AGILE: GIScience Series, 6, 39, 2025. https://doi.org/10.5194/agile-giss-6-39-2025
Proceedings of the 28th AGILE Conference on Geographic Information Science, 10–13 June 2025.
Eds.: Auriol Degbelo, Serena Coetzee, Carsten Keßler, Monika Sester, Sabine Timpf, Lars Bernard
This contribution underwent peer review based on a full paper submission.

LAND IT: A Decision Support System for Optimising Land Use Planning Strategies

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Abstract. Over the past two decades, Portugal has been severely affected by large-scale forest fires. In response, the Portuguese government launched a programme aimed at transforming the landscape to make it more resilient to wildfires and economically sustainable. The process of creating new land-use proposals, however, remains highly complex, involving multiple stakeholders and error-prone workflows reliant on disconnected geographic information systems (GIS) and spreadsheets.

This paper presents LAND IT, a web-based spatial decision support system (SDSS) designed to optimise OIGP (Integrated Landscape Management Operations) creation process. An OIGP is a management model that define a new landscape proposal. Unlike conventional GIS software, LAND IT provides a structured framework that streamlines version control, scenario comparison, and stakeholder collaboration. The system enables users to create and manage multiple proposals iteratively, preserving decision-making knowledge and minimising costly errors. It also integrates essential geospatial datasets, automates dependency management, and enhances data-driven decision-making.

Mação, a wildfire-prone municipality, was selected as the pilot case study due to its strategic role in implementing nine OIGP. The results were approved by Mação's stakeholders as they demonstrate significant improvements in efficiency, transparency, and the ability to compare alternative landscape transformation strategies. While LAND IT is currently tailored to Mação, its scalable architecture allows for future expansion to other municipalities.

LAND IT represents a significant step towards more resilient and sustainable territorial management, ultimately contributing to wildfire mitigation and long-term environmental planning.

Submission Type. project, case study, spatial decision support system

BoK Concepts. [GS3] Use of geospatial information; [GD4] Data Quality, Metadata and Data Infrastructure; [WB7] Web Application development elements

Keywords. Geospatial Data Integration; Spatial Decision Support System; Land use planning and optimization; Web-based GI Systems and Services

1 Introduction

In recent decades, Portugal has been severely impacted by large-scale rural fires, particularly in the years 2003, 2005, 2017 and 2024. These events have made Portugal one of the most wildfire-affected countries in Europe, with vast forested areas burned—nearly 6% of mainland territory (PORDATA, 2024; INE, 2022). These figures underscore the unsustainability of the current landscape and the urgent need for structural actions focused on restoration and prevention.

In response, the Portuguese Government has launched the Landscape Transformation Programme (PTP), a strategic initiative to restore high-risk areas (DGT, 2020). A key component of this strategy is the establishment of Integrated Landscape Management Areas (AIGP) and their associated Integrated Landscape Management Operations (OIGP). The AIGP framework promotes a holistic territorial approach, expanding managed forest areas to enhance fire resilience, protect natural capital, and strengthen rural economies (DGT, 2024a).

These areas are designed to support landscape transformation through a collaborative management model, either led by a designated management entity or directly managed by landowners (DGT, 2024a).

In 2021, 70 AIGP were established, covering 142,070 ha (1.59%) of mainland Portugal, primarily in the Centre and North regions—areas most severely affected by wildfires (DGT, 2024a; INE, 2022). The successful implementation of OIGP is critical to initiating landscape transformation and achieving the expected improvements.

However, creating OIGP is a complex, lengthy, and error-prone process that involves multiple stakeholders, such as, geographers, forest engineers and Portuguese state services. To address these challenges, LAND IT system (Land Analysis and Design of the Integrated areas of the Territory) (Matias, 2023), was developed to assist management entities in designing and implementing OIGP. LAND IT is a decision support system that does not rely on optimization models and is not intended to propose a final solution. Instead, its primary objective is to support a multidisciplinary team in the development of an OIGP by providing smart tools and statistical visualizations based on territory data and the necessary knowledge to build OIGP. Accordingly, it can be classified as a hybrid decision support system, being knowledge-driven and data-driven (Fernando and Baldelovar, 2022). By streamlining workflows, integrating geospatial data, and improving collaboration, LAND IT promotes efficiency and decision-making in integrated territorial management.

2 Materials and Methods

2.1 Study Area

The Municipality of Mação, located in Portugal's inland Centre region (Fig. 1), has been severely affected by wildfires, particularly in 2017, when nearly 70% of its territory burned (Matias, 2023), with 71% of it consisting of forests (DGT, 2025).

Mação plays a strategic role in the OIGP programme, overseeing nine AIGP, also depicted in Fig. 1. With one of the highest concentrations of AIGP, it serves as a key location for evaluating the effectiveness of landscape transformation strategies. The LAND IT system was developed with Mação as a case study.

2.2 Data and Software Availability

The territorial data available in the LAND IT system pertains exclusively to the municipality of Mação and was provided by its local administration. All data was supplied in the shapefile format. Some datasets were developed by Mação's OIGP team, while others were sourced from governmental websites. The shapefiles created by Mação for this project — covering aspects such as slope classes, hypsometry, and hazard levels — are available in this folder.

