Designing a new valuation model for rural properties in Portugal

Deliverable 5: Final Report

Technical Support Instrument

Supporting reforms in 27 Member States

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List of Abbreviations

Abbreviation	**Full**
AG	Advisory Group
APA	Portuguese Agency for the Environment
AT	Tax and Customs Authority
DG REFORM	Directorate-General for Structural Reform Support
DGADR	Directorate-General for Agriculture and Rural Development
DGT	Directorate-General for Territory
DLV	Deliverable
GPP	Design, Policy and General Administration Office of the Ministry of Agriculture
ICNF	Institute for Nature Conservation and Forests
IFAP	Financing Institute for Agriculture and Fisheries
INE	Statistics Portugal
ISA	School of Agriculture of the University of Lisbon
JRC	Joint Research Centre
KoM	Kick-off Meeting
KPI	Key Performance Indicators
NOVA SBE	NOVA School of Business and Economics
PM	Project Manager
QAM	Quality Assurance Manager
RfS	Request for Services
SC	Steering Committee
ToR	Terms of Reference
eBUPi	Simplified Land Digital Registry Mission Unit

1. Executive Summary

This report is the fifth and final deliverable in the project “Designing a New Valuation Model for Rural Properties in Portugal” that is funded by the European Union via the Technical Support Instrument. The project is implemented by the AARC Consortium and its subcontractors Innerlands, Lobovasques, NOVA SBE and ESRI in cooperation with the European Commission’s Directorate-General for Structural Reform Support (DG REFORM).

Deliverable 5 represents the culmination of the work developed throughout the project, providing a synthetic overview of the performed activities and the corresponding lessons learned and recommendations for further actions. A brief context of the project, as well as its key points can be found in **Section 2**.

Following, in **Section 3,** an overview of all five Deliverables, their methodologies and key results is presented. **Section 3.1** outlines Deliverable 1, which posed as the initial phase of the project and ensured that all involved parties understood its goals, its implementation methodology and its deadlines.

Section 3.2 presents Deliverable 2, in which an assessment report with international good practices on valuation models was conducted. Such international benchmarking is of the utmost importance when recognizing and anticipating the administrative intricacies and limitations that can impact the implementation of the proposed valuation model.

The methodology adopted by the Project Team when developing the New Valuation Model and its technical specifications is presented in **Section 3.3**. This Deliverable is of crucial importance for this project, considering the fact that the proposed model has been crafted during such phase.

In **Section 3.4**, the progresses achieved under Deliverable 4 are highlighted by describing the five different training Modules taught during the sessions for Capacity Building for the Beneficiary. Additionally, this section provides information on the development of the technical manual and on the proceedings of the Workshop on the General Aspects of the Model that was conducted.

Being the last Deliverable of the project, **Section 3.5** states the three different events that were crucial to the project’s flow. As parts of Deliverable 5, two Advisory Group workshops and the final Steering Committee meeting were held; the workshops helped the Project Team to refine the model by including on it the expert’s feedback and the SC meeting served as a closing to the project.

Section 4 lists the main challenges encountered, and lessons learned from field work and/or interactions with local stakeholders during the project. The experiences and insights acquired by the Project Team have laid the foundation for the recommendations presented in the subsequent section.

Lastly, **Section 5** presents a 2-layer recommendation system, including those specific to the further development of the model and its monitoring framework, and recommendations for potential future projects, which can be relevant to the valuation of the rural property in Portugal or in other Member States.

The sub-reports on the workshops of the Advisory Group convey the main messages that the Project Team presented to the representatives from the Stakeholders - the presentations can be found in **Annexes B** and **D**, respectively.

2. Project Overview

2.1 Project Context

DG REFORM coordinates and provides tailor-made technical support to the EU Member States, in cooperation with the relevant Commission services. DG REFORM provides support for the design and implementation of resilience-enhancing reforms in a wide range of topics, including the area of tax policy. The Portuguese Tax and Customs Authority (Autoridade Tributária e Aduaneira) requested in October 2021 support from the European Commission on **a new valuation model for rural properties** to help diminish distortions arising from property valuation in Portugal by reducing the gap between the property's value for tax purposes and its market value.

Thus, the New Valuation Model for Rural Properties in Portugal aims to be of assistance to national authorities in improving their capacity to design, develop and implement reforms identified as critical by the Beneficiary, the Portuguese Tax and Customs Authority. In particular, it aims at supporting the edafo-climato-morphological (soil and climate) characterization and assessment of economic potential tax value of rural properties, a target set in the Portuguese Recovery and Resilience plan.

There is a considerable number of issues in the current Portuguese context that stresses the need to implement such a valuation model. The first issue is that **Land Tax may be efficient for urban buildings taxation but it is clearly not efficient for rural land taxation** – Land Tax over Rural land is merely 0,5% (8 Million €/year) of the total land tax volume in Portugal, a value that is significantly lower than that in comparable jurisdictions. Secondly, there are risks and inefficiencies that theory suggests that can arise from the apparent **lack of coordination between income and land tax on rural land**. Lastly, there seems to be **insufficient cooperation between public entities** in the topic (at least, when it is compared to the level that will be required for a sustainable and transversal implementation of a valuation model), with a clear potential for improvement in this regard.

The outcomes of this model are centered around the **estimation of what is proposed as an "adequate and fair" value for land units**, one that incorporates existing data from relevant sectorial ministries that is already possible to treat in an integrated way. This first version of the model may pave the way for it to be accepted and adopted as a **good reference value for public policy** purposes, such as, taxation, grants and subsidies, territorial ordinance, etc. Additionally, it is flexible enough to be fine-tuned in the future, by incorporating new relevant datasets, making it more robust and accurate. By implementing this model, it is expected to estimate, with already significant accuracy, the property's land base value. It is also expected that the **gap** between the **Land Base Value** (LBV) and **actual market transaction value will be low in rural areas** (when considering only the rural variables while excluding the urban relevance and agent's expectations).

Such proximity between the Land Base Value and market value will **enhance the accuracy, fairness, and transparency of rural property taxation**, contributing to a more efficient and equitable tax system. It is expected that, as an outcome, producers who make the best use of their land will be comparatively beneficiated, as the new tax base will be lower than that which would be derived from income flows from land use alone and that, in opposition, those who abandon or make a non-efficient use (including the misuse of environmental externalities, like biodiversity, energy, environment and climate change protection measures) of the land will be comparatively penalized.

By addressing the aforementioned current challenges in the valuation of rural properties, this model aims at providing national authorities with a useful tool for land valuation, empowering them to make richer-informed decisions and to add more value to the design of future public policies in Portugal.

2.2 Project Objectives

Project title	**Designing a new valuation model for rural properties in Portugal**
Overall Objective	The general objective of this project is to assist national authorities in improving their capacity to design, develop, update, and implement a Valuation Model of the Rural Property, for tax purposes in Portugal.
Specific Objectives	• Analyse good international practices for Valuation Models for Rural Properties and provide recommendations for a tailor-made and hybrid solution of a valuation model that is suitable for Portugal. • Define and test a New Valuation Model, together with a technical specification report and recommendations on how to maintain and develop the model. • Create Capacity within the Entities expected to use the proposed Valuation Model, ensuring the sustainability of the Project's results.
Consequences of the Project	• The Portuguese Tax and Customs Authority can operate the new valuation model for rural properties that could underpin tax policy reform aiming to reduce the gap between the property's value for tax purposes and its market value. • Relevant public entities are knowledgeable to the New Valuation Model and involved in the process of data gathering.
Deliverables	**Deliverable 1:** Kick-off and Inception Report **Deliverable 2:** Assessment Report with International Good Practices on Valuation Models **Deliverable 3:** New Valuation Model and Technical Specifications Assessment Report with International Good Practices on Valuation Models for Documentation of the Model **Deliverable 4:** Capacity Building (Training and User Guide) in Use of the Valuation Model **Deliverable 5:** Final Report and Closure of the Project
Main Activities	• Identification of Market and Administrative Failures and in-depth analysis of Good Practices of Rural Land Valuation (DLV2); • Workshop on International Good Practices and drafting an Assessment Report with International Good Practices on Valuation Models (DLV2); • Development New Valuation Model and Technical Specifications for Documentation of the Model (DLV3); • Estimation and Testing the New Valuation Model (DLV3); • Hold Targeted Specific and Technical Training Sessions (DLV4); • Hold Workshop on the Model (DLV4); • Drafting of the step-by-step Technical Manual on the Valuation Model (DLV4);
Project Outcomes	**Outcome 1:** Outputs adequately tailored to tax system in the Portuguese context **Outcome 2:** Design of a New Valuation Model **Outcome 3:** Strengthened technical capacity to use the New Valuation Model
Project starting date	The contract was signed on the 12th of September 2022.
Kick-off Meeting	The Kick-off meeting was held on the 3rd of October 2022.
Project duration	12 months

3. Summary of project activities

The project was organized into five main activities, which are described in detail below:

1. Organize the Kick-off Meeting and adjust the methodological approach in the Inception Report, according to its conclusions and on discussions with the Beneficiary (Portuguese Tax and Customs Authority), as well as producing a project summary sheet that summarizes its main elements **(Deliverable 1)**;
2. After identifying Market and Administrative Failures of the current situation in Portugal, undertake an in-depth analysis of Good Practices of Rural Land Valuation and hold a Workshop on International Good Practices, enabling the provision of a Summary of Pros and Cons and of a comprehensive Assessment Report with International Good Practices on Valuation Models **(Deliverable 2)**;
3. Develop a New Valuation Model and a summary of its main results, and also present examples on the impact of the new model together with a Technical Report of the Valuation Model **(Deliverable 3)**;
4. Create Capacity in Use of the Valuation Model, both by providing training sessions (covering from the basis of the software in use until the technical specifications of the model) and by developing a step-by-step Technical Manual, suitable for both experienced and inexperienced staff members from the Beneficiary Authority **(Deliverable 4)**;
5. Summarize the project in a Final Report, one that can serve to provide to all Stakeholders a concise and comprehensive description of the tasks undertaken, as well as an updated project summary sheet and a presentation of the following events: Advisory Group workshops and Final Steering Committee Meeting **(Deliverable 5)**.

