Science Brief
Mapping Essential Life Support Areas in Nepal

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Executive Summary

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

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

1. Introduction: Essential Life Support Areas (ELSAs) — 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 Nepal, despite existing technical capacity and strong political will, the government faces similar challenges, including: limited access to free, high quality and updated national datasets on biodiversity and ecosystems, a lack of decision support tool at the national level, and a need for guidance on environmental planning, including around management priorities,and provide each relevant department with recommendations on where to protect, manage and restore nature.

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 Nepal 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 Nepal'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 Nepal's workspace, please contact Dr. Buddi Sagar Poudel, Chief, Joint Secretary, Climate Change Management Division/MoFE at buddi.poudel@gmail.com, and Menaka Panta Neupane at menaka72@gmail.com. The successful approaches developed in Nepal will inform the further development of the ELSA project in other pilot countries.

The Partnership

Working with Nepal, Chile, Cambodia, Colombia, Costa Rica, the Dominican Republic, Ecuador, Haiti, Kazakhstan, Liberia, Peru, South Africa, and Uganda as the 13 initial pilot countries, this work brings together a powerful coalition of governments, NGOs, research institutes, and intergovernmental organizations.

The Nepal case

In Nepal, the project is led by the United Nations Development Programme (UNDP) and the Ministry of Forest and Environment of Nepal, with funding from the Sustainable Markets Foundation (SMF).

Quick Resources on ELSA

Introduction to ELSA

- 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 ELSA process.
- Monitoring ELSA 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 ELSA in Nepal.
- 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 Nepal scientists and leaders introduces the fundamentals of the science behind ELSA, Systematic Conservation Planning.
- Prioritizr: information about the prioritizr R code that runs the ELSA analysis is available on the prioritizr website and the prioritizr workshop manual.
- Data included in Nepal ELSA analysis: This presentation slides describes the pre-processing of the datasets included in the second ELSA map for Nepal.
- Development of Nepal's second ELSA map (Day 1 | Day 2): These recordings show the interactive co-creation of Nepal's second ELSA map.

ELSA in Nepal

- Workshops and reports:
  - Report from the preparatory meeting
  - Report from the final workshop
  - Workshop website

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
- South Africa solution video

2. The Science of ELSA

2.1 Overview of the ELSA Process

In order to identify key nature-based actions that can support priority policy commitments in Nepal, 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 show where nature-based actions can best contribute to the achievement of these 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 Nepal, stakeholders worked together to execute the nine steps of the ELSA process, with a continued focus on steps 8 and 9 on policy development and implementation & monitoring, as well as on communication (Figure 1).

