Convention on Biological Diversity

UN environment programme

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SUMMARY OF TOOLS FOR PARTICIPATORY SPATIAL PLANNING

UNBiodiversity Lab

BACKGROUND

Spatial planning and prioritization

Spatial planning is a participatory process to evaluate and designate the spatial and temporal distribution of human activities to achieve economic, ecological, and social goals. [Target 1 of the Kunming-Montreal Global Biodiversity Framework] calls for all areas to be "under participatory, **integrated biodiversity-inclusive spatial planning**" by 2030 (see Glossary in Annex 2). Among the various approaches to spatial planning, **systematic conservation planning** (SCP) provides a transparent and structured framework for identifying, assigning, and monitoring actions in space and time for conservation, management, and/or restoration (Margules and Pressey, 2000). A central component of SCP is **spatial prioritization**, the process of spatially allocating management actions to meet desired socioeconomic and ecological objectives (Tallis et al., 2021). Spatial prioritization uses mathematical **optimization algorithms** (e.g. Ball et al., 2009, Moilanen et al., 2022; Hanson et al., 2024) to allocate management actions across land and/or sea in a cost-effective manner following a set of core principles (Kukkala and Moilanen, 2013).

Spatial prioritization tools

A wide range of software tools is available for the spatial prioritization step within SCP (often referred to as optimization tools), with Marxan (Ball et al., 2009), prioritizr (Hanson et al., 2024), and Zonation (Moilanen et al., 2022; for a detailed overview of optimization tools, see Giakoumi et al., 2025) most commonly used. These tools vary in the algorithms they use, which affects their outputs (optimal or heuristic solutions), as well as in their speed, flexibility, and customizability. Each tool has its own strengths and limitations, but all share a fundamental approach: providing a systematic, scientific, and transparent method for allocating space to management actions based on defined objectives following clear principles. This approach is significantly more advanced than simple overlay-based mapping techniques or other less systematic spatial planning methods and therefore can offer some of the best options for policymakers and technical experts working to develop and implement national approaches for Target 1 of the Global Biodiversity Framework. However, the choice of the most suitable tool ultimately depends on the planner's capacity and the specific nature of the problem being addressed.

Tools for participatory spatial planning

While spatial prioritization can help to systematically allocate space for different management actions in a cost-efficient way, there are some initial barriers for planners and stakeholders to overcome to start a spatial prioritization. These include the technical expertise required to use prioritization software and the need to communicate the planning process clearly to foster stakeholder understanding and engagement, both of which are essential for collaborative spatial planning. A transparent planning process can facilitate informed discussions, help to define objectives and priorities more clearly while avoiding misunderstandings, and design actionable spatial plans. To address these challenges, a range of tools has been developed to democratize spatial prioritization. These tools either serve as user-friendly interfaces around prioritization software or are stand-alone tools with custom software, enabling planners and stakeholders to explore spatial plans based on their own priorities and make well-informed, participatory decisions.

This brief introduces a subset of participatory spatial prioritization tools that primarily build on existing prioritization software and provide user-friendly interfaces to facilitate use by non-technical experts.The tools included here have been compiled with the goal of supporting national policymakers and technical experts to understand and access tools for their national needs and work around Target 1 of the Global Biodiversity Framework.

1. **Essential Life Support Area (ELSA) Integrated Spatial Planning Tool**
2. **Marxan Planning Platform (MaPP)**
3. **WePlan-Forests**

Determining the best tool for use in your country

Taking a systematic approach, regardless of which participatory spatial prioritization tool is used, is already an important step towards transparent, efficient, and reproducible integrated spatial planning.

Sometimes, however, this means choosing between tools to identify the one best suited for the project at hand. Several considerations can help guide that choice.