3.1. Deliverable 1: Inception Report

The initial phase aimed to ensure that all Stakeholders had a common understanding of the project, allowing for a shared vision of its goals, implementation methodology, and deadlines. The initial phase also served to update the general work plan, as well as to define communication practices and to conduct the management of Stakeholders' expectations. A summary of the project's terminology and Core Stakeholders was also presented to ensure consistency in nomenclature:

Beneficiary: Portuguese Tax and Customs Authority
• **GPP:** Gabinete de Planeamento, Políticas e Administração Geral do Ministério da Agricultura • **DGADR:** Direção Geral de Agricultura e Desenvolvimento Rural • **IFAP:** Instituto de Financiamento da Agricultura e Pescas, I.P • **DGT**: Direção Geral do Território • **ICNF:** Instituto da Conservação da Natureza e das Florestas • **APA:** Agência Portuguesa do Ambiente, I.P. • **eBUPi:** Estrutura de Missão para a Expansão do Sistema de Informação Cadastral Simplificado • **INE:** Instituto Nacional de Estatística

Table 1: Core Stakeholder Group

The official start date of the project was set to September 12th, 2022 (contract signature), with the **Kick-off meeting** being held on October 3rd, 2022.

To support the project's activities, to ensure its coordination, and to approve the scope of certain activities, a **Steering Committee** (SC) was established. The role of the SC during the project was to review and provide feedback and suggestions on the project's activities, work plans, and draft report versions. The composition of the SC included DG REFORM, the Beneficiary (Portuguese Tax and Customs Authority), and the Contractor's Project Team.

Additionally, **2 quarterly progress reports** were presented, where the status of all the planned activities in the project was updated, clearly describing the progress made and the obstacles encountered at each stage.

3.2. Deliverable 2: Assessment Report with International Good Practices on Valuation Models

Deliverable 2 focused on **international benchmarking and on in-depth research** into existing valuation models adopted in selected jurisdictions. Its significance lies in the way it laid the groundwork for subsequent deliverables, setting the stage for a comprehensive and innovative valuation approach tailored to the Portuguese context. It entailed an extensive **exploration of various valuation models** aimed to **identify successful elements from global practices** that could be transposed into the development of a novel valuation framework for Portugal's rural properties.

At the core of this phase was a comprehensive examination of the **pros and cons of diverse valuation models**, its specific jurisdiction valuation methods, mechanisms, and the outcomes they have yielded. This meticulous evaluation allowed the Project Team to collect insights into the components that contributed to the efficacy of these models, as well as the areas where they fell short of expectations, thus capitalizing on the successes of other models while addressing their limitations in a tailored approach. This allowed for fully **assessing the methodologies that could best serve as inspiration to the design of a suitable framework for the unique Portuguese landscape**.

As part of Deliverable 2, the Project Team organized a **Workshop on International Good Practices of Rural Land Valuation** on the 20th of November 2022, which encompassed the presentation of worldwide-used valuations methods, good practices and examples aligned with Portugal's needs. This contextual exploration allowed juxtaposing Portugal's existing valuation model with those adopted by other jurisdictions. Furthermore, Deliverable 2 played an instrumental role in delineating the legal concepts that would underpin subsequent actions. By closely examining the legal frameworks of various jurisdictions, the Project Team was able to identify the foundational principles that resonated with the Portuguese context. This process was essential in ensuring that the new valuation method would **seamlessly integrate into the existing legal landscape** while addressing the unique challenges posed by Portugal's administrative framework and its limitations.

Incorporating them was a pivotal aspect. Deliverable 2 allowed for **recognizing and anticipating the administrative intricacies** and limitations that could impact the implementation of the proposed valuation model. This insight provided a holistic perspective that enabled to tailor an approach to not only meet the specific administrative demands but also to streamline the adoption and execution of the new method within the Portuguese Public Administration structure.

In essence, Deliverable 2 extended beyond international benchmarking; it **served as the foundation** upon which the Project Team began crafting a novel valuation method. It laid down the legal concepts that would inform subsequent deliverables and offered an in-depth understanding of the administrative intricacies unique to Portugal. By doing so, it ensured that the proposed valuation framework **would not only be innovative but also seamlessly aligned with the legal and administrative reality of the country, fostering a holistic and effective approach to the valuation of rural properties.**

3.3. Deliverable 3: New Valuation Model and Technical Specifications for Documentation of the Model

The aim of Deliverable 3 was to **design and apply a valuation model capable of assessing the Land Base Value** (LBV), a rural property's value based on its economic aptitude. In order to achieve such objective, the Deliverable was subdivided into four actions: (i) the characterization of the farming and forestry systems in the pilot areas and the assessment of productive potential, (ii) the development of the valuation model itself, (iii) a summary of the main results obtained, at each step, when running exploratory versions of the valuation model on the existing data, (iv) a technical report of the valuation model.

The **characterization of the farming and forestry systems** is of the utmost importance for obtaining good estimations on the **potential economic value of the land**, as well as to **assess the productive capacity**. After completing this first action, the Project Team developed the **New Valuation Model using econometric theory,** all the way aiming for a relatively, simple approach (such as a linear model) that would not **compromise the efficiency of the model**.

With the purpose of obtaining **good and accurate estimates from running the model**, the Project Team made use of **several datasets, comprising multiple variables** that were believed to impact land's productivity. The use of large datasets from various **official sources** is one of the best available approaches to securing that Stakeholders will meet the results with a reasonable **degree of confidence**. The New Valuation Model is built upon what is defined as the Base Model, a linear regression whose dependant variable is the profitability variable (created by the Project Team with the assistance of Stakeholders) and is explained by the **aptitude classes and the distance to the closest urban centre** (distance to the geometric centre of closest the municipality's polygon). Such Base Model allows for further development, namely for its extension and refinement into what is described as the **Complete Model, by including majorants and minorants**. The process of selecting majorants and minorants is defined as the **Model Specification process**. This process consists of two distinct phases, in order to guarantee a flexible and efficient use of the model. At any particular moment and once all the relevant variables have been chosen, the Complete Model is the version that shall be used, at that point in time, in order to obtain the Land Base Value at the parcel level.

Deliverable 3 consists of a significant number of technical terms and extensive information, hence, the last two actions of the deliverable aim at **assisting the Beneficiary**, and any reader, to **fully grasp the methodology designed by the Project Team**. A summary of the main results was drafted, which included the coefficients, standard errors, t-statistics, and p-values of the main regressions that have been run, as well as possible extensions to the model (such as an inclusion of a regional dummy variable and a comparison between the values obtained by the model and market transaction values for that same parcel). Lastly, this Deliverable contains a **technical report that includes a step-by-step guide** on the **methodology used by the Project Team**, a **flowchart** of this methodology, **tips at maintaining the code and the model and screenshots of examples of the R code used when programming the New Valuation Model**.

3.4. Deliverable 4: Capacity Building (Training and User Guide) in Use of the Valuation Model

Deliverable 4 sought to **create capacity within the entities expected to use the proposed valuation model**, ensuring that the work developed in the technical phases (DLV3) will extend beyond the project timeline, **guaranteeing future**

sustainability of the project's results. To this end, three main actions were enacted: (i) the development of a Technical Manual, (ii) holding a Workshop on the General aspects of the model and (iii) holding Technical Training sessions.

The Technical Training sessions were held over a period of approximately 3 months (Table 2), at the Beneficiary's facilities. The training plan has been developed by the Project Team and was intended to cover from the most basic concepts on the chosen Software (R), to econometric concepts, finalizing with the model application. Below, the objective of each module is outlined:

- **Module 1 - Introduction to R:** Provide a general knowledge of the software, what is it, how to install and set up, basic syntax and commands, data types, objects, and classes.

- **Module 2 - Data Management in R:** Demonstrate how to import data into R, understanding data structures and subsetting, data cleaning: missing values, outliers and transformations and finalizing with merging datasets.