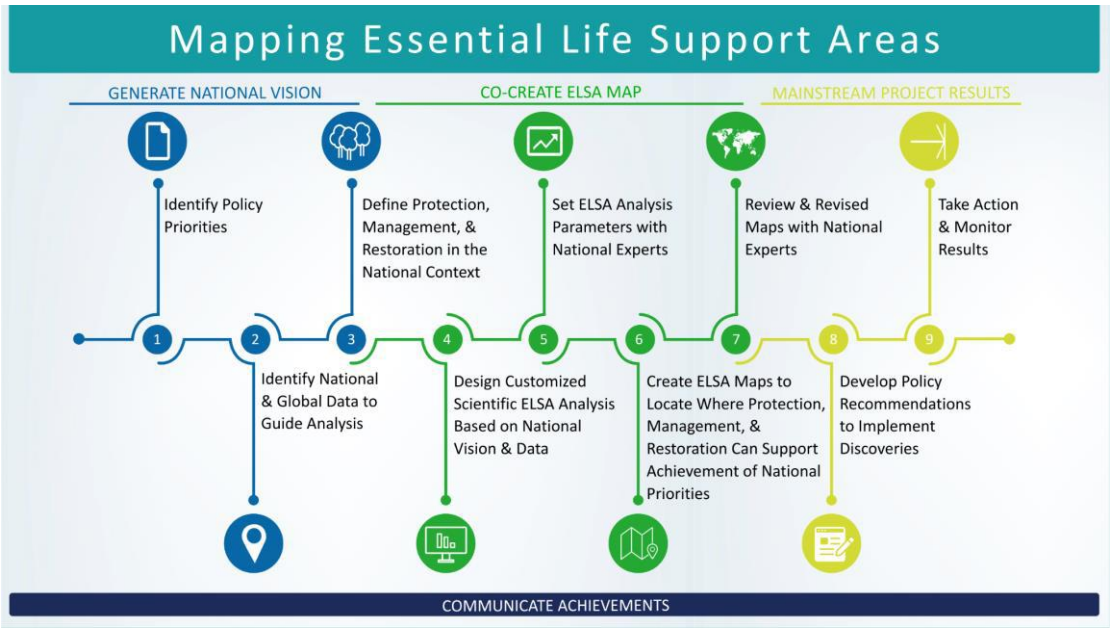


Figure 1. The ELSA process

2.2 Methods Used to Create the 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 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 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 (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 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 Nepal

In Nepal, ten priority policy commitments were initially identified. They are shown in Figure 2. The selected policy commitments span ecosystem integrity & conservation, species conservation, food and water security, land degradation neutrality, climate change mitigation and adaptation, disaster risk reduction, urban health, jobs and livelihoods, and sustainable forest management.

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

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

The ELSA Nature-based Actions in Nepal

Nepal chose to focus their ELSA analysis on actions to protect, manage, and restore natural ecosystems, and urban greening. National stakeholders additionally highlighted that within these

broad classes of nature-based solutions, it was incredibly important to take in mind the underlying food insecurity and poverty in the country, as well as disaster risk reduction and water management. They highlighted that any action must take into account this reality and offer support for rural livelihoods and food production.

The area-based targets used in the analysis are equal or higher than existing policy commitments. This enables the final ELSA map to indicatively suggest areas for each nature-based action that can be discussed with local stakeholders rather than prescriptively determining a specific course of action.

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 ELSA analysis (Figure 1, Steps 4-7).

Mapping of Priority Policy Commitments in Nepal

Twenty-six planning features were identified that could serve as spatial proxies for the ten policy commitments selected by Nepal. The relationship between the policy commitments and planning features is shown in Figure 3. See Annex 2 for further information on the data sources used.

