being.

Steps

1. Click “Result Map” to view the action maps in the webtool.
2. Zoom into particular areas by clicking the “+” icon.
3. Switch to an aerial / terrain view by clicking “Aerial” / “Terrain” on the bar at the right of the map.
4. Click “Results + Download“, then click “Results download (output layers)” to download the maps as GeoTIFF. This can be viewed and analysed in GIS software.
5. When using the ELSA map in a formal report or publication, please use the following citation: UNDP and UNBC. 2021. Essential Life Support Areas (ELSA) [Country]. Created at: [insert link to webtool] on Day Month Year.

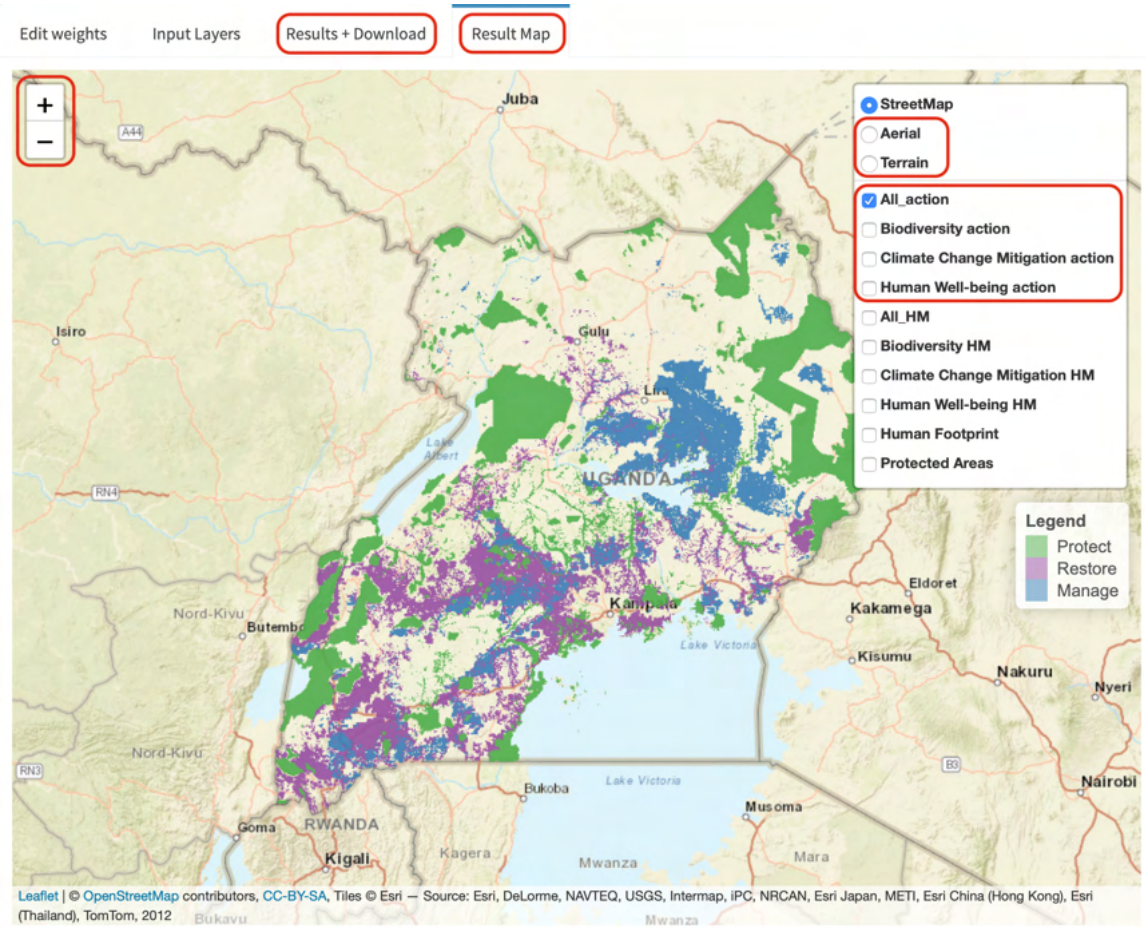


Figure 13. Action map

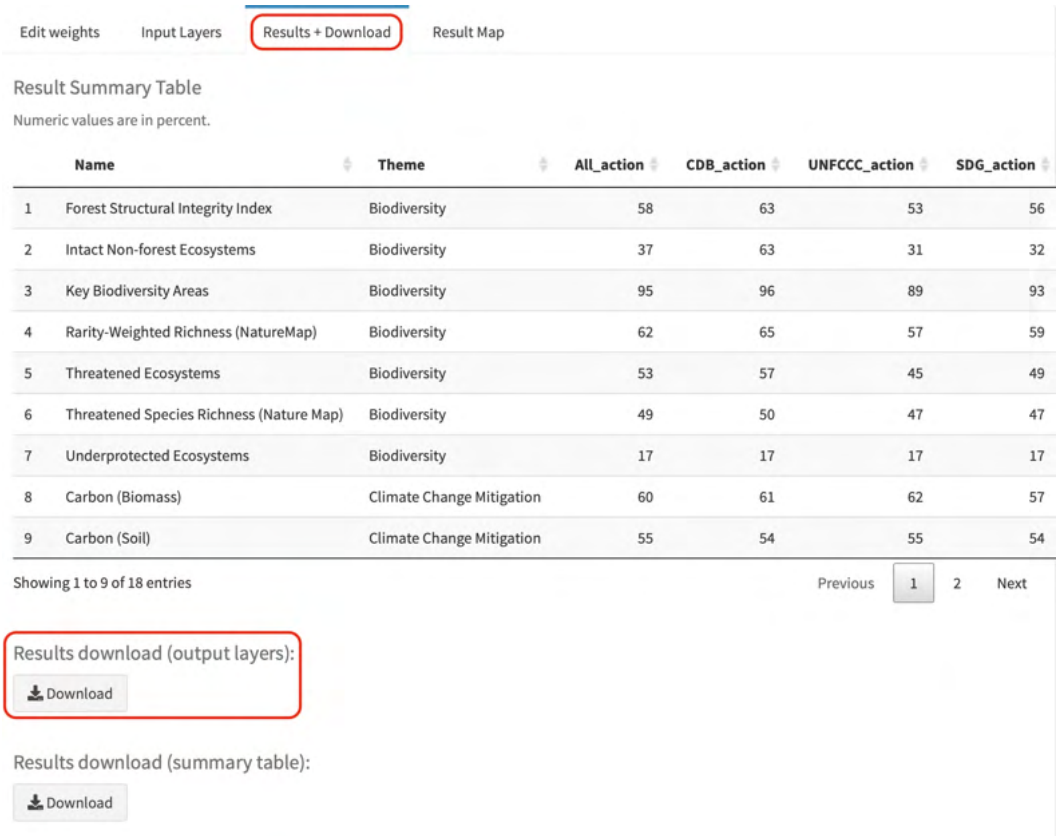


Figure 14. Download Output Layers

3.13 Further Support

For further support, please contact: Di Zhang at di.zhang@undp.org, copying Anne Virnig at anne.virnig@undp.org.

4. References

Beyer, H. L., Dujardin, Y., Watts, M. E., & Possingham, H. P. (2016). Solving conservation planning problems with integer linear programming. Ecological Modelling, 328, 14–22.

Hanson JO, Schuster R, Morrell N, Strimas-Mackey M, Watts ME, Arcese P, Bennett J, Possingham HP (2021). prioritizr: Systematic Conservation Prioritization in R. R package version 7.0.1. Available at https://CRAN.R-project.org/package=prioritizr.

Margules, C. R., & Pressey, R. L. (2000). Systematic conservation planning. Nature, 405, 243–253.

5. Annex

5.1 Key Terms Used in the ELSA Process

Term	Definition	Application in Uganda
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 ELSA areas.	A boundary penalty of 8e-06 was applied to produce the second ELSA map for Uganda. 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: 20% Restore: 13% Manage: 10%
Conservation 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 ELSA process, each priority commitment for a country may correspond to one or multiple conservation features depending on its complexity.	The ELSA webtool for Uganda includes 18 features that map the ten priority policy commitments (Table 2).
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 ELSA project in Uganda, 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 ELSA 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 ELSA 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 conservation 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 protection, restoration, and management on each of the conservation features for Uganda 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 ELSA process in Uganda 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 ELSA 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: UTM 36N Resolution or pixel size: 1km x 1km

Term	Definition	Application in Uganda
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 ELSAs in Uganda.
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 ELSA Webtool is a GUI that provides stakeholders with the ability to directly run the ELSA analysis themselves.	The ELSA Webtool is a GUI that provides stakeholders with the ability to run the prioritizr ELSA 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 Uganda ELSA analysis were collaboratively developed through two stakeholder engagement sessions. Stakeholders can modify these weights through the ELSA webtool based on changed priorities.
Zones/Actions	A land use zone, equivalent to a nature-based action, that serves to improve specific conservation features. Zones are determined by constraints 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 Uganda, the ELSA analysis zoning maps three different actions: protect, restore, manage. Data used for zoning constraints including human footprint, open water, commercial farmland, subsistence farmland, urban areas, forest and tree biomes, and fully stocked topical forest.

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