- **Module 3 - Basic Statistics in R:** Descriptive statistics: measures of central tendency, variation, and shape., probability distributions: discrete and continuous variables and hypothesis testing.

- **Module 4 - Linear Regression:** Simple linear regression model., estimation of parameters using OLS method, hypothesis testing: significance of coefficients and goodness-of-fit measures, multiple linear regression model, assumptions checking: multicollinearity, heteroscedasticity, normality of residuals, model selection criteria.

- **Module 5 -The Model:** Model structure and assumptions – Understanding the Model, data employed and treatment, Model Walkthrough, application of the Model to each Pilot, Independent application of the model to a region.

Modules	Module 1: Introduction to R	Module 2: Data Management in R	Module 3: Basic Statistics in R	Module 4: Linear Regression	Module 5: The Model
Time Dedicated	4 hours	8 hours	8 hours	12 hours	32 hours
Day	04th May	05th May, 14th June	15th, 16th, 22nd June	23rd, 27th, 29th June	29th June, 4th, 28th, 29th July

Table 2: Training session plan

In order to understand **the impact of the training sessions**, **two surveys were conducted:** the first one requested information on the participants and their knowledge regarding skills related to programming in R and in statistics; the second and last survey questioned the participants on their opinion on the training sessions and how much they feel they learned during such sessions. When it comes to the participant's characteristics, **64% of the responders have obtained an academic degree in agronomy and 64% have been working in the Tax and Customs Authority for 10 or more years**.

In the first survey, the participants were requested to self-assess their own knowledge on multiple topics using a scale from 1 to 4 (where: 1 – no exposure to the concept; 2 – some basic notions; 3 – have used such concept in a work context;

4 – frequently uses it). From the answers of the survey, it was possible to conclude that, in general, the **participants had little knowledge on statistics and econometrics;** there was **considerable experience in using Excel** or other spreadsheet software but **little experience in using R** as a programming language.

The second survey asked for the participants appraisal on how much they felt they have learned during the training sessions. This survey also used a scale from one to four, 1 being the lowest grade and 4 the highest grade. The main result of this survey is that there was **overall satisfaction regarding the training sessions** (when asked about such satisfaction the **average grade given was 3 out of 4**). Additionally, when questioned about if the participants felt that the **training sessions increased their knowledge on the R software** and applying it to the New Valuation Model, the results were positive (**average grade of 3.1 out of 4**).

3.5. Deliverable 5: Final Report and Closure of the Project

The last Deliverable - the Final Report - consists of two main results: this very report and the organization of three events: 2 Workshops of the Advisory Group and the final meeting of the Steering Committee, all of which were held in Nova SBE headquarters, in Carcavelos.

The **first workshop of the Advisory Group** took place on the 7th of June 2023. It counted 35 participants, 3 of whom were members of the advisory panel. The workshop provided an opportunity for the Project Team to present the activities of the project up to that point to a broader audience, including the Core Stakeholder Group, whose experience is relevant to the project and to its dissemination, and whose independence was ensured by them not being directly involved in the project. During the meeting, the participants had the occasion to express their opinions on how each Deliverable could be enriched and improved.

The presentation used during the 1st Workshop of the Advisory Group can be found in **Annex B**.

As for the **second workshop of the Advisory Group**, it took place on the 6th of September 2023, having been attended by 41 participants, 2 of whom were once again members of the advisory panel. During this session, the Project Team could share the conclusions of the proposed New Valuation Model to the audience, on which the advisors provided their insights and validation, playing an important role in the quality assurance process.

The presentations used during the workshop can be found in **Annex D**.

As mentioned, the **final meeting of the Steering Committee** also took place on the 6th of September 2023. It served to present the draft of the Final Report and discuss key results, challenges encountered, lessons learned and recommendations for the project’s sustainability and for potential future projects. This meeting also served as a concluding event, allowing to make an evaluation of the overall experience of the project from all involved parts.

4. Challenges Faced & Lessons Learned

The following section is dedicated to detail the several challenges faced during the implementation of this project, based on the work that was developed and presented throughout the project's deliverables as well as in the interaction between the Project Team, the relevant stakeholders of the project and the entities that compose the Steering Committee and the Advisory Group. Such challenges led the Project Team to actively brainstorm solutions in order to guarantee that the work being done would be impactful, and thus, these same challenges can also be seen as lessons learned along the way.

The first big challenge observed is the fact that the **Beneficiary does not retain full autonomy in the implementation of the model.** This, as the Project Team came to learn, is a consequence of the **high degree of fragmentation of the necessary resources** needed to implement the model. During the project, it became clear that there was a need to obtain data from a significant number of public entities, as it will become clear in the following paragraphs. The natural result of this phenomenon is the dependency of the Beneficiary to the partner entities given that these are responsible for obtaining and reporting the data to the Tax Authority, posing as an obstacle to an efficient application of the model.

In terms of governance, some of the approaches were considered by several stakeholders as being **too rigid, with discussion and consequent decision not being effectively collaborative in the last decades.** In addition, several stakeholders (both nuclear and non-nuclear), **were not sufficiently involved in the original formulation** from the beginning. Additionally, it is important to note that some of the technicians present at the meetings (despite the AT, who was always represented at the highest level) did not have decision-making power, which may have hindered taking more meaningful steps towards ensuring future governance. The implementation of the model requires an effectively collaborative governance model that integrates all relevant stakeholders at its various levels, empowering them to make decisions.

Another relevant challenge associated with the implementation of the model was **missing key information,** which none of the stakeholders could provide in time. For example, the Directorate-General for Territory, who until recently was responsible for implementing the cadaster, has a very limited cadaster. BUPI is trying to speed up the collection of simplified cadaster registries, but it is also still very incomplete (for instance, within the eBUPi zone - 153 municipalities in the *Norte* and *Centro* regions, only around 22% of the parcels had been georeferenced), which translated into a lack of usable data to work with the model.

One of the main challenges was related to the low degree **of cadaster implementation** within the timeframe of this project. The main results of the eBUPI project and of the implementation of the new cadaster regime set in August 23rd 2023 will only come to fruition in the coming years. Therefore, not only a comprehensive chart was not yet realized (to the necessary extent), but also political, technical and budgetary definitions needed to implement the new cadaster regime are still being drafted and are expected to be concluded only at the beginning of 2024.

Another of the main challenges was due to the **implementation of the aptitude map**. The learning resulting from the existence of dedicated spaces for experimentation in the implementation of a new system and paradigm (i.e., the pilots) was impaired. It is concluded that the spatial and temporal overlap of other levels of implementation of the same program is counterproductive and makes the existence of pilot areas as spaces for experimentation insignificant.

Some positive aspects are highlighted, which are related to **relevant experience of the stakeholders in learning from the cadaster implementation.** The implementation of a new paradigm requires "exclusive" time and benefits from the existence of collaborative spaces that allow the exchange of experiences, visions, and ideas, with a clear and balanced sharing of responsibilities and functions among those involved.

5. Recommendations

5.1. Follow up Plan: further developments to the model and monitoring framework

Following the work developed, **the project team has prepared a follow up plan with recommendations** aimed to **strengthen the implementation of the new valuation model** and to enhance land management and land use practices in Portugal by addressing regulatory, administrative, and technical aspects.

By implementing these measures, we can foresee a **smooth execution of the new valuation model**, while **promoting sustainable agriculture and forestry**, **streamlining land transactions**, and **supporting efficient land use** for the benefit of both landowners and the environment. The set of recommendations goes as follows:

i) Requiring the **Elaboration of the New Regulatory Model for Parcel-Level Agricultural and Forestry Activities**

This recommendation involves the development of a regulatory framework that governs agricultural and forestry activities at the parcel level. The aim is to **create a structured system** that provides **guidelines** and rules for landowners and farmers regarding how they can use **their land for agricultural and forestry purposes**. This new model would likely address issues such as land use planning, environmental considerations, and best practices for sustainable agriculture and forestry.

The foremost aim of this regulatory model is to introduce structured and systematic land use planning. By delineating specific zones and designating land for various types of agricultural and forestry activities, this framework helps ensure that land is utilized efficiently and sustainably. By optimizing land use, the framework promotes resource efficiency.

ii) **Improving the Characterization of Cultural Themes**, particularly in Forestry and Agriculture

This recommendation focuses on enhan**cing the understanding and documentation of cultural practices within agriculture and forestry**. It involves conducting in-depth research and documentation to better understand traditional and sustainable agricultural and forestry methods. By preserving and promoting these cultural practices, it's possible to maintain biodiversity and sustainable land management.

A primary goal of this recommendation is the **preservation of cultural heritage**. It acknowledges that agriculture and forestry practices often carry deep-rooted traditions and knowledge systems. By documenting and safeguarding these practices, we can prevent the loss of invaluable cultural heritage.

Traditional agricultural and forestry methods have often evolved in harmony with local ecosystems. By understanding and preserving these methods, we can actively contribute to biodiversity conservation. These practices may include crop rotation, seed saving, and low-impact forestry techniques that minimize disruption to ecosystems.