Regarding the data available from government entities, these were sourced from the following:

- COS 2018 (latest official Land Use Map of Portugal) - DGT
- Burned Areas - ICNF
- National Road Network - dados.gov

Certain datasets, such as property registration records, cannot be publicly shared due to privacy regulations. Additionally, all OIGP-related documents remain confidential, as they contain private information. However, upon completion of the OIGP creation process, selected data was made available online for public consultation, given the direct involvement of landowners. This information can be accessed here.

Regarding the LAND IT's code, it is not publicly available as it is part of an ongoing funded project.

2.3 Current OIGP Creation Process

The OIGP creation process is highly complex, and requires careful consideration of multiple key factors, including: collaboration among a wide range of stakeholders, such as, government bodies, property owners, management entities (responsible for the OIGP creation), and the general population living in or connected to these territories; diverse technical competencies for agriculture, environmental science and economics; and a variety of territory data since the management entities need a starting point by knowing the land.

To facilitate this process, the Directorate-General for Territory (DGT) established a data model that relies on shapefiles, spreadsheets, and ad-hoc databases.

The first step in creating an OIGP is generating POSA (Current Land Occupation Map), representing the existing landscape. POSA is an updated version of the COS, as the latest COS dataset dates back to 2018 (DGT, 2024b). Fig. 2 and Table 1 illustrate examples of OIGP polygons. In Fig. 2, a POSA polygon (dark green) is classified as eucalyptus forest.

The second step consists in creating the OIGP itself. According to DGT, an OIGP consists of several geometry collections, with the ones that represent the land-use planning being:

- **POSP:** Representing the Proposed Land Use Plan, this collection contains the necessary attributes to specify each polygon's proposed land use. In Fig. 2 these polygons are represented in light green, and there are three of them.
- **Transformation Units:** The polygons in this collection represent the necessary transformations required to implement the land-use classifications outlined in the POSP collection. Each transformation polygon is linked to a corresponding POSP polygon. A single POSP polygon may have multiple transformation polygons, as operational costs can vary depending on factors such as differing slope classes. In Fig. 2, an interesting case is the transformation polygons in POSP