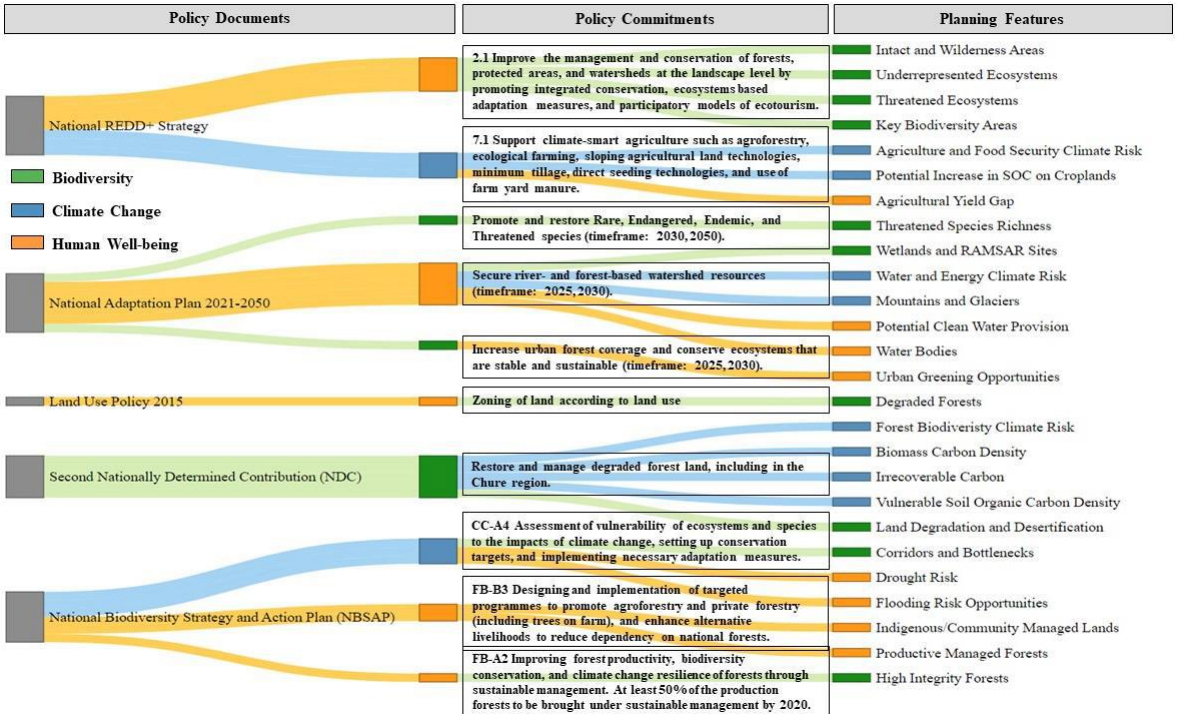


Figure 3: Relationship among policy documents, priority commitments, and planning features selected for inclusion in the analysis.

Mapping of Nature-based Action Zones in Nepal

Nepal identified four nature-based actions that were critical to include in its ELSA map: protect, manage, restore natural ecosystems, and urban greening. 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 ecological conditions, improve environmental outcomes and prevent and control its deterioration. The Protect Zone is derived from analysing the Human Footprint (HFP) distribution within existing protected areas to determine the threshold value above which excludes the most modified 5% of areas within existing protected areas (17 in Nepal). The zone excludes all agriculture and urban areas.

The **management** zone covers areas that are suitable for sustainable forest management that increases soil organic material, reduces erosion, and increases habitat structure while simultaneously supporting human needs. This zone is mapped including all forest areas in Nepal’s national land cover data from 2019.

The **restoration** zone includes areas that are suitable for recovery of forest ecosystems that have been degraded or destroyed. In Nepal, this is mapped using the Ecoregion forest layer, minus current forest, plus degraded forest (Forest Structural Integrity Index <2.6).

The **urban greening** zone includes areas that are suitable for active restoration of greenspace and trees. In Nepal, this is mapped using built up areas in Nepal’s national landcover data from 2019, and is limited to urban areas only.

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

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	Protected areas and Other Effective area-based Conservation Measures. These areas can allow for some human use (e.g., tourism, harvesting of trees and non-timber forest products). These areas maintain ecological conditions, improve environmental outcomes and prevent and control its deterioration.	30% of national territory	GBF Target 3. Ensure that at least 30 per cent globally of land areas and of sea areas, especially areas of particular importance for biodiversity and its contributions to people, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.	The Protect Zone is derived from analysing the Human Footprint (HFP) distribution within existing protected areas to determine the threshold value above which excludes the most modified 5% of areas within existing protected areas. The zone excludes all agriculture and urban areas.	● Protect zone: HFP<17 ● NOT include urban ● NOT include agriculture
Management	Sustainable forest management techniques that are utilized for community livelihoods and food security, and promote ecosystem function. These techniques include sustainable forest management that	24.69% of national territory	Second Nationally Determined Contribution (NDC): Forests under community-based management will comprise at least 60% of Nepal's forest area.	The Manage Zone is national forest from 2019 land cover	● Forest cover in Nepal from the 2019 national land cover data.