The first step involves conducting in-depth research into local agricultural and forestry practices. Once these practices are documented, they should be cataloged and organized for future reference. This may involve creating a comprehensive database or repository that captures the richness and diversity of cultural practices.

Another essential aspect of this recommendation is the **dissemination of knowledge**, which should involve educational initiatives to promote the understanding and adoption of traditional practices among current and future generations of land managers and farmers.

To ensure the preservation of cultural practices, it's vital to integrate this understanding into relevant policies and regulations. This might involve creating incentives for landowners who adopt sustainable traditional practices or designating protected areas for cultural heritage preservation.

iii) Realizing the **Land Registry**

Establishing a **comprehensive and accurate land cadastral registry system** is crucial for **transparent and efficient land management**. This recommendation calls for the completion or improvement of the land cadastral registry system to ensure that all land parcels are correctly documented, and that ownership information is up to date. This is essential for property rights, land transactions, and overall land governance.

iv) Drawing Up the Aptitude Map

An aptitude map at a greater scale assesses the suitability of land for various uses, such as agriculture, forestry, or conservation. Drawing up an aptitude chart involves **conducting detailed assessments of the land's characteristics**, including soil quality, topography, and climate. This information is then used to **guide land-use planning**, helping to determine which areas **are best suited for specific purposes and ensuring more sustainable and productive land management**.

The continuous development of the aptitude map is a vital component of sustainable Land Management. This recommendation underscores the ongoing commitment to enhancing and finalizing the aptitude map — a foundational element for the New Valuation Model. This map serves as a pivotal tool for assessing the land's suitability for various uses, including agriculture, forestry, and conservation.

This holistic understanding of the land's attributes is indispensable for guiding land-use planning and ensuring that specific areas are earmarked for their optimal purpose, contributing to sustainable, efficient, and productive land management.

Implementation Milestones

Year 1: Laying the Groundwork

Gap Analysis: *Perform a meticulous gap analysis to identify areas where the aptitude map remains incomplete or lacks sufficient data. Prioritize the acquisition of missing information in these areas.*

Data Inventory: *Conduct a thorough inventory of existing data sources related to soil quality, topography, climate, and land cover. Collaborate with government agencies, research institutions, and environmental organizations to collect comprehensive datasets.*

Stakeholder Engagement*: Engage with the local entities and experts to gain insights into regional land characteristics and fill information gaps. Encourage their involvement in data collection efforts.*

Technology Integration: *Leverage advanced Geographic Information System (GIS) technology and remote sensing tools to integrate collected data and begin creating a preliminary optimized aptitude map.*

Year 2: Advancing Towards Completion

Data Enhancement*: Focus on enhancing the quality and accuracy of existing data. Utilize techniques, such as field surveys and soil sampling, to validate and refine datasets.*

Aptitude Map Finalization*: Collaborate with experts to finalize the aptitude chart, ensuring that all necessary information is incorporated. Address any remaining gaps and discrepancies.*

Integration with Valuation Model: *Integrate the completed aptitude chart into the New Valuation Model, specifically the Base Model, to enhance its accuracy and reliability.*

Education and Awareness: *Launch educational initiatives to inform the public, landowners, and policymakers about the significance of the aptitude chart and its role in sustainable land management.*

Continuous Monitoring: *Establish a monitoring system to regularly update the aptitude chart as new data becomes available and environmental conditions evolve.*

5.2. Recommendations for future projects

The project team has devised a novel hybrid indirect valuation approach tailored for Portugal, and it is poised for execution. To ensure a well-calibrated model, the team **leveraged extensive datasets** featuring numerous variables that can impact land productivity. Apart from the set of recommendations designed to oversee and ensure the smooth implementation of this complex methodology (see Section 5.1.) we crafted a **series of recommendations for future projects which will complement and enrich the valuation model and its framework**, which we set below.

Incorporating these recommendations into future projects will undoubtedly enrich the valuation model and its framework, facilitating a holistic and sustainable approach to land management in Portugal.

i) Creation of an Incentive Model for Land Aggregation (Parceling)

Encouraging land aggregation or parceling involves **creating incentives for landowners to consolidate smaller land parcels into larger, more efficient units**. This can lead to increased agricultural and forestry productivity, as larger parcels are often easier to manage and cultivate effectively. The incentive model may include tax benefits, grants, or other mechanisms to motivate landowners to participate in this process.

We would advise starting with a **pilot area** or region where the incentive model can be tested and soliciting participation from interested landowners. This should be followed with an assessment of the results of the pilot program, including the number of parcels consolidated, productivity improvements, and economic impacts.

Once this is done, the incentive model based on lessons learned during the pilot phase should be refined, making adjustments as necessary to maximize effectiveness.

Then a strategy should be developed for scaling up the incentive model, targeting areas where land aggregation could have significant benefits.

ii) Facilitating the Inheritance System

In many cases, land parcels are divided among heirs, **leading to fragmented land ownership** that can **hinder efficient land use**. Facilitating the inheritance system **involves streamlining the process by which land is passed down from one generation to the next.** This might include legal reforms, simplified procedures, or financial incentives to encourage land consolidation among heirs.

iii) Designing **New Models and Precise Methodologies** for **Defining Production Costs and Profitability**

To promote efficient land use, it's essential to have **accurate models and methodologies** for **calculating production costs and assessing profitability**. This recommendation suggests the development of new tools and methods that help landowners and farmers calculate the costs associated with agricultural and forestry activities accurately. This information can inform decision-making and help optimize land use practices.

iv) Development of a **Complementary Framework for Incorporating Environmental System Considerations** into **Land Profitability Models**.

The current valuation model **lacks an assessment of environmental systems (water, biodiversity and carbon environmental systems)**, which is a crucial aspect in today's sustainable landscape. To address this gap, we recommend the creation of a framework that integrates environmental elements into land profitability systems. This framework will **enhance the model's accuracy and relevance by accounting for ecological aspects**, ultimately promoting environmentally responsible land management practices.

This recommendation is rooted in the recognition of a critical gap within the current valuation model: the absence of an assessment of environmental systems, which are increasingly important in today's landscape of sustainable land management. The essence of this recommendation lies in creating a comprehensive framework that seamlessly integrates environmental elements into land profitability models. By factoring in ecological aspects, it ultimately fosters environmentally responsible land management practices, thereby aligning economic interests with ecological stewardship.

Annex B: Presentation of the first workshop of the Advisory Group

Annex D: Presentation of the second workshop of the Advisory Group

DESIGNING A NEW VALUATION MODEL FOR RURAL PROPERTIES IN PORTUGAL

First Workshop of the Advisory Group

June 7th, 2023

This project is carried out with funding by the European Union via the Technical Support Instrument and in cooperation with the Directorate General for Structural Reform Support of the European Commission

AGENDA

WELCOME SESSION – LUNCH:
12h00 to 14h00: Restaurante *Azure* (Nova SBE)

WORKSHOP AGENDA (ROOM D139)	TIME	ENTITY I SPEAKER	CONTENT
	14h00 – 14h10	Project Team	• Presentation of the context of the Project
	14h10 – 14h30	Beneficiary & DG Reform	• Introductory Remarks
	14h30 – 15h30	Project Team (i) – All (ii)	• Presentation (i) & Discussion (ii) of Deliverable 2 (Assessment Report with International Good Practices on Valuation Models)
	15h30 – 16h45	Project Team (i) – All (ii)	• Presentation (i) & Discussion (ii) of Deliverable 3 (New Valuation Model and Technical Specifications for Documentation of the Model)
	16h45 – 17h15	All	• *Coffee Break*
	17h15 – 17h35	Project Team (i) – All (ii)	• Presentation (i) & Discussion (ii) of of Deliverable 4 (Capacity Building (Training and User Guide) in Use of the Valuation Model)
	17h35 – 17h45	All	• Concluding Remarks and Next Steps

1. Introductory Remarks & Project Context

Presenter: Beneficiary

AARC

NOVA
NOVA SCHOOL OF BUSINESS & ECONOMICS

LOBO VASQUES

esri

INNERLANDS


Designing a new valuation model for rural properties
in Portugal - projeto REFORM/SC2022/126
Advisory Group | 1st Workshop – june 2023

Project background (AT diagnostic aligned with the AARC Consortium diagnostic)

The current rules for evaluating rustic property for tax purposes are based on the use of the land and the income generated as an outcome of such use.

- This type of evaluation, based on income value, requires a high consumption of resources and therefore is not applied as often as it would be advisable, resulting in extremely outdated taxable value data.
- Variability in soils, climate, morphology, parcel size, farming and forestry systems, etc., are key factors for the determination of possible production outcomes.
- Income and costs can thus vary substantially, making it difficult to implement an approach for estimating the net value of production outcomes. This also makes it difficult to use an adequate capitalization rate.
- With this methodology it is not possible to achieve the goal of assessing the productive potential of land, namely underexploited land.

Non completion and actualization of "Land cadastral register" is also critical to achieve massive evaluations.