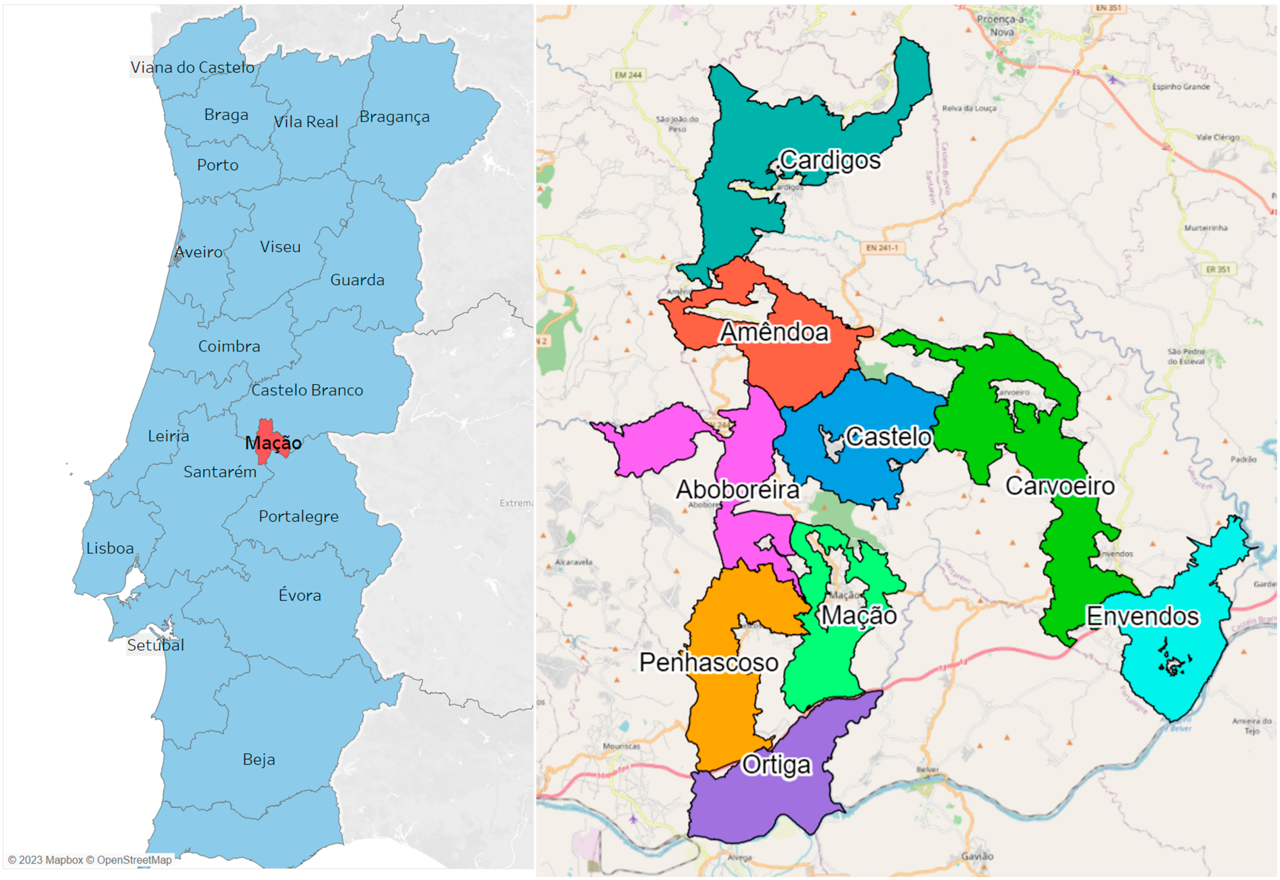

Figure 1. Municipality of Mação in Portugal and the nine Mação's AIGP

Table 1. Example of some OIGP polygons

POSA Polygons	POSP Polygons	Transformation Polygons	Ecosystem Services Polygons
Eucalyptus Forests	Rainfed and irrigated temporary crops (POSP 1)	Polygon covering all POSP polygon area with slope < 25% and belonging to the management entity	None. These crops are not remunerated
	Eucalyptus forests (POSP 2)	None. No territory transformation is required since the landowner will handle this area	None. There aren't transformation polygons
	Olive groves (POSP 3)	Polygon covering the bigger part of the POSP polygon with slope < 25%	The left-most ecosystem services polygon is inserted in REN
			The right-most ecosystem services polygon is not inserted in REN
		Polygon covering the smaller part of the POSP polygon with slope >= 25%	The transformation from eucalyptus to olive groves is remunerated, so there is an ecosystem services polygon

3 polygon, since there are different slopes across it, as explained in Table 1.

- **Ecosystem Services:** Ecosystem services refer to the benefits humanity derives from ecosystems (Florestas.pt, 2021). This classification is significant because, in the coming 20 years, the Portuguese Government will annually remunerate the AIGP areas that fall under this classification (DGT, a). This classification promotes certain land-use types, such as maritime pine forests, cork oak forests, and olive trees, while discouraging others, such as eucalyptus forests. It also depends on factors including POSA, POSP, the physical characteristics of the territory, territorial classifications (e.g., REN – National Ecological Reserve and landscape structure (DGT, b)), and is

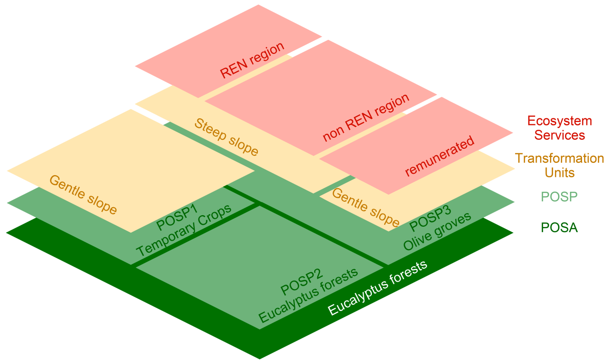

Figure 2. The representation of three POSP polygons with its correspondent transformation and ecosystem services polygons

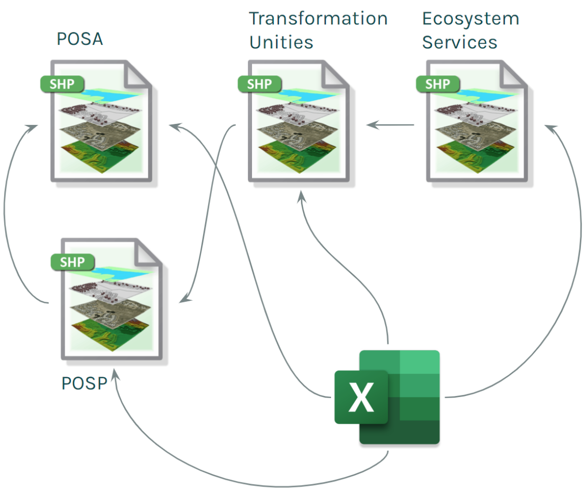

Figure 3. Existing dependencies between OIGP elements.

only applicable to polygons undergoing transformation. A transformation polygon may have more than one ecosystem service polygon. This case can be observed in Table 1.

The last step of the process is the external evaluation, where all geometry collections are delivered to the stakeholders. This sequential process involves multiple technicians, making it prone to errors that may only be detected later, leading to costly corrections. Additionally, the lack of a systematic record of decision-making results in knowledge loss and reduces transparency. The current workflow also discourages the creation of alternative scenarios, limiting comparative analysis for both initial design and execution planning.

This data model has numerous interdependencies between its elements (shapefiles), as evidenced by the fact that polygons in one shapefile are contained within polygons in another. A direct consequence of these dependencies is that when the most independent file is modified, all related files must also be updated. This issue arose frequently during the OIGP creation process, as stakeholders often