	increases soil organic material, reduces erosion, and increases habitat structure while simultaneously supporting human needs.				
Restoration	Assisting in the recovery of forest ecosystems that have been degraded or destroyed. Restoration can involve actively planting trees or removing pressures so that nature can recover on its own, and does not always entail fully returning an ecosystem to its original state.	3% of national territory	National Biodiversity Strategy and Action Plan (NBSAP): By 2020, at least five percent of the forested ecosystems restored through implementation of REDD+ program.	Restore zone: ecoregion forest but currently not forest, or currently is degraded forest (mapped using FSII lowest 60%).	● Ecoregion forest, minus current forest, plus degraded forest (FSII <2.6)
Urban greening	Active restoration of greenspace and trees. Decreases the urban heat island effect by 2-3 C, improves health and well-being of urban residents, provides habitat for some biodiversity.	0.5% of national territory	Default setting from global target - used when national targets are not available.	The Urban-Greening Zone is derived from built up areas in Nepal national landcover 2019, and is limited to urban areas only.	● Built up areas in Nepal national landcover 2019

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 4-7) for Nepal uses Systematic Conservation Planning (SCP) to identify where nature-based actions to protect, manage, and restore nature, along with urban greening, 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 ELSA 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 ELSA analysis also offers the option to create separate maps focused *only* on the commitments 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 weight the relative importance of 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 ELSA analysis and the ELSA 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:* Weights enable users to set relative priorities across the planning features associated with their policy commitments. Weighing is implemented in the ELSA webtool on a scale of zero to five. For example, if Nepal assigns greater importance to threatened ecosystems than agriculture and food security, the maps will reflect both, but prioritize areas most important for threatened ecosystems over those important to agriculture and food security.
- *Impacts:* An impact score is given to determine how each nature-based action contributes to achieving each planning feature. This impact score is determined by the ELSA science team based on the specific actions and planning 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 planning 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 planning features. 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 ELSA 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 ELSA map (which optimizes for all planning features) as in a more directed planning scenario that only focuses on the theme (biodiversity, climate change or human well-being) to which that feature belongs.

In cases where the ELSA 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 ELSA webtool enables an iterative approach to developing the ELSA 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 ELSA webtool manual.

Overall, the ELSA analysis provides Nepal 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 & Results for Nepal

The first ELSA products for Nepal are heatmaps of ecological values across the country. The heatmaps identify the distribution of ecological values that support Nepal'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, climate change, and human well-being in Nepal. The first map shows the distribution of biodiversity 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 colors 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 ELSA 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.