Priorities

To define a cadastral evaluation model which is

- simple
- and is supported by an automated valuation methodology that
  - uses market values as a reference
  - is based on econometric procedures
  - is capable of correlating actual market values with the georeferenced attributes of the rural properties

Challenge: to find "the right formula"…

$$P(a)=\alpha + \beta_1 a1 + \ldots + \beta j a_j + \varepsilon$$

Challenge:

Characteristics to analyze relevance and feasibility :

- Parcel size (cadaster)
- Land suitability (DGADR)
- Irrigation perimeters (DGADR)
- Easements and public utility restrictions (SRUP - CRUS, DGT)
- Urban vs Rural environment (TIPAU, INE)
- Existence and/or proximity of built/residential structures
- Distance to the nearest municipal hall (locations and road network)
- Ease of access (locations and road network)
- …

Objetives

- **Definition of the landscape characterization model and of other parameters for the evaluation formula by the year end of 2023**

- **Selection of supporting georeferenced data, as well as a draft proposal for new legislation by the year end of 2023**

- **Operationalization of the final version of the information system that supports the simplified evaluation of rustic property by the year end of 2025**

- **Completion of the general assessment of rural (georeferenced) properties by the year end of 2026**

Tools available

Web based GIS application

- **Present:**
  - visualization of land suitability (DGADR' Land suitability) and other georeferenced parameters.
  - visualization of some cadastral data
  - calculations of georeferenced land suitability values for each property (DGADR' Land suitability)
- **Shortcomings:**
  - interoperability with cadastral information systems (SICS, CGPR, SiNErGIC)
  - replacement of land suitability cartography (DGADR) and completion of other parameters cartography
  - calculations of parameter values for each property
  - ...

IMT-AT alphanumeric data on property sales

- **Shortcomings:**
  - Selection of statistical relevant data
  - Georeferencing data of property sales
  - …

2. Project Context

Project Overview

- **DLV1:** Kick-off and Inception Report.
- **DLV2:** Assessment Report with International Good Practices on Valuation Models.
- **DLV3:** New Valuation Model and Technical Specifications for Documentation of the Model.
- **DLV4:** Capacity Building (Training and User Guide) in use of the Valuation Model.
- **DLV5:** Final Report and Closure of the Project.

Project Summary

THE PROBLEM: AN OBSOLETE SYSTEM, BASED ON WRONG INCENTIVES

The Municipal Property Tax over the Rural Land in Portugal (hereafter Rural IMI):

- uses a **technology with two Millenniums**,
- is extremely **incomplete**,
- produces the **wrong incentives** when it comes to land abandonment, usage or productivity.

TEAM'S APPROACH AND METHODOLOGY:

The **taxable value of land** should be **calculated** according to the **potential income of a property**, if the latter is being **efficiently** used. Nevertheless, other equity considerations must be carried out: an **equitable Valuation Model** should have into account **fiscal justice – linkage** between **land and income taxation**.

GOAL:

Contribute to an institutional **tax system reform**, based on a Pilot Valuation Model, that will **address owner incentives to generate innovative dynamics**: push efficient rural land use and management, avoid the widespread "*ghost*" landownership and minimize the risk and severity of wildfires in Portugal.

3. Presentation of Deliverable

2 (Assessment Report with International Good Practices on Valuation Models)

Overview of Dlv2: Assessment Report with International Good Practices on Valuation Models

- **OBJECTIVES:** Assess on the Best Practices for Valuation Models for Rural Properties, to provide smart recommendations for Portugal.

- **TASKS:**

T2.1: Identification of Market and Administrative Failures in mainland Portugal towards a better Regulatory Framework.

T2.2: Learning from Experience: In-depth Analysis of Good Practices of Rural Land Valuation.

T2.3: Workshop on International Good Practices and Examples Aligned with Portugal's Needs.

T2.4: Summary of Pros and Cons of the Land Valuation Approaches Analysed.

Introduction | The Problem

- The current land valuation system in **Portugal is based on cadastral value**, which fails to consider factors like merit, investment, architecture, and landscape configuration that contribute to property value.

- The country **lacks an updated and centralized cadastre**, leading to fragmented information produced by multiple entities without coordination. Rural property valuation is particularly outdated, **and a significant portion of the territory remains unregistered.**

- Land taxation for rural properties is determined based on the land's yield and factors such as cultivation income and operating costs. However, the absence of a comprehensive cadastre hinders accurate identification of taxpayers and determination of taxable amounts.

Introduction | The Problem

- The **current method disproportionately burdens well-developed properties, discouraging agricultural and forestry activities while favoring non-exploitative landholders.**
- **This disincentive model leads to neglect, abandonment, and poor conservation** of rural properties. The lack of charges for non-availability of land **reduces its potential for income generation**.
- A **much-needed review** of rural land valuation and updating of the cadastre and land registry in Portugal would have a significant positive impact on land markets and facilitate appropriate land use in the public interest and for landowners.

International Practices

Overview | Europe

Country	Main Valuation Method(s)
Spain	Cadastral Valuation Approach (general rule) Declared value, tax value or market value/deed value (Rustic or rural properties) *Valor de referencia catastral*
Italy	Stated value approach / Cadastral Valuation Approach (Hybrid) *Rendita catastale*
Sweden	Market Value Approach / Cadastral Valuation System (Hybrid) *Fastighetsvärdering*
Belgium	Rental value approach / Cadastral Valuation System (Hybrid) *Kadastraal Inkomen*

Overview | Europe

Country	Main Valuation Method(s)
Cyprus	Market value approach
Greece	Market value approach/ Unit approach (Hybrid)
Germany	Market Value Approach / Cadastral Valuation approach (Hybrid) *Bodenrichtwert*
France	Market Value Approach / Cadastral Valuation approach (Hybrid) *Valeur Locative Cadastrale*
United Kingdom	Depending on the location and purpose different methods may apply
The Netherlands	Market Value Approach

**This table lacks comprehensive summarization and consideration of the various complexities, schemes, methods, and sub-methods employed by each jurisdiction. To gain a comprehensive understanding, it is recommended to thoroughly review the Assessment Report along with the official sources referenced within.*

Overview | Europe

- Generally speaking, **European models still seem to obey to a static valuation logic**, with countries such as France or Spain basing their models on an arguably outdated **registry rental value or cadastral reference value/deed value** and countries such as the Netherlands and Germany making use of **price-based formulas** t**o calculate an approximate market value** on which to base their valuation models.

- While certain elements related **to productivity or potential income may be incorporated** in some instances, **none of these approaches adhere to a framework of advancing economic efficiency and growth.**

- These models have, however, the merit of simplicity and an underlying market economy logic, which is to be welcomed.

OVERVIEW | UNITED STATES

State	Main Valuation Method(s)
Texas	(Hybrid)
Nevada	Market value approach-sales/cost approach (submethod) (Hybrid) *Taxable value method*
New York	Market value approach-sales/cost approach (submethod) / Income Approach to Value (Hybrid)
Virginia	Market value approach/Income Approach to Value *but Virginia's valuation method takes into consideration productivity elements associated with the land. This highlights the multifaceted nature of their approach, which combines different valuation techniques and considers productivity factors when assessing land value.* (Hybrid)

Overview | United States

State	Main Valuation Method(s)
Oregon	Market value approach, *but assessors can resort to cost, sales comparison or income methods subsidiary, to determine the market value* (Hybrid)
California	Market value approach, *but each county can resort to various submethods to determine the market value* (Hybrid)

**This table lacks comprehensive summarization and consideration of the various complexities, schemes, methods, and sub-methods employed by each jurisdiction. To gain a comprehensive understanding, it is recommended to thoroughly review the Assessment Report along with the official sources referenced within.*

Overview | United States

- The United States seem to offer a much **more heterogeneous picture**, with the various states having a **customized model, often using several indirect-methods simultaneously** to create hybrid solutions.

- This comes closer to something similar to our proposed approach which will requires a tailor-made hybrid system as well.

- Nevertheless, it is important to note that the majority of American models **still prioritize cost or sales-based approaches and rely on private assessments or appraisals**, which will not be compatible with our proposed land valuation method.

Overview | United States

- Assessors and private entities play a significant role in property valuation in the United States:
  ⇒ **Unharmonized system:** Despite following a market value approach, assessors freely use several sub-methods such as cost, income or sales comparison approach;

- Most of the systems analysed (New York, Texas, California) have an element of sales comparison but there is a problem of **lack of comparable rural properties for valuation purposes:**

  - **Properties** can be **spread out over large distances**, and lack comparability;

  - **Properties** can **vary widely in terms of size, shape, topography, soil type**, and other factors, making it difficult to apply a standard valuation method (insight as to why methods and formulas may vary depending on the assessor and county);

- The **most complex and developed valuation systems** (*e.g.,* Virginia,Texas) regarding the range of valuation criteria, however, the market value-based methods still allows for **well-maintained properties** to have **aggravated taxation,** in comparison to abandoned properties.