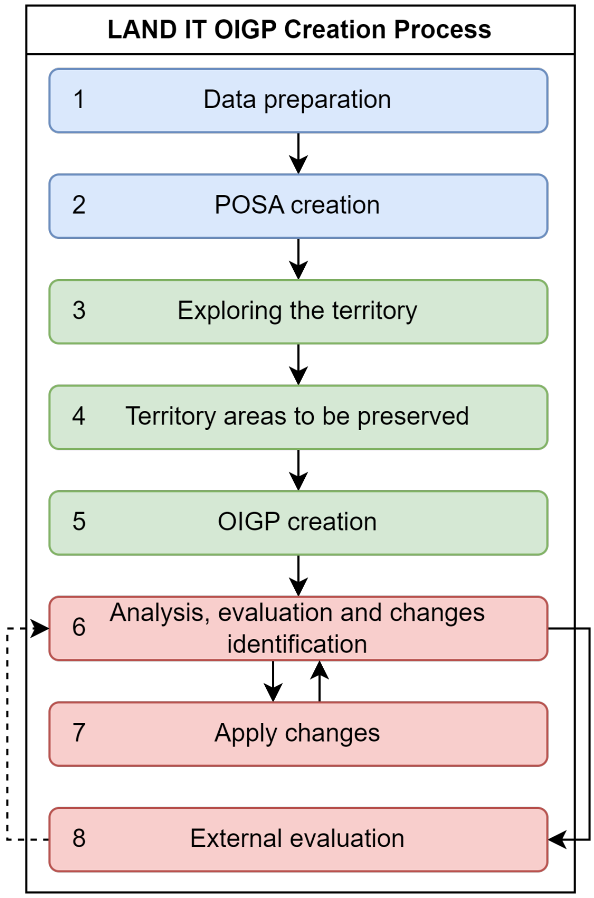

Figure 4. LAND IT OIGP creation process

proposed numerous changes. These frequent adjustments delayed progress and created bottlenecks, as even small changes in one shapefile could result in hours of additional work.

In addition to the shapefiles, each OIGP also requires spreadsheets containing estimated operation costs and statistical data. Consequently, every time a shapefile was edited, the spreadsheets also needed to be updated. These dependencies are illustrated in Fig. 3, where the element at the head of the arrow depends on the element at the tail of the arrow.

These limitations underscore the need for a more robust, efficient, and transparent approach to support the landscape transformation process.

2.4 LAND IT OIGP Creation Process

The primary innovation introduced by the LAND IT system lies in its ability to support users throughout the entire land-use planning process. The advantage of this approach is that users retain full control over the choices they make, while the system captures and preserves knowledge at each step of the process. Two mechanisms that enhance this feature are the ability to add annotations throughout the entire process and the system's capability to suggest

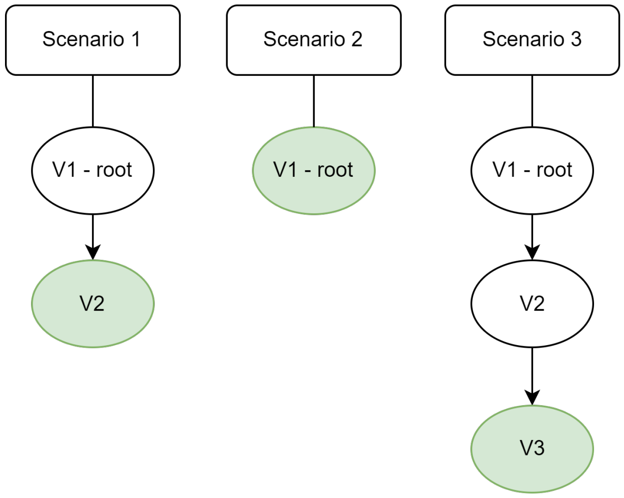

Figure 5. Example of scenarios and versions

transformations for polygons based on existing associations. A key objective of LAND IT is to address a major bottleneck in the previous OIGP creation process, where numerous modifications required in certain files caused a ripple effect, requiring updates across other files.

The OIGP creation process proposed by LAND IT is illustrated in Fig. 4, where each colour represents a phase. Solid arrows indicate mandatory paths, while dashed arrows denote optional ones. The first phase involves preparing all available territorial data, including the production of POSA. The second phase is to build an OIGP and the final phase is focused on analysis and iterative modifications until the final proposal is completed. This phase is the most time-consuming, requiring thorough evaluation and adjustments.

The concept of a scenario—a partial or complete proposal for an OIGP—was created. This allows users to create multiple scenarios and compare them in order to determine the most suitable option to pursue. Additionally, the concept of versions was introduced, with each version representing an improvement over the previous one.

An example of scenarios and versions is shown in Fig. 5, where the green nodes indicate editable versions (in leaf nodes).

A user can either create a scenario from scratch or import an existing one, and can also export a version of a scenario (DGT format).

Each version of a scenario consists of three layers of polygons: POSP, Transformation Units, and Ecosystem Services. The complex system of dependencies inherent in the OIGP process was carefully adapted to the LAND IT system. Therefore, it was essential to ensure these relationships were maintained when users edit versions. The available geometric tools, including splitting, clipping, and union functions, manage this complexity.

The following sections will outline the most important functionalities implemented in LAND IT and explain their relevance to the creation process.

2.4.1 Land-Use Editing

LAND IT allows to copy geometries between layers, which allows the realization of step 4, where users select the territory areas to be preserved in the scenario. When a user adds or edits a POSP polygon, the system automatically performs several intersection operations between layers of polygons and computes the corresponding transformation and ecosystem service polygons (steps 5 and 7 of the process). Moreover, when the transformation linked to a transformation polygon is modified, the system automatically recalculates the associated transformation costs. This is because each transformation consists of a sequence of land operations, each with its corresponding cost (steps 5 and 7).

Therefore, the geometric editing tools in LAND IT are far more complex than those in GIS systems, as they do not merely modify geometries but also influence the transformation of the territory. When using any tool within POSP, for instance, splitting a polygon, a series of background operations are triggered. This includes not only splitting the POSP polygon itself but also the corresponding transformation and ecosystem services polygons. Additionally, it is necessary to manage the attributes and transformations associated with all these polygons. These characteristics align LAND IT more closely with a decision support system than with a traditional GIS application.