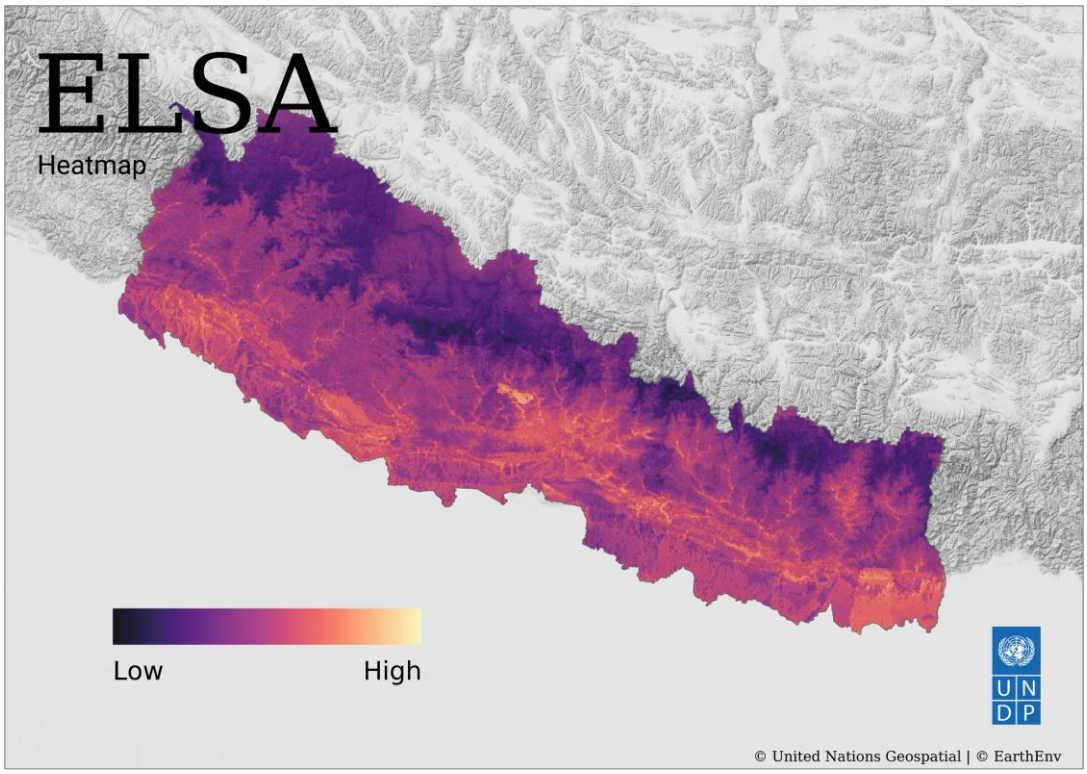
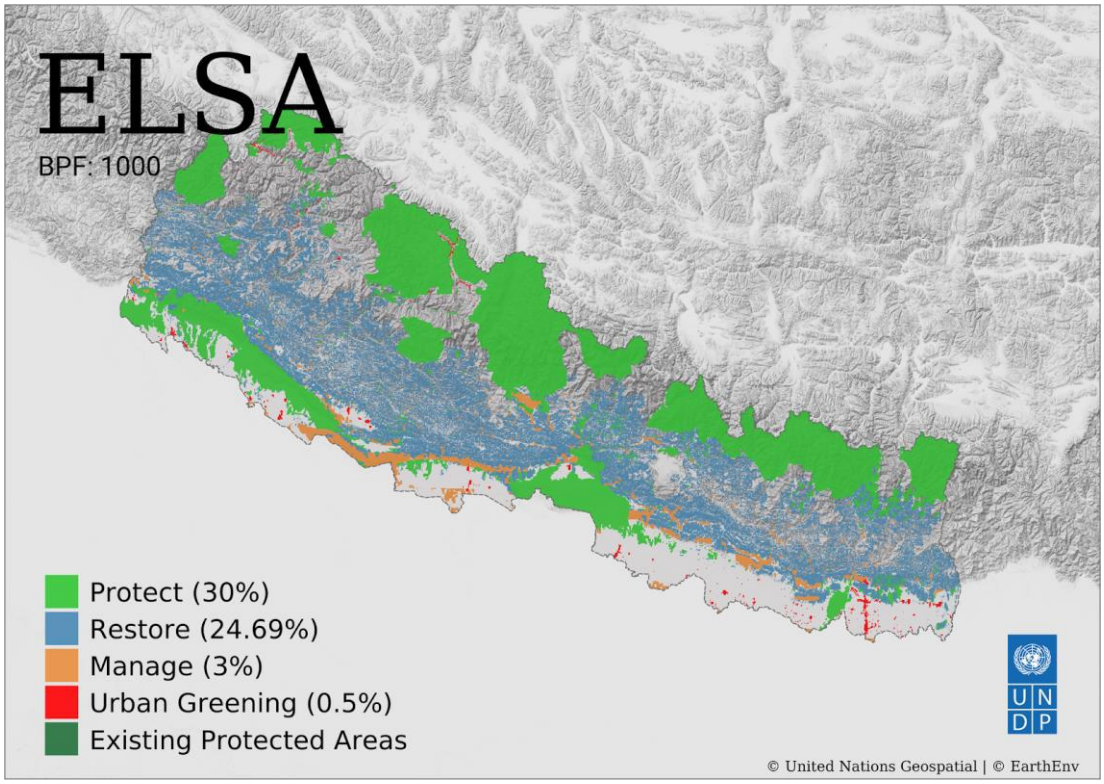


Figure 4: ELSA heatmap -- areas important for biodiversity, climate change, and human well-being.