Overview | Australia

State	Main Valuation Method(s)
South Australia	Market value approach using an unimproved value referencial
Northern Territory	No land tax
Queensland	Market value approach using an unimproved value referencial
Tasmania	Market value approach using an unimproved value referencial
Western Australia	Market value approach using an unimproved value referencial, *through a mass appraisal approach.*
New South Wales	Market value approach using an unimproved value referencial
Victoria	Market value approach using an unimproved value referencial

Overview | Australia

- In Australia, the standard is to use some sort of **unimproved value method** intended to reflect the value of the land in its natural, undisturbed condition, which albeit interesting, does not take into consideration the productive ability of the land, nor the production effort put into it, in a rather elementary approach.

- The explanation for such a model may be found on the land typology and intrinsic richness of the land in a country like Australia, which is hardly comparable to European standards in terms of population density, environmental or natural value and land fertility.

Final Remarks | A New Valuation Model for Portugal: The potential income value

- The new approach should **incentivize efficient land use and discourage abandonment**. Unlike other assets, land should be viewed as a common resource that needs to be exploited efficiently. Therefore, land valuation should prioritize **increasing economic efficiency.**

- To achieve this, a major step up is required in terms of cadastral systematization of lands.

- The value of the land should be calculated based on its **potential income value, considering the primary use rather than the current use and crops.**

- Non-productive land would not be affected by this model, focusing only on land with productive potential that is not adequately utilized.

- **Factors such as agricultural area distribution and forest species distribution will be used to map and categorize land according to its average production value.**

Final Remarks | A New Valuation Model for Portugal: The potential income value

- **The assessment factors used for value assessment coefficient calculation will determine not only the income but also the potential productive value of the land. The coefficient will consider the income pattern associated with the land's typical occupation.**

- **The proposed model ensures that properties with similar characteristics but differing conditions of use and maintenance have the same value for taxable values.** It aims to discourage speculative practices and incentivize investment and production.

- Implementing an effective land valuation system is contingent upon major steps in cadastral systematization.

- Overcoming such obstacles will be a key focus in the subsequent stages of the project to ensure a truly efficient valuation system.

Discussion
DLV2

This project is carried out with funding by the European Union via the Technical Support Instrument and in cooperation with the Directorate General for Structural Reform Support of the European Commission

4. Presentation of Deliverable

3 (New Valuation Model and Technical Specifications for Documentation of the Model)

Overview of Dlv3: New Valuation Model and Technical Specifications for Documentation of the Model

- **OBJECTIVES:** Definition of a New Valuation Model and Technical Specifications for Documentation of the Model.

- **TASKS:**

T3.1: Characterization of the Farming and Forestry Systems in the Pilot Areas and assessment of Productive Potential.

T3.2: Development of the Appraisal Model: estimation and testing.

T3.3: Summary of the Main Results.

T3.4: Technical Report of the Valuation Model.

DELIVERABLE 3 | METHODOLOGY PROPOSED

Qualitative Component

Soil Occupation

COS – Forest Inventory → Land Systems defined by OTE *(to be developed by the technical team)*

COS – Forest Inventory — *Gives us* — **What is produced and where**

Land Systems defined by OTE — *Gives us* — **Culture Pattern**

Quantitative Component

Productivity

INE – Declaration of production disaggregated according to the exploration unit

ICNF – Declaration of production disaggregated according to the forestry inventory

Production Value

GPP – Agricultural
EU Project - Forestry

Achievable Value = Production Quantity * Production Value

Deliverable 3 | Data Requests

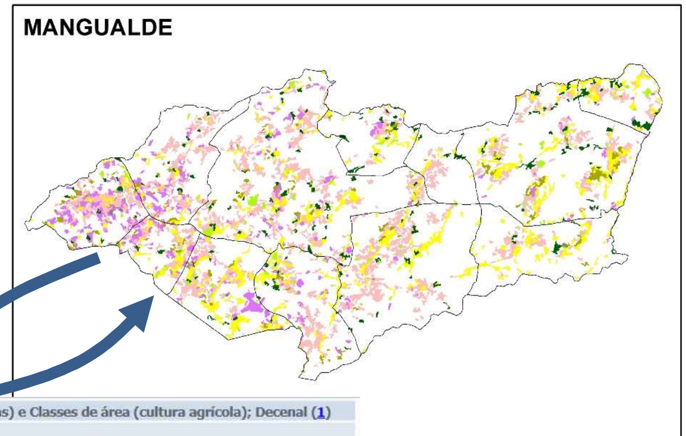
Main Goal	Data Needed	Supplier Entity
Land Occupation Qualification	Land Cover Map (COS)	DGT (Mapping Agency)
	National Forest Inventory	ICNF (Forestry Agency)
	Land Systems (OTE)	INE (Statistics Portugal)
Production Quantification	Agrarian Census of Holdings	INE (Statistics Portugal)
	Average profitability of forest production	ISA (School of Agriculture of the University of Lisbon)
Production Valuation	Agriculture Income (RICA)	GPP (Design, Policy and General Administration Office of the Ministry of Agriculture)
	Forest Production Value	Consortium

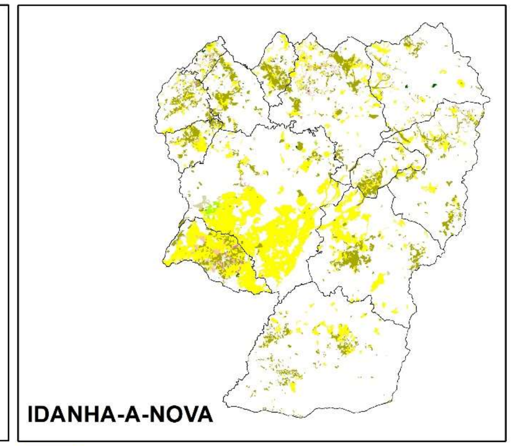
DELIVERABLE 3 | METHODOLOGY PROPOSED

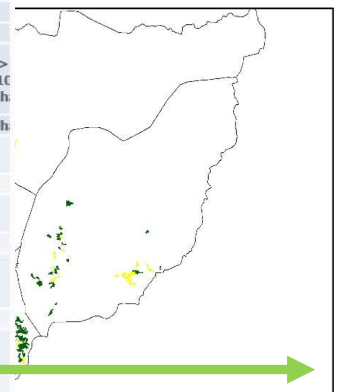
Qualitative Component

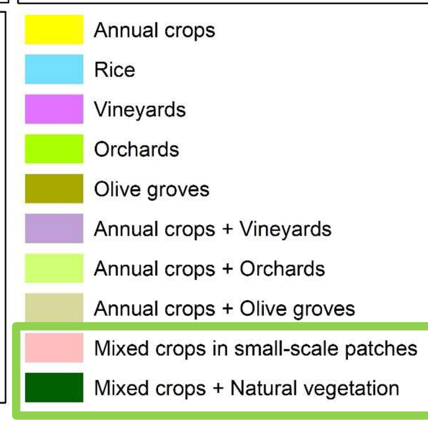
Why we need to combine different datasets?

Spatial Precision/Accuracy









Crops diversity

Superfície das culturas temporárias (ha) por Localização geográfica (NUTS - 2013), Tipo (culturas temporárias) e Classes de área (cultura agrícola); Decenal (1)

Tipo (culturas temporárias): Cereais para grão — Classes de área (cultura agrícola)

Localização geográfica (NUTS - 2013)	Tota	<0,5 ha	0,5 - <1 ha	1 - <2 ha	2 - <5 ha	5 - <20 ha	20 - <50 ha	50 - <100 ha	>= 100 ha
	ha	ha	ha	ha	ha	ha	ha	ha	ha
Abrunhosa-a-Velha		1	1	-	-	-	-	-	-
Alcafache		3	4	1	-	-	-	-	-
Cunha Baixa	1	4	4	1	-	-	-	-	-
Espinho	1	4	3	3	6	-	-	-	-
Fornos de Maceira Dão	1	5	6	5	-	-	-	-	-
Freixiosa		1	3	1	2	-	-	-	-
Quintela de Azurara	1	5	3	-	2	-	-	-	-
São João da Fresta	4	2	4	2	23	12	-	-	-

Tipo (culturas temporárias): Leguminosas secas para grão — Classes de área (cultura agrícola)

Localização geográfica (NUTS - 2013)	Total	<0,5 ha	0,5 - <1 ha	1 - <2 ha	2 - <5 ha	5 - <20 ha	20 - <50 ha	50 - <100 ha	>= 100 ha
	ha	ha	ha	ha	ha	ha	ha	ha	ha
Abrunhosa-a-Velha	1	1	-	-	-	-	-	-	-
Alcafache	1	0	-	1	-	-	-	-	-
Cunha Baixa	0	0	-	-	-	-	-	-	-
Espinho	0	0	-	-	-	-	-	-	-
Fornos de Maceira Dão	1	1	-	-	-	-	-	-	-
Freixiosa	-	-	-	-	-	-	-	-	-
Quintela de Azurara	1	1	-	-	-	-	-	-	-
São João da Fresta	1	0	1	-	-	-	-	-	-