- **Use case.** Projects with a strong focus on restoration of tropical forests may find **WePlan-Forests** most relevant, particularly when forest-specific ecosystem services are central to the analysis. Still, **ELSA** and **MaPP** can also be applied to optimize forest outcomes, each in slightly different ways. MaPP is currently the only tool on our list for spatial prioritization in marine environments. **ELSA** is currently the only tool on our list that supports spatial planning for different management zones. The spatial scale of the project also matters: while **MaPP** supports analyses at any spatial extent, **ELSA** and **WePlan-Forests** are primarily designed for national projects, with regional applications available on request.
- **Data availability.** Where only limited data exist, a tool with a strong foundation of pre-compiled datasets, such as **ELSA** or **WePlan-Forests**, may be the most practical option. Where small-scale or high-resolution regional data are available, or when data availability is generally strong, a tool that provides greater flexibility in incorporating diverse datasets, such as **MaPP** or **ELSA**, could be considered. **MaPP** users can directly process and add data at the relevant scale to the tool, whereas **ELSA** offers this as a service at cost.
- **Capacity.** Some tools emphasize a participatory approach that guides users through key aspects of the planning process (e.g., **ELSA** and **WePlan-Forests**). Others, such as **MaPP**, offer more freedom to define the entire problem from the ground up. While this flexibility is powerful, it also requires greater technical expertise and capacity to process and interpret results. For some projects, a guided process such as the **ELSA** pipeline may be more appropriate.

- **Stakeholder engagement.** **ELSA** and **WePlan-Forests** are designed with participatory processes in mind, helping to structure dialogue with decision-makers and communities. **MaPP** can also be used in participatory settings, but its greater flexibility typically requires more technical facilitation to engage stakeholders effectively.
- **Decision-support outputs.** **ELSA** provides standardized outputs such as planning scenarios, indicators, and prioritization performance measures that are well suited for policy processes. **WePlan-Forests** produces forest-specific prioritization maps and analyses that can be directly linked to ecosystem service benefits. **MaPP** is highly customizable, producing outputs that can be tailored to technical or scientific audiences but may require additional effort to communicate to policymakers.

Table 1 provides a high-level comparison of these three tools to support policymakers to identify the right tool based on national needs and context. The remainder of this brief explores each tool in more detail.

TABLE 1.

High-level comparison of the tools for participatory spatial planning.

	ELSA	MaPP	WePlan-Forests
Summary	A national-scale tool to identify priority areas for conservation, restoration, and sustainable management.	A web-based version of Marxan for scenario-based conservation planning.	A forest restoration planning tool that balances objectives for biodiversity, climate, and costs.
Cost	Free	Free	Free
Open access	Yes	Yes	Yes
User profile	National policymakers, UNDP country offices, NGOs	National policymakers, Spatial planners, technical staff, NGOs,	National policymakers, forest agencies, NGOs
Technical expertise required	No GIS expertise; basic understanding of systematic conservation planning and spatial prioritisation	Basic to medium GIS expertise; basic theory of the science of spatial prioritisation	No GIS expertise; medium understanding of systematic conservation planning and spatial prioritisation
Input data	Global layers included and available; national data added in co-design	Some global data layers included; user uploads all other required data	Global layers included
Problem formulation	Some flexibility in problem formulation (e.g., weights, constraints, zones)	High flexibility in problem formulation (e.g., targets, parameters, constraints)	Built-in multi-objective optimization problem formulation (only targets flexible)
Realm	Terrestrial	Terrestrial, freshwater, marine	Terrestrial (tropical forests)
Availability	All countries	All countries	37 countries
Analysis scale	National (or custom scales by request)	Custom scale (user data upload dependent)	National

1. ELSA INTEGRATED SPATIAL PLANNING TOOL

Main use case: Conservation, restoration, sustainable management, urban greening

Main use area (terrestrial, freshwater, marine): Terrestrial

POLICY MAKER SUMMARY

The ELSA Integrated Spatial Planning Tool on UN Biodiversity Lab (UNBL) is a customized application of the Essential Life Support Area (ELSA) framework, a participatory approach to integrated spatial planning that empowers nations to meet their biodiversity, climate, and sustainable development commitments. The ELSA Integrated Spatial Planning Tool is designed specifically to support national action around the Global Biodiversity Framework targets and indicators. This free, open-source, cloud-hosted tool provides stakeholders in all countries with a science-based methodology to identify national priority areas where protection, restoration, management, and urban greening can lead to the best outcomes across the Global Biodiversity Framework targets and indicators. Adapted versions of the ELSA pipeline have been used in participatory spatial planning approach to support 13 countries in developing an ELSA map based on national priorities and inputs, which led to ELSA informing diverse policies across the 13 countries, ranging from securing water security, developing climate change mitigation strategies to defining national protected areas networks.