2.4.2 Other Layers

LAND IT incorporates a dependency management mechanism. When a layer with territorial characteristics (slope classes, burned areas,...) is updated, all versions depending on that layer are flagged with a permanent warning. The owner of the version must approve the update, which will then be automatically propagated to the polygons in all layers of the version. If the owner refuses the update, the version remains in a read-only state (steps 6 and 7).

2.4.3 Analysis of Scenarios

LAND IT provide users with statistics for each version or allow them to compare two versions (step 6). These dashboards include various charts that analyse areas and costs within a specific version. In Fig. 6, a graph is presented as part of the statistical analysis, illustrating the area differences between POSA and POSP, where the y-axis represents the land-use occupation and the x-axis the total area in hectares. This is a particularly important chart, as it allows users to visualize the differences between the current and proposed landscapes, along with their respective advantages and disadvantages. For instance, the chart shows a considerable reduction in the number of hectares of scrubland.

2.4.4 Communication

Stakeholders can share scenarios among themselves, significantly accelerating the process since multiple stakeholders are typically involved in developing a new proposal. Additionally, the system includes chat functionalities to facilitate communication, and users can leave comments directly within the system. Collaborative and simultaneous editing is still under development (steps 5 to 7).

2.5 Design and System Components

The LAND IT system is a web-based application. The system is subdivided in three main components:

- **Database:** PostgreSQL, along with its spatial extension, PostGIS.
- **Back-end:** Developed in Java using the Quarkus Reactive framework, enabling it to function as an API. It facilitates access to the database and processes its data and models. To manage the spatial component of the project, three key dependencies are employed: GeoTools (the primary library, extensively used throughout the project), GDAL (utilised for operations between geometry layers), and the Esri Geometry API for Java (primarily used for validating and correcting invalid geometries).
- **Front-end:** The front-end is developed in TypeScript using the Next.js framework, which is based on React. It communicates with the back-end to retrieve all necessary information and deliver it to users. To display maps and manage geometries provided by the back-end, the system utilises the OpenLayers library.

3 Results and Analysis

3.1 Demonstration

The design of LAND IT's interface was carefully planned to be as intuitive and simple as possible, given that its users come from diverse scientific backgrounds, and some may not even be familiar with GIS systems. Nevertheless, it has been designed to resemble GIS interfaces to ensure familiarity for its users. The main page to edit scenario versions is represented in Fig. 7.

3.2 Stakeholders Feedback

Throughout the development of the LAND IT system, there was continuous communication with the team responsible for implementing land-use transformations using the files required by the DGT. This team consists of a lead forestry engineer and three additional technicians, including geographers who commonly work with ArcMap. They have approved the current functionalities of LAND IT and consistently provide feedback on their needs and the tools they consider most useful to include in the system.

During the system's development, user tests were conducted to evaluate whether users could effectively adapt to and use LAND IT, given that it is not a traditional GIS system like those they are accustomed to. In these tests, the three technicians were tasked with completing fifteen predefined and enumerated tasks. The results of these tests, shown in Fig. 8, indicate that most tasks were successfully completed. These tests were carried out as part of Márcia Matias' thesis. For a detailed description of the tasks performed, refer to (Matias, 2023).

4 Discussion

4.1 Challenges and Limitations

The LAND IT system has demonstrated significant improvements in the OIGP creation process. However, during its development, some challenges and difficulties were encountered.

Regarding the challenges and limitations, these are as follows:

- The interface is currently available only in Portuguese.
- Convincing stakeholders to adopt LAND IT into their daily workflow has been a considerable challenge, as they are accustomed to using ArcMap. Additionally, due to the tight deadlines they face, finding time for the adjustment period has proven difficult.

4.2 Comparison with Other Systems

In general, there are not many decision support systems developed as web or desktop applications specifically dedicated to land-use planning. Among the few that exist, one group consists of multi-criteria analysis systems, which aim to find an optimal solution for alternatives based on several criteria, such as the system proposed by (Omari et al., 2023), which has the objective to select the most suitable vacant areas for housing construction.

There are two web-based spatial decision support systems that are particularly noteworthy. The first is SOILCON-SWEB (Terribile et al., 2015), a system designed to address the complex and multifunctional challenges associated with land management and soil conservation. This system integrates various types of spatial data (e.g., soil, climate, land use) and models (physical, empirical, etc.) to provide dynamic, multidisciplinary tools for applications in agriculture, forestry, and urban planning. The use cases