Tipo (culturas temporárias): Culturas forrageiras — Classes de área (cultura agrícola)

Localização geográfica (NUTS - 2013)	Total	<0,5 ha	0,5 - <1 ha	1 - <2 ha	2 - <5 ha	5 - <20 ha	20 - <50 ha	50 - <100 ha	>= 100 ha
	ha	ha	ha	ha	ha	ha	ha	ha	ha
Abrunhosa-a-Velha	157	1	3	6	41	107	-	-	-
Alcafache	38	0	3	7	4	24	-	-	-
Cunha Baixa	30	0	-	5	12	12	-	-	-
Espinho	219	1	6	7	23	141	41	-	-
Fornos de Maceira Dão	158	2	2	4	17	57	-	76	-
Freixiosa	6	-	-	-	-	6	-	-	-
Quintela de Azurara	3	0	1	2	-	-	-	-	-
São João da Fresta	61	-	1	5	8	47	-	-	-

Tipo (culturas temporárias): Culturas hortícolas — Classes de área (cultura agrícola)

Localização geográfica (NUTS - 2013)	Total	<0,5 ha	0,5 - <1 ha	1 - <2 ha	2 - <5 ha	5 - <20 ha	20 - <50 ha	50 - <100 ha	> 10
	ha	ha	ha	ha	ha	ha	ha	ha	h
Abrunhosa-a-Velha	-	-	-	-	-	-	-	-	
Alcafache	2	-	-	2	-	-	-	-	
Cunha Baixa	-	-	-	-	-	-	-	-	
Espinho	0	0	-	-	-	-	-	-	
Fornos de Maceira Dão	3	0	3	-	-	-	-	-	
Freixiosa	0	0	-	-	-	-	-	-	
Quintela de Azurara	1	0	1	-	-	-	-	-	
São João da Fresta	-	-	-	-	-	-	-	-	

DELIVERABLE 3 | METHODOLOGY PROPOSED

Qualitative Component

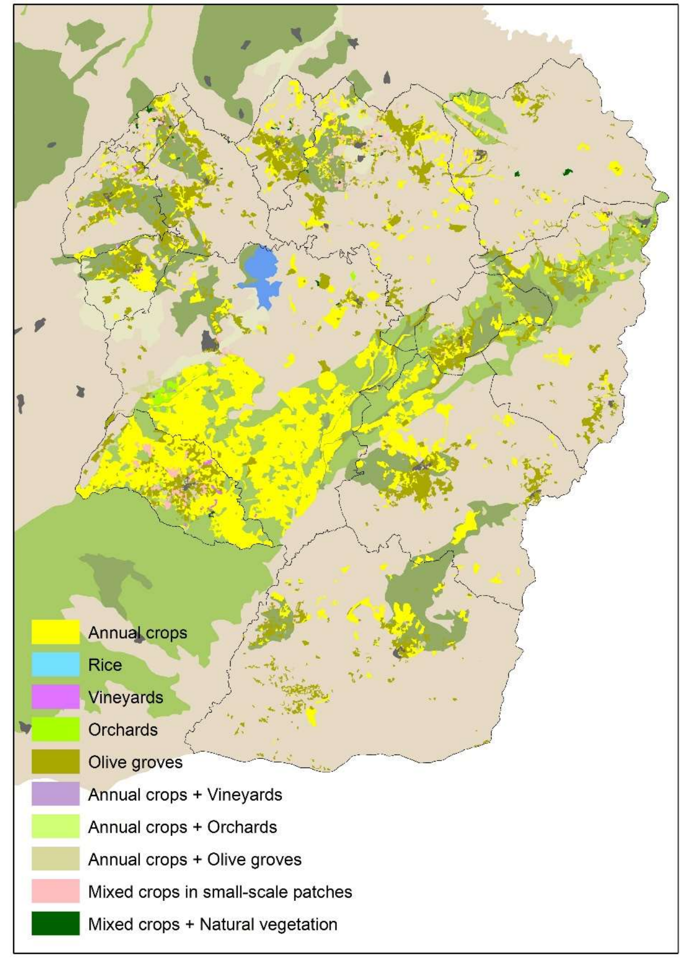
Why we need to combine different datasets?

Variability between regions

Variability between crops

Unidade: EUR

Produto	Norte	Centro	Lisboa	Alentejo	Algarve	Açores	Madeira
Trigo Mole	353	443	509	431	313	353	4 608
Trigo Duro	353	494	504	505	400	353	353
Centeio	315	237	315	315	181	315	315
Cevada	185	462	553	415	258	185	185
Aveia	203	232	333	281	238	203	203
Milho grão	1 688	1 742	2 408	2 363	1 639	1 688	1 688
Arroz	1 563	1 563	1 778	1 838	1 326	a)	a)
Outros Cereais para Grão	292	318	451	319	292	292	292



Deliverable 3 | Spatial Analysis Undertaken

A variety of spatial analysis between the available datasets to identify the spatial relations and trends in data has been made:

(1) Spatial intersection between the administrative division and the Agriculture Suitability Map for the four pilot areas allowed us to characterize each area in terms of its soil suitability by calculating the percentage of each type of suitability present in each parish and identify the most representative.

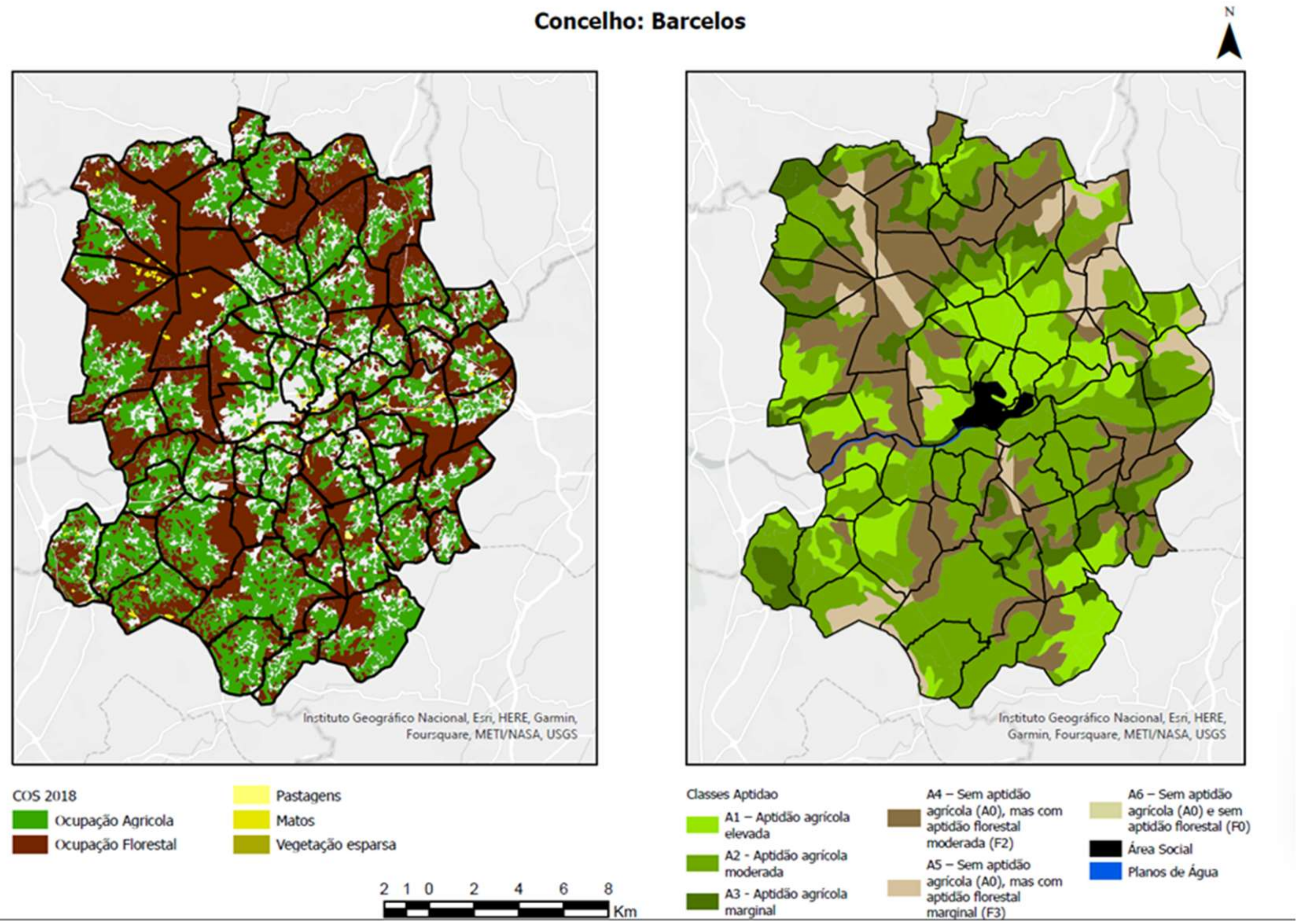
(2) Spatial intersection between the Land Cover Map (COS) and the Agriculture Suitability Map allowed us to characterize each area in terms of its soil suitability by calculating the percentage of each type of suitability present in each polygon and identify the most representative.