The second ELSA product for Nepal is the ELSA action map. This results from the ELSA optimization analysis. It shows areas that should be prioritized for protection, management, restoration, and

urban greening in order to most efficiently deliver across the ten policy commitments associated with biodiversity, climate change and human well-being.

The ELSA action map, developed and validated by stakeholders in Nepal, 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 ELSA 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 ELSA map that captures the most optimal outputs (at the pixel level) of the ELSA analysis and shows small areas where nature-based actions would produce optimal outcomes for the ten priority commitments.



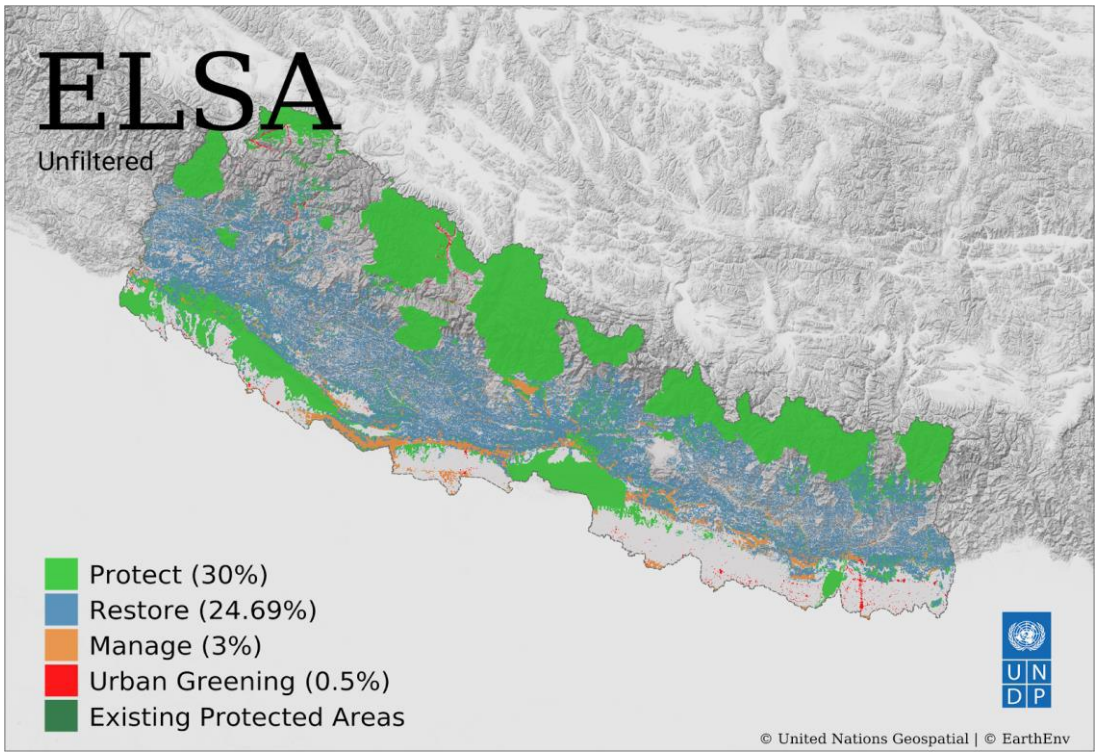


Figure 5. The ELSA map for Nepal: (a) Filtered ELSA map (BPF=1000), (b) Unfiltered ELSA map.

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 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.

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.