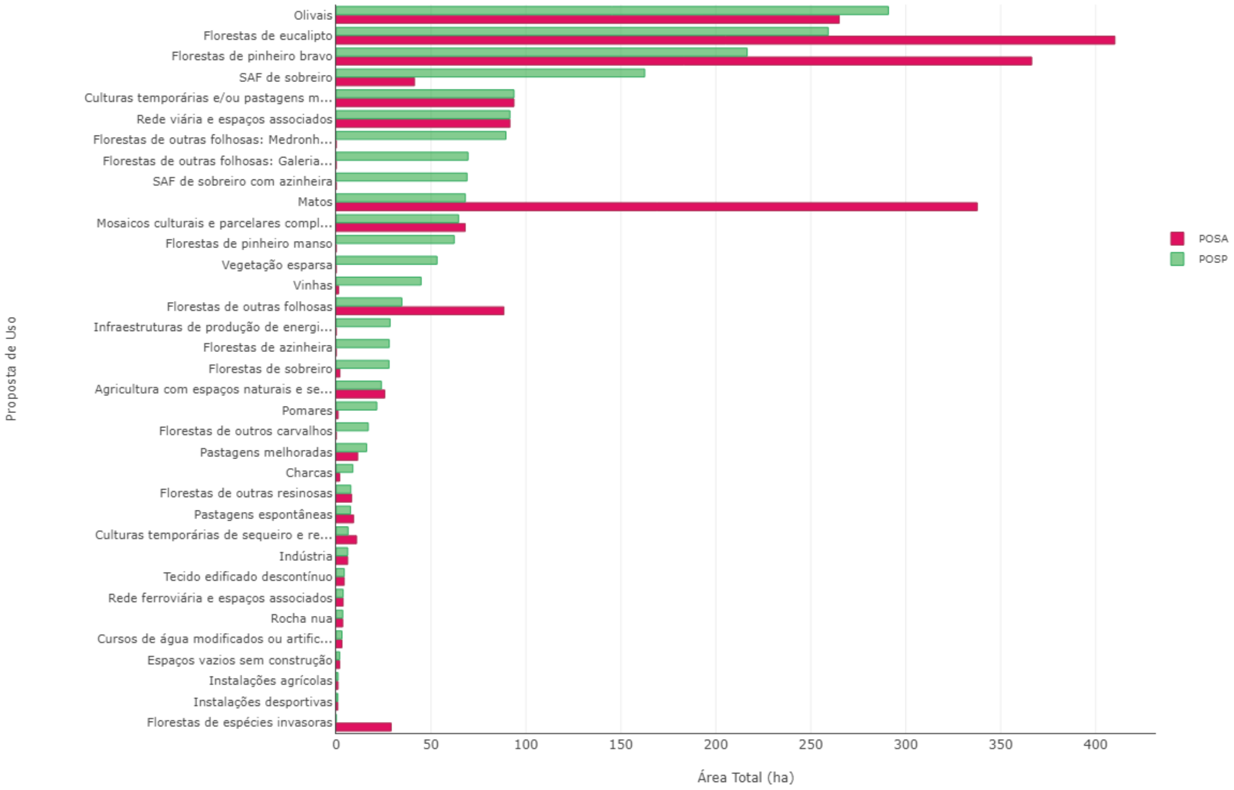

Figure 6. Graph showing the area differences between POSA and POSP

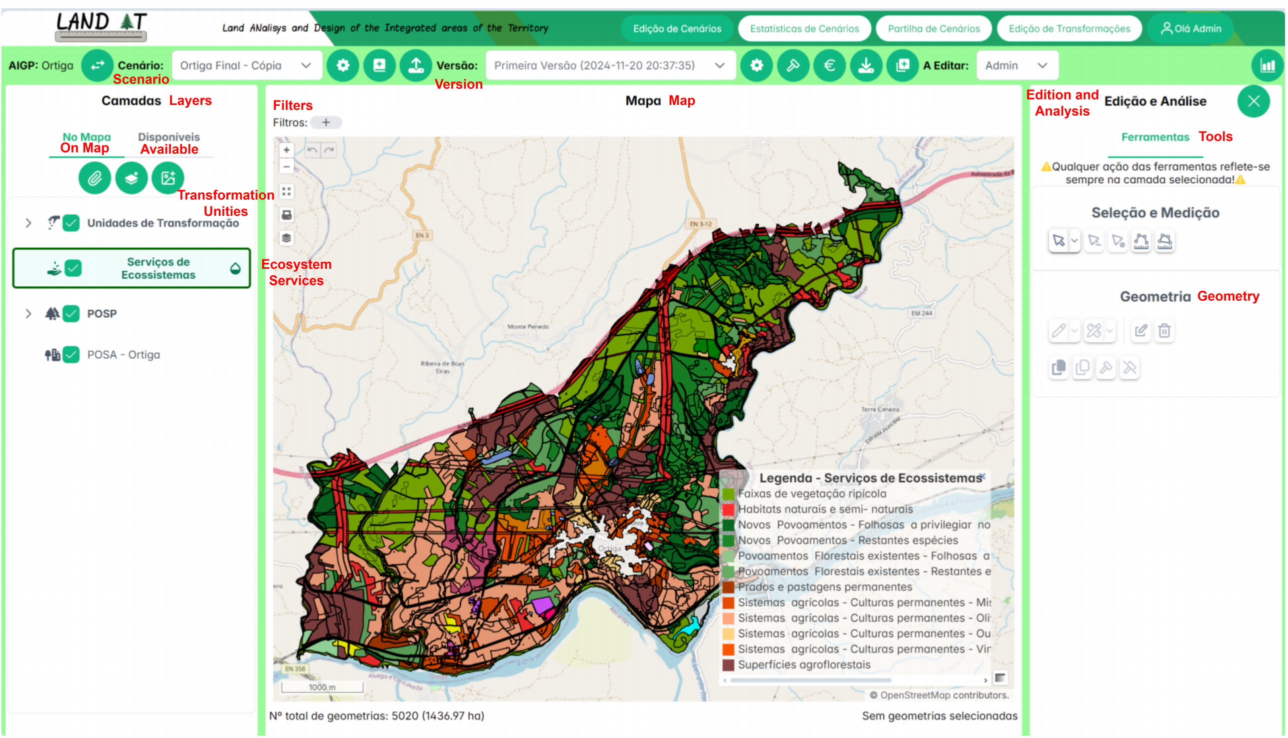

Figure 7. LAND IT main edition page

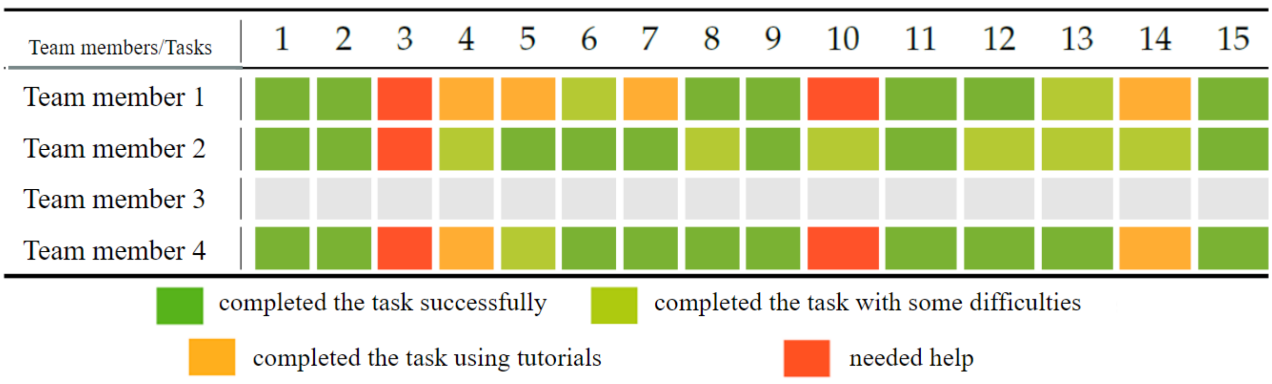

Figure 8. User tests results of fifteen proposed tasks

for SOILCONSWEB are based in Italy and focus on assessing the suitability of olive cultivation and the soil's capacity to protect groundwater from pollution.

Another relevant system is LANDSUPPORT (Coppola and Moccia, 2019), a Horizon 2020 project funded by the European Union. This system is designed to support sustainable agriculture and forestry, assess trade-offs between different land uses, and contribute to the development and implementation of land-use policies across Europe. Users can define a specific Region of Interest (ROI) on the map and apply the desired tool to perform analyses (Bancheri et al., 2023). Since it is an open-source initiative, further development has continued, with new tools being added to the toolbox. Several research articles have been published detailing these tools, such as a pesticide fate tool for groundwater vulnerability assessment (Bancheri et al., 2022).

It can be concluded that, although these systems are highly useful for analysing the landscape and assisting stakeholders in decision-making regarding its future, neither of them is appropriated for OIGP creation since they don't allow a multidisciplinary team to analyse, evaluate, and compare different territorial redesign scenarios, considering not only land use but also the effort and cost of transformation.

5 Conclusions

The aim of this paper was to describe the LAND IT system, its purpose, the rationale behind its creation, and the scope of the work undertaken. The advantages of utilising LAND IT over the traditional manual process are evident and irrefutable. With LAND IT, the OIGP creation process is enhanced, not only by significantly reducing the time required to complete it, but also by improving the quality of the results.

One of the key strengths of LAND IT is its ability to manage and integrate complexity by accurately computing the impact of land-use changes, including transformation processes and associated costs. Furthermore, the system enhances scenario analysis by providing intuitive mechanisms for creating, evaluating, and comparing different land-use scenarios. A particularly impactful feature of LAND IT is its support for the collaborative design and management of OIGP, achieved through knowledge-sharing mechanisms.