By leveraging global datasets and advanced scenario modeling, the ELSA Integrated Spatial Planning Tool allows users to assess national priorities and make informed decisions that balance the needs of nature, climate, and development in a collaborative process. The tool

uses a transparent approach to balance competing land uses. Users can adjust priorities, set constraints, and revisit their plans to ensure critical areas are adequately protected or restored while addressing economic and societal needs. The resulting spatial prioritization map can directly support the implementation of Targets 1, 2, and 3 of the Global Biodiversity Framework, with co-benefits for Targets 4-12, as well as CBD Decision 16/12, which recognizes the need for advancements of biodiversity-inclusive spatial planning.

This interactive and flexible process ensures that decision-making is both evidence-based and adaptable, supporting better outcomes for people and the planet.

The ELSA Integrated Spatial Planning Tool is freely available upon request on UNBL for all countries. To use the ELSA Integrated Spatial Planning Tool for your country, simply request a workspace on UN Biodiversity Lab using our form and indicate that you would like access to the ELSA tool. Further national customization, including to specific biodiversity planning contexts including national biodiversity targets and using national data, is available on a cost-recovery basis.

SHORT TECHNICAL SUMMARY

The ELSA Integrated Spatial Planning Tool is a customized web-based application of the Essential Life Support Area (ELSA) framework, an operational framework for national-level integrated spatial planning. This free, open-source, cloud-hosted tool provides a systematic approach to identifying priority areas for conservation, restoration, sustainable management, and urban greening that aligns with the Global Biodiversity Framework targets and indicators. By employing principles of systematic conservation planning and leveraging global datasets, the tool enables real-time scenario analysis using the R package prioritizr, thereby allowing diverse stakeholders to collaboratively assess national priorities for the Global Biodiversity Framework, explore trade-offs and synergies, and develop actionable spatial plans to support national implementation of Targets 1, 2, and 3.

The problem formulation includes planning features that map elements of Targets 1-12 of the Global Biodiversity Framework as well as zones explicitly designed based on Targets 1, 2, 3, 10 and 12. Input data draw primarily on the global data referenced in the metadata of the Global Biodiversity Framework monitoring framework, with alternative datasets used only where monitoring framework datasets are not applicable for spatial planning or not publicly available (see Annex 1). Conservation planning is done using a maximum utility objective, which includes as much of the features as possible without exceeding a budget in the planning zones. Users can adjust weights and constraints, rerun analyses, and explore trade-offs between competing objectives. For example, the representation score of each planning feature can be reviewed, and weights can be adjusted to prioritize underrepresented or critical features. This iterative process fosters transparent and defensible decision-making, enabling governments and stakeholders to balance competing land uses effectively.

CAPACITY BUILDING SOURCES

- LfN - Integrated Spatial Planning

EXAMPLE CASE STUDIES

- Short summaries of ELSA outputs for a range of countries

IMPORTANT LINKS

- Integrated Spatial Planning Workbook
- ELSA User Guide
- Preprint: An operational framework to map Essential Life Support Areas (ELSAs) for biodiversity, climate, and sustainable development

2. MARXAN PLANNING PLATFORM (MAPP)

Main use case: Conservation, restoration, and a wide range of human uses

Main use area (terrestrial, freshwater, marine): Terrestrial, freshwater, and marine

POLICY MAKER SUMMARY

The Marxan Planning Platform (MaPP) is a free and open-source tool that helps spatial planners with the effective allocation of management actions for conservation and sustainable development. By leveraging cloud computing and cutting-edge technology, it streamlines the process of designing, analyzing, and implementing conservation plans that align with national and global priorities.

MaPP equips planners with the tools to create targeted strategies that balance environmental protection with economic considerations. It enables users to design new plans, integrate existing planning efforts, and collaborate securely with stakeholders, all within an online platform that ensures efficient data management and privacy. The platform's ability to test scenarios, identify gaps, and generate clear visualizations ensures that plans are transparent, evidence-based, and defensible. MaPP has many functionalities of the Marxan software suite, the most widely used conservation planning tool for real-world conservation planning in terrestrial, marine and freshwater environments.