Supporting development and implementation of the Kunming-Montreal Global Biodiversity Framework of the Convention on Biological Diversity

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

- **Target 1** on land and sea areas under integrated spatial planning;
- **Target 2** on restoring at least 30 percent of areas of degraded ecosystems;
- **Target 3** on protecting and conserving at least 30 percent of the planet;
- **Target 8** on increasing contributions to climate change mitigation, adaptation, and disaster risk reduction from nature-based solutions;
- **Target 10** on supporting the productivity, sustainability and resilience of biodiversity in agricultural and other managed ecosystems;
- **Target 11** on ensuring that nature-based solutions contribute to regulation of air, water, and climate, soil health, pollination and reduction of disease risk for human well-being; and
- **Target 12** on increasing the area and benefits from green and blue spaces in urban areas.

3. 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.

Annex 1: Key Terms Used in the ELSA Process

Term	Definition	Application in Nepal
Area-based target (budget)	The maximum land area (expressed as % of total country land area) that can be allocated to a 'zone'.	Protect: 30% Restore: 3% Manage: 24.69% Urban-greening: 0.5%
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 2000 was applied to produce the second ELSA map for Nepal. This score was selected to create a scientifically rigorous but actionable map that promotes protection, management, restoration, and urban greening over contiguous areas.
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 ELSA process, each priority commitment for a country may correspond to one or multiple planning features depending on its complexity.	The ELSA webtool for Nepal includes 26 planning 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 ELSA project in Nepal, 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	The ELSA webtool uses GIS software to present spatial data to users. No GIS expertise is required to use it.

	presentation of geographic (spatial) data.	
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 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 protection, management, restoration and urban greening on each of the planning features for Nepal 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 Nepal 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,	Coordinate Reference System: Custom Mollweide projection. Resolution or pixel size: 450m x 450m

	cadastral parcels and hydrological units.	
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 ELSA Nepal analysis, representation is used to measure how well the ELSA areas capture or represent planning features relative to a more directed planning approach focused only on biodiversity, 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 ELSAs in Nepal.
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 Nepal 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 planning 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 Nepal, the ELSA analysis zoning maps four different actions: protect, restore, manage, and urban greening. Data used for zoning constraints including Human Footprint Index 2013 (global data), Natural Forest in 2018 (national data), Forest Structural Integrity Index and NatureMap Potential Natural Vegetation (all forest classes, global data).

Annex 2: Data Layers Used in ELSA Nepal

Groups	Theme	Label-name	Data Source	Reference
Features	Biodiversity	Natural forest	Nepal REDD+ Program, 2020	Nepal Forest Cover 2018
		Mangrove	Nepal REDD+ Program, 2020	Nepal Forest Cover 2018
		Under-represented Ecosystems	Nepal REDD+ Program, 2020	Nepal Forest Cover 2018 DGIS-MoE, 2021
		Intact ecosystems	Nepal REDD+ Program, 2021	Nepal Forest Cover 2018
		Threatened ecosystems	Nepal REDD+ Program, 2020	Nepal Forest Cover 2018
		Biodiversity corridors	DGIS-MoE, 2017	DGIS-MoE, 2017
		BPAMP priority areas - all taxa	Conservation International. 2015	Conservation International. 2015. Metrics for Green Growth in Nepal: Demonstration of Metrics for Conservation and Human Well-being. Conservation International. 64 pp. Accessed 2/9/2016: http://www.metricsci.org/assets/metrics-technical-report-Nepal-2015.pdf
		KBAs		BirdLife International (2021). World Database of Key Biodiversity Areas. Managed by BirdLife International on behalf of the KBA Partnership: BirdLife International, International Union for the Conservation of Nature, American Bird Conservancy, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Re:Wild, NatureServe, Rainforest Trust, Royal Society for the Protection of Birds, Wildlife Conservation Society and World Wildlife Fund. March 2021 Version. Available at http://www.keybiodiversityareas.org.