The next steps in the development of LAND IT primarily involve implementing an extension system to simplify and modularise the addition of new functionalities. One planned extension focuses on integrating economic models to assess the financial sustainability of scenarios. This evaluation can be conducted over the years by updating territorial data and incorporating external cost and price factors. Initial efforts have already been made to develop models for forestry activities (eucalyptus, maritime pine, and cork oak) (Barreiro et al., 2016) and agriculture (olive groves).

Subsequently, LAND IT aims to integrate externally executed models for assessing wildfire resilience (Sá et al., 2022; Aparício et al., 2023) in the created scenarios. Finally, another key functionality to be introduced will be the management and monitoring of landscape transformation activities and their respective impacts, incorporating elements of local observation and remote sensing. For further details or to learn more about LAND IT, please visit: https://land-it.github.io.

Declaration of Generative AI in writing

The authors declare that they have used Generative AI tools in the preparation of this manuscript. Specifically, the AI tools were utilized for language editing and improve sentence structure, but not for generating scientific content, research data, or substantive conclusions. All intellectual and creative work, including the analysis and interpretation of data, is original and has been conducted by the authors without AI assistance.

Author contributions. **Carlos Viegas Damásio:** Supervision, Writing - review & editing;
Cristina D. Henriques: Supervision, Writing - review &

editing;
Fernando Birra: Writing - review & editing;
João Moura Pires: Conceptualization, Funding acquisition, Methodology, Supervision and Writing - review & editing ;
Márcia Matias: Writing – original draft, Writing - review & editing, Methodology, Software and Project administration

All authors have read and agreed to the published version of the manuscript.

Competing interests. The authors declare that no competing interests are present.