MaPP particularly supports Targets 1, 2, 3, 8, and 11 by enabling spatially explicit optimization for protected area expansion, ecosystem restoration, climate resilience, and ecosystem service maintenance across land, water and sea. It also supports Target 21 by improving access to and usability of diverse environmental and spatial data. The platform's transparent, scenario-based process contributes to Targets 14 and 23 on equitable governance and participatory decision-making. MaPP supports biodiversity-inclusive spatial planning promoted in CBD Decision 16/12, and contributes to marine spatial planning and ecosystem-based approaches, consistent with CBD Decision 16/17.

SHORT TECHNICAL SUMMARY

Marxan Planning Platform (MaPP) is a cloud-hosted, free, and open-source platform, designed to streamline conservation planning by leveraging the Marxan software suite (see Annex 1). The platform improves the efficiency of Marxan through cloud computing, automated processing of spatial data, and custom workflows, enabling faster, more effective planning. It allows users to design and evaluate new conservation plans, integrate existing Marxan projects, and collaborate with teams and stakeholders. The platform also offers cloud storage, allowing users to securely upload and manage datasets, ensuring private access for teams while enabling the use of hosted datasets.

Conservation planning is done using the minimum set objective function that follows the core principles of conservation planning, by ensuring that set targets are met for all features whilst minimising a cost, and thereby creating plans that adequately represent the features in a planning region in an efficient way. Users can create and explore multiple scenarios that include selected features with flexible targets and other conservation planning parameters, perform gap analyses, compare solutions, and generate comprehensive project summaries, maps, and figures.

CAPACITY BUILDING SOURCES

- Marxan Learn for training resources
- MaPP Rwanda tutorial
- Example studies and guides available on MaPP (requires an account)

EXAMPLE CASE STUDIES

- **Marine:** Transboundary planning in the Pacific (Baja California); Establishing and expanding effective marine protected areas in the Coral Triangle
- **Freshwater:** Land-use planning for the Daly River Catchment (Australia); Conservation planning for the Tagus River Basin (Portugal)
- **Terrestrial:** Planning of Mongolia's network of representative protected areas; Balancing trade-offs in Central Kalimantan (Indonesian Borneo)

IMPORTANT LINKS

- Marxan MaPP
- Marxan MaPP short description
- Marxan GitHub repository

3. WEPLAN-FORESTS

Main use case: Tropical and sub-tropical forest ecosystem restoration

Main use area (terrestrial, freshwater, marine): Terrestrial (forests)

POLICY MAKER SUMMARY

WePlan-Forests is an open-access tool designed to support national forest and landscape restoration efforts in tropical and subtropical countries. It helps decision-makers identify the most effective places to restore forests and thereby deliver the highest benefits for climate, biodiversity, while also considering the cost of restoration. Using environmental and economic data, WePlan-Forests makes it possible to quickly compare different restoration options. The platform helps decision-makers find solutions that work best for their country's priorities and available resources.

The tool is especially valuable because it takes complex science and turns it into clear, easy-to-understand information. Policymakers and stakeholders can explore scenarios online, adjust targets, and create tailored, evidence-based plans without needing specialist training in spatial modelling or programming. Built to support implementation of the Global Biodiversity Framework, the tool can aid in turning global and national goals into practical, country-specific restoration strategies. This includes targets related to restoration (Target 2), species conservation (Target 4), and climate mitigation (Target 8). It also contributes to the goals of the UN Decade on Ecosystem Restoration by translating high-level pledges into actionable national priorities, and CBD Decision 16/12, promoting biodiversity-inclusive spatial planning.

WePlan-Forests supports Targets 1, 2, 3, 10, and 11 of the Global Biodiversity Framework by allowing for the spatial allocation of actions for forest restoration, sustainable management, and ecosystem service enhancement within landscapes. It integrates multiple ecological and economic values in an accessible platform to support participatory planning, contributing to Targets 14 and 23 on inclusive governance and equitable decision-making.

SHORT TECHNICAL SUMMARY

WePlan-Forests is an open-access decision-support tool for national-scale forest and landscape restoration planning in tropical and subtropical countries. Through a user-friendly web interface, it enables decision-makers to assess and balance multiple objectives within a spatial optimization framework designed to identify cost-effective restoration opportunities (see Annex 1). The tool uses a multi-objective spatial optimization approach to identify areas where restoration would yield the greatest benefit per unit cost. Restoration benefits are quantified using two metrics: carbon sequestration potential for climate mitigation, and the average reduction in national extinction risk for forest-associated species as proxy for biodiversity conservation. Restoration costs account for both opportunity costs of land use and implementation costs, such as those associated with natural regeneration or active restoration.