		Community protected area	DGIS-MoE, 2021	DGIS-MoE, 2021
		Main river and buffer	Derive from CMAC,1999	CMAC,1999
	Climate Change	Biomass Carbon	NASA 2020	Spawn, S.A., and H.K. Gibbs. 2020. Global Aboveground and Belowground Biomass Carbon Density Maps for the Year 2010. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1763
		Vulnerability of deforestation	Maliwan Namkhan, Pilot Plant Development and Training Institute (PDTI), King Mongkut's University of Technology Thonburi Conservation International. 2015.	Namkhan, M., Gale, G. A., Savini, T., & Tantipisanuh, N. (2021). Loss and vulnerability of lowland forests in mainland Southeast Asia. Conservation Biology, 35(1), 206-215. Conservation International. 2015. Metrics for Green Growth in Nepal: Demonstration of Metrics for Conservation and Human Well-being. Conservation International. 64 pp. Accessed 2/9/2016: http://www.metricsci.org/assets/metrics-technical-report-Nepal-2015.pdf
		Areas with high potential emissions	Conservation International. 2015	Conservation International. 2015. Metrics for Green Growth in Nepal: Demonstration of Metrics for Conservation and Human Well-being. Conservation International. 64 pp. Accessed 2/9/2016: http://www.metricsci.org/assets/metrics-technical-report-Nepal-2015.pdf
		Climate adaptive capacity 2012	Conservation International. 2015	Conservation International. 2015. Metrics for Green Growth in Nepal: Demonstration of Metrics for Conservation and Human Well-being. Conservation International. 64 pp. Accessed 2/9/2016: http://www.metricsci.org/assets/metrics-technical-report-Nepal-2015.pdf
		Population affected by flood 2011	Conservation International. 2015	Conservation International. 2015. Metrics for Green Growth in Nepal: Demonstration of Metrics for Conservation and Human Well-being. Conservation International. 64 pp. Accessed 2/9/2016:

				http://www.metricsci.org/assets/metrics-technical-report-Nepal-2015.pdf
		Upland watershed		HydroBASINs - Lehner and Grill (2013)
	Human Well Being	Important areas for food security (provision of NTFPs)	Conservation International. 2015	Conservation International. 2015. Metrics for Green Growth in Nepal: Demonstration of Metrics for Conservation and Human Well-being. Conservation International. 64 pp. Accessed 2/9/2016: http://www.metricsci.org/assets/metrics-technical-report-Nepal-2015.pdf
		Community fishery	Open Development Nepal, 2020	Open Development Nepal, 2020
		Fisheries dependence	Conservation International. 2015	Ministry of Planning. 2010. Poverty and select CMDGs maps and charts 2003–2009. Ministry of Planning, Nepal, Phnom Penh, Nepal.
		Community - forestry	Open Development Nepal, 2016	Open Development Nepal, 2016
		Watershed - agroforestry	MRC, 2001	MRC, 2001
		Urban buffer	Nepal REDD+ Program, 2020	Nepal Forest Cover 2018
		Tourism hotspot	Natural Capital Project. 2014	Natural Capital Project. 2014. Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) modeling tool. Stanford Woods Institute for the Environment, University of Minnesota's Institute on the Environment, The Nature Conservancy, World Wildlife Fund. http://www.naturalcapitalproject.org/InVEST.html
Lock-in	Biodiversity	Protected Areas	DGIS-MoE, 2021	DGIS-MoE, 2021
Zones		Human footprint index	Williams et al. 2020	Williams, B.A., et al. 2020. Change in Terrestrial Human Footprint Drives Continued Loss of Intact Ecosystems. One Earth 3, 371–382. https://doi.org/10.1016/j.oneear.2020.08.009

		Natural forest	Nepal REDD+ Program, 2020	Nepal Forest Cover 2018
		NatureMap Potential Natural Forest	NatureMap 2020	Hengl, Tomislav, Jung, Martin, & Visconti, Piero. (2020). Potential distribution of land cover classes (Potential Natural Vegetation) at 250 m spatial resolution (v0.1) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.3631254