Acknowledgements. This work is supported by UID/04516/NOVA Laboratory for Computer Science and Informatics (NOVA LINCS) with the financial support of FCT.IP. This work is also supported by AZR and Mação City Council, the management entities of the Mação OIGP.

References

Aparício, B. A., Benali, A., Pereira, J. M. C., and Sá, A. C. L.: MTTfireCAL Package for R—An Innovative, Comprehensive, and Fast Procedure to Calibrate the MTT Fire Spread Modelling System, Fire, 6, https://doi.org/10.3390/fire6060219, 2023.

Bancheri, M., Fusco, F., Torre, D. D., Terribile, F., Manna, P., Langella, G., De Vita, P., Allocca, V., Loishandl-Weisz, H., Hermann, T., De Michele, C., Coppola, A., Mileti, F. A., and Basile, A.: The pesticide fate tool for groundwater vulnerability assessment within the geospatial decision support system LandSupport, Science of The Total Environment, 807, 150 793, https://doi.org/https://doi.org/10.1016/j.scitotenv.2021.150793, 2022.

Bancheri, M., Langella, G., Manna, P., Mileti, F. A., Ferraro, G., Minieri, L., Basile, A., and Terribile, F.: The LandSupport platform to help land managers in the mitigation of degradation of natural resources, in: 2023 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor), pp. 7–12, IEEE, 2023.

Barreiro, S., Rua, J., and Tomé, M.: StandsSIM-MD: A management driven forest SIMulator, Forest Systems, 25, eRC07, https://doi.org/10.5424/fs/2016252-08916, 2016.

Coppola, E. and Moccia, F. D.: LANDSUPPORT, a decision support system for territorial government, UPLanD-Journal of Urban Planning, Landscape & environmental Design, 4, 29–38, 2019.

DGT: Documentos úteis, https://www.dgterritorio.gov.pt/paisagem/ptp/documentos-uteis, [Online; accessed 2025-01-22], a.

DGT: Elaboração de propostas, https://www.dgterritorio.gov.pt/paisagem/ptp/oigp/elaboracao-propostas, [Online; accessed 2025-02-06], b.

DGT: Programa de Transformação da Paisagem (PTP), https://www.dgterritorio.gov.pt/paisagem/ptp, [Online; accessed 2025-01-18], 2020.

DGT: Áreas Integradas de Gestão da Paisagem (AIGP), https://www.dgterritorio.gov.pt/paisagem/ptp/aigp, [Online; accessed 2025-01-17], 2024a.

DGT: Cartografia de Uso e Ocupação do Solo, https://smos.dgterritorio.gov.pt/cartografia-de-uso-e-ocupacao-do-solo, [Online; accessed 2025-01-22], 2024b.

DGT: Carta de Uso e Ocupação do Solo - 2018 - dados.gov.pt - Portal de dados abertos da Administração Pública, https://dados.gov.pt/pt/datasets/carta-de-uso-e-ocupacao-do-solo-2018/, [Online; accessed 2025-02-10], 2025.

Fernando, J. and Baldelovar, M.: Decision Support System: Overview, Different Types and Elements, Technoarete Transactions on Intelligent Data Mining and Knowledge Discovery, 2, https://doi.org/10.36647/TTIDMKD/02.02.A003, 2022.

Florestas.pt: O que são os serviços do ecossistema?, https://florestas.pt/saiba-mais/o-que-sao-os-servicos-do-ecossistema/, [Online; accessed 2025-01-22], 2021.

INE: Superfície (km^2) das unidades territoriais por Localização geográfica (NUTS - 2013), https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&contecto=pi&indOcorrCod=0011866&selTab=tab0&xlang=pt, [Online; accessed 2025-01-17], 2022.

Matias, M. B.: Decision Support System for Integrated Landscape Management Areas, Master's thesis, NOVA School of Science and Technology, Almada, Portugal, available at https://run.unl.pt/handle/10362/163563, 2023.

Omari, Y., Hamdadou, D., and Mami, M. A.: Towards an intelligent agent-based multi-criteria group decision support system: A case study in land use management, International Journal of Computing and Digital Systems, 13, 303–325, 2023.

PORDATA: Área ardida e incendios rurais em Portugal Continental, https://www.pordata.pt/sites/default/files/2024-06/Portugal_Area_ardida_e_incendios_rurais_em_Portugal_Continental.xlsx, [Online; accessed 2025-01-17], 2024.

Sá, A. C. L., Aparicio, B., Benali, A., Bruni, C., Salis, M., Silva, F., Marta-Almeida, M., Pereira, S., Rocha, A., and Pereira, J.: Coupling wildfire spread simulations and connectivity analysis for hazard assessment: a case study in Serra da Cabreira, Portugal, Natural Hazards and Earth System Sciences, 22, 3917–3938, https://doi.org/10.5194/nhess-22-3917-2022, 2022.

Terribile, F., Agrillo, A., Bonfante, A., Buscemi, G., Colandrea, M., D'Antonio, A., De Mascellis, R., De Michele, C., Langella, G., Manna, P., Marotta, L., Mileti, F. A., Minieri, L., Orefice, N., Valentini, S., Vingiani, S., and Basile, A.: A Web-based spatial decision supporting system for land management and soil conservation, Solid Earth, 6, 903–928, https://doi.org/10.5194/se-6-903-2015, 2015.