WePlan-Forests automates these complex analyses, making advanced spatial planning fast and accessible for users without technical GIS or programming expertise. The platform provides planning scenarios across five area-based restoration targets, using three optimization approaches: maximizing cost-efficiency, maximizing total benefit, or minimizing cost. Users can explore different scenarios based on the various objectives and spatial targets for 37 countries, and compare their trade-offs in terms of ecosystem service generation, spatial allocation and potential associated establishment and opportunity costs.

CAPACITY BUILDING SOURCES

- WePlan-Forests webinar
- WePlan-Forests 2.0 (video)

EXAMPLE CASE STUDIES

- Colombia case study
- Mexico case study (video)

IMPORTANT LINKS

- WePlan-Forests

ANNEX 1

TABLE 2.

Technical comparison of the tools for participatory spatial planning.

	ELSA	MaPP	WePlan–Forests
Underlying optimisation tool	prioritizr	Marxan	Bespoke tool
Underlying algorithm	Integer linear programming (optimal)	Simulated annealing (heuristic)	Linear programming (optimal)
Objective	Maximum utility (implemented in prioritizr)	Minimum set	Cost-effectiveness (maximise benefits while accounting for costs; multi-objective)
Programming language	R, R Shiny	C++	NA
Input data types used	Raster (terra)	Vector (DAT files)	NA
Input data available	Yes, extensive datasets on UNBL	Some datasets available (limited spatial extent)	Yes (for 37 countries)
Input data upload possible	No	Yes	No
Output produced	Spatial maps (categorical rasters), feature representation tables	Spatial maps (categorical), representation tables	Spatial maps, tables with costs and ecosystem services in solution
Output data types generated	Raster	CSV	Raster
Zoning	Yes	No (only supported in Marxan with Zones)	No
Standalone or part of suite	Combined with elsaR package	Part of the Marxan software suite	Standalone tool
UI or locally run	UI (R Shiny), also implemented on UNBL (non-R Shiny)	UI (Microsoft)	UI
Easily adaptable	Yes, adaptable R code	No (tool); yes (analysis via available code)	No (code not open-source)
Already integrated with other tools	Integrated into UNBL	No	No

ANNEX 2: GLOSSARY

This glossary is adapted from Neubert et al. (2025).

SPATIAL PLANNING

Integrated spatial planning: Participatory, integrated, and biodiversity-inclusive spatial planning builds on traditional spatial planning by emphasizing collaboration in decision-making and by placing biodiversity at the center of the planning process. It guides the spatial allocation of human activities and actions across terrestrial, freshwater, and marine systems to simultaneously achieve social, economic, and ecological objectives, while explicitly integrating biodiversity considerations.

Multi-objective (spatial) optimization: A type of planning problem that incorporates several objective functions within a single model.

Systematic conservation planning: A structured approach for selecting, allocating, and evaluating areas for biodiversity conservation, restoration, or sustainable use through a series of steps. It is guided by principles such as complementarity, irreplaceability, representativeness, adequacy, connectivity, and efficiency, and frequently employs decision-support tools to balance biodiversity conservation with social and economic factors. Spatial prioritization is one step in this process.

Spatial planning (marine or land-use): A "public process of analyzing and allocating the spatial and temporal distribution of human activities [...] to achieve ecological, economic, and social objectives that are usually specified through a political process" (Ehler and Douvere, 2009). It can, but does not have to, include nature-related objectives.

Spatial prioritization: A subset of broader planning processes (e.g., systematic conservation planning) focused on allocating actions in space and time, using optimization or other methods.

Spatial optimization: The use of mathematical algorithms (exact or heuristic) to determine the best spatial allocation of resources or actions based on specific criteria.

Trade-off analysis: A method for assessing conflicting objectives in spatial planning, such as conservation versus economic development, or disparities in how different stakeholders experience costs and benefits.

Zoning: The process of creating a spatial plan that includes management zones. These zones may support individual actions (e.g., fishing, offshore wind, conservation) or multiple actions (e.g., sustainable use zones), and may target one or multiple objectives.

SPATIAL PRIORITIZATION

Spatial data: Geographic information that describes the landscape, including locations of biodiversity-rich areas, land costs, or human activities, which can be used as inputs in spatial optimization.

Features: Spatial elements of interest in a planning area (e.g., important habitats, energy sites) that the plan is designed to represent or protect. „Features" can also refer to spatial datasets that serve as proxies for specific policy targets – for example, species richness data as a proxy for biodiversity protection, or aboveground carbon density as a proxy for climate change mitigation.

Performance metrics: Quantitative measures used to evaluate how well the plan meets its objectives, often involving targets like the percentage of habitat covered.

Targets: Predefined quantitative indicators for features, such as protecting a minimum amount or percentage of a particular habitat.

Costs: Economic or social values tied to specific areas such as acquisition cost or opportunity cost due to restricted use, which are used to guide efficient allocation of resources.

Objective function: The mathematical expression the optimization tries to minimize or maximize, such as minimizing overall cost while achieving targets, or maximizing overall benefit.

Constraints: Conditions or rules applied to ensure that the solution is realistic, such as budget limitations or the inclusion of particular areas.

Problem formulation: The step of translating planning goals, features, cost data, and constraints into a mathematical problem that can be solved.

Zones: Different land-use or management designations assigned to planning units, enabling more complex spatial allocations than simple inclusion/exclusion.

Planning units: Individual spatial units (e.g., grid cells, parcels) that are considered in the optimization process.

Weight: A numerical value assigned to a feature to reflect its relative importance in the planning problem, influencing prioritization and trade-offs.

OTHER TECHNICAL TERMS

Optimization tool: The core software or package used to solve the spatial prioritization problem (e.g., Marxan, prioritizr).

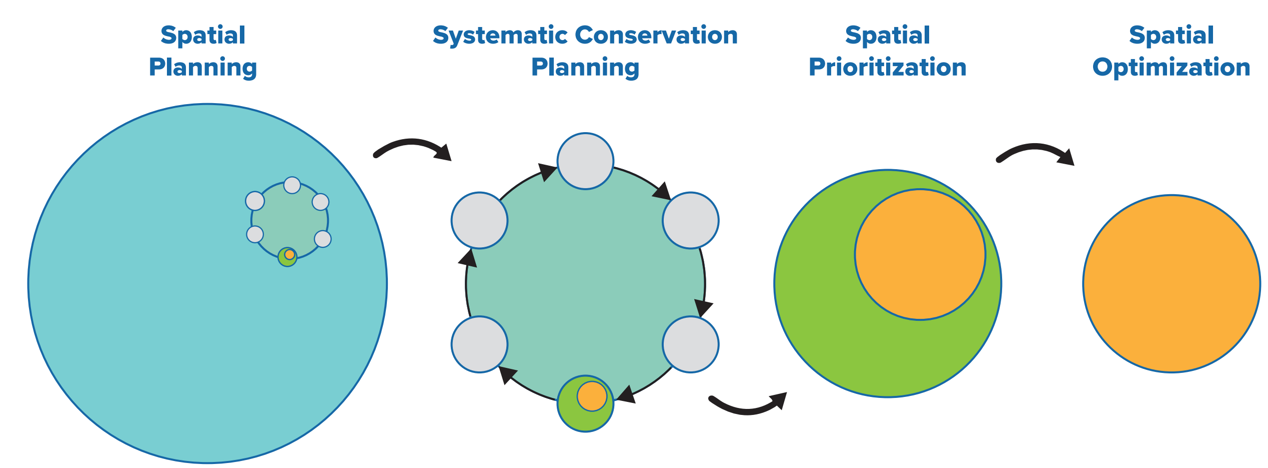
Optimization algorithm: The mathematical method used to find solutions, such as simulated annealing (heuristic/non-optimal) or integer linear programming (optimal).

Input data types: The formats of geographic data the tool accepts, like raster data (grid-based maps showing values per cell) or vector data (points, lines, polygons representing real-world features).

User interface (UI): How users interact with the tool—through a web app, desktop software, or programming environment.

FIGURE 1.

Adapted schematic of the relationship between spatial planning, systematic conservation planning, spatial prioritization and spatial optimization from Neubert et al. (2025).



ANNEX 3: REFERENCES

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