- The **advantage of using COS** is the **accuracy of the results**. The dominant suitability is far more representative at this level when compared to the parish level.
- Could the Agriculture Suitability Map be applicable to smaller parcels, and this would enable to establish a base for valuation that is closer to reality than the administrative boundaries, thus providing a more transparent and coherent valuation.

Deliverable 3 | Spatial Analysis Undertaken

Confronting parishes with Land Cover and Agriculture Suitability: Side-by-side Map

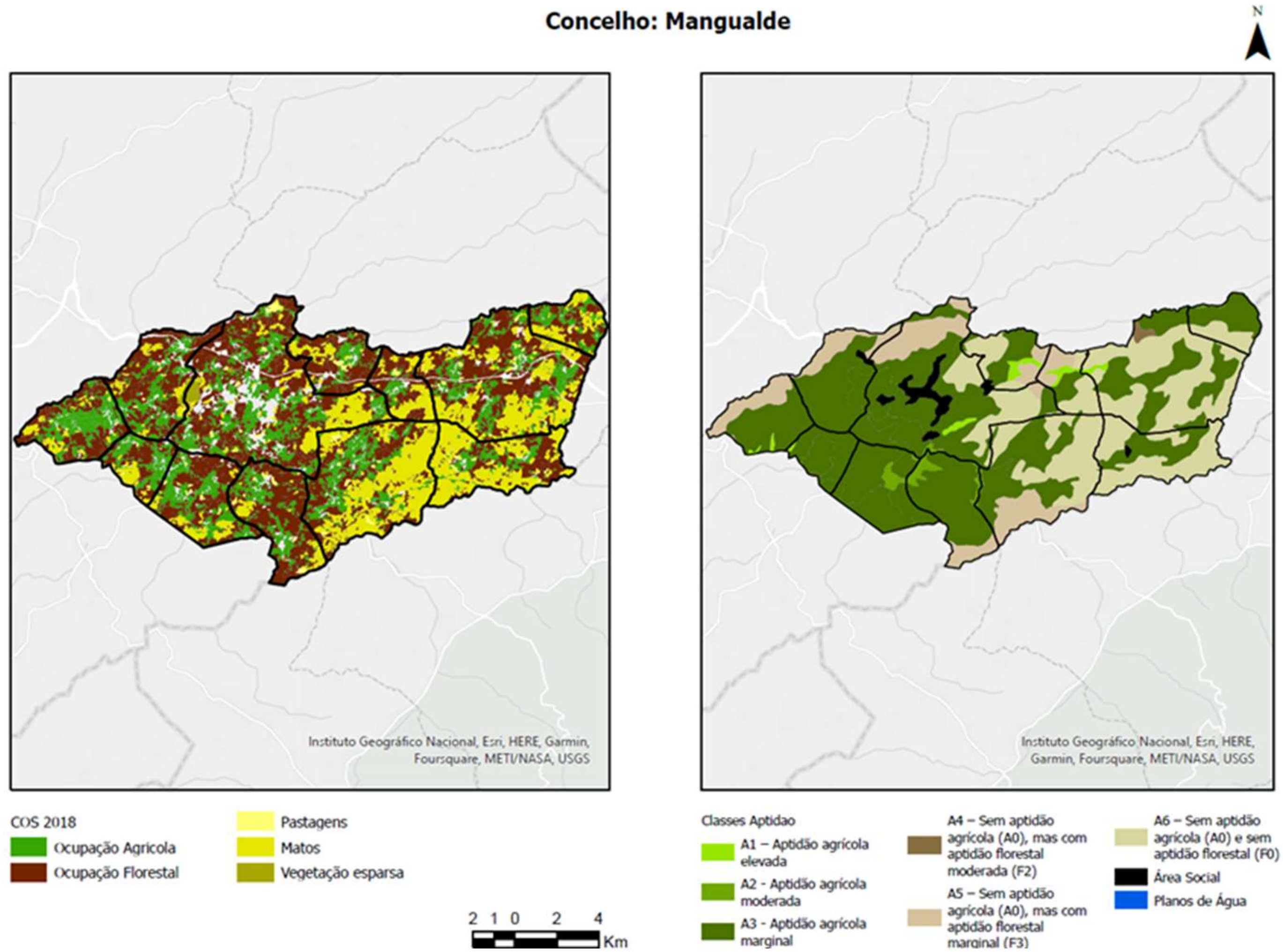
- In **Barcelos**, we can find a direct relation between agriculture coverage (LCM) and agriculture suitability (ASM).



Deliverable 3 | Spatial Analysis Undertaken

Confronting parishes with Land Cover and Agriculture Suitability: Side-by-side Map

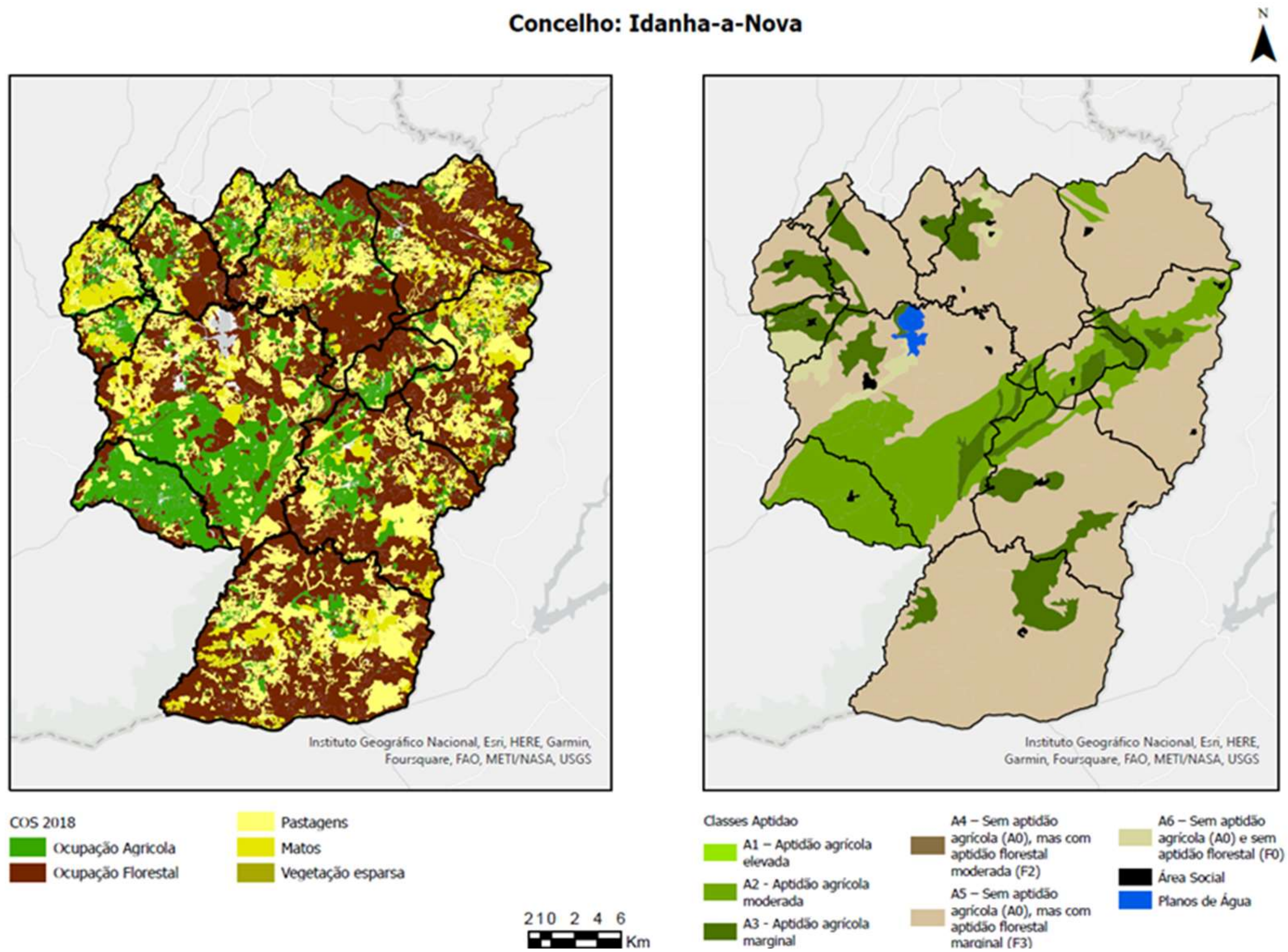
- As opposed to the other three pilot areas, where one can find differences, in **Mangualde** one finds:
    - Forest coverage in areas with agriculture suitability as well as in areas with no forest suitability (ASM).



DELIVERABLE 3 | SPATIAL ANALYSIS UNDERTAKEN

Confronting parishes with Land Cover and Agriculture Suitability: Side-by-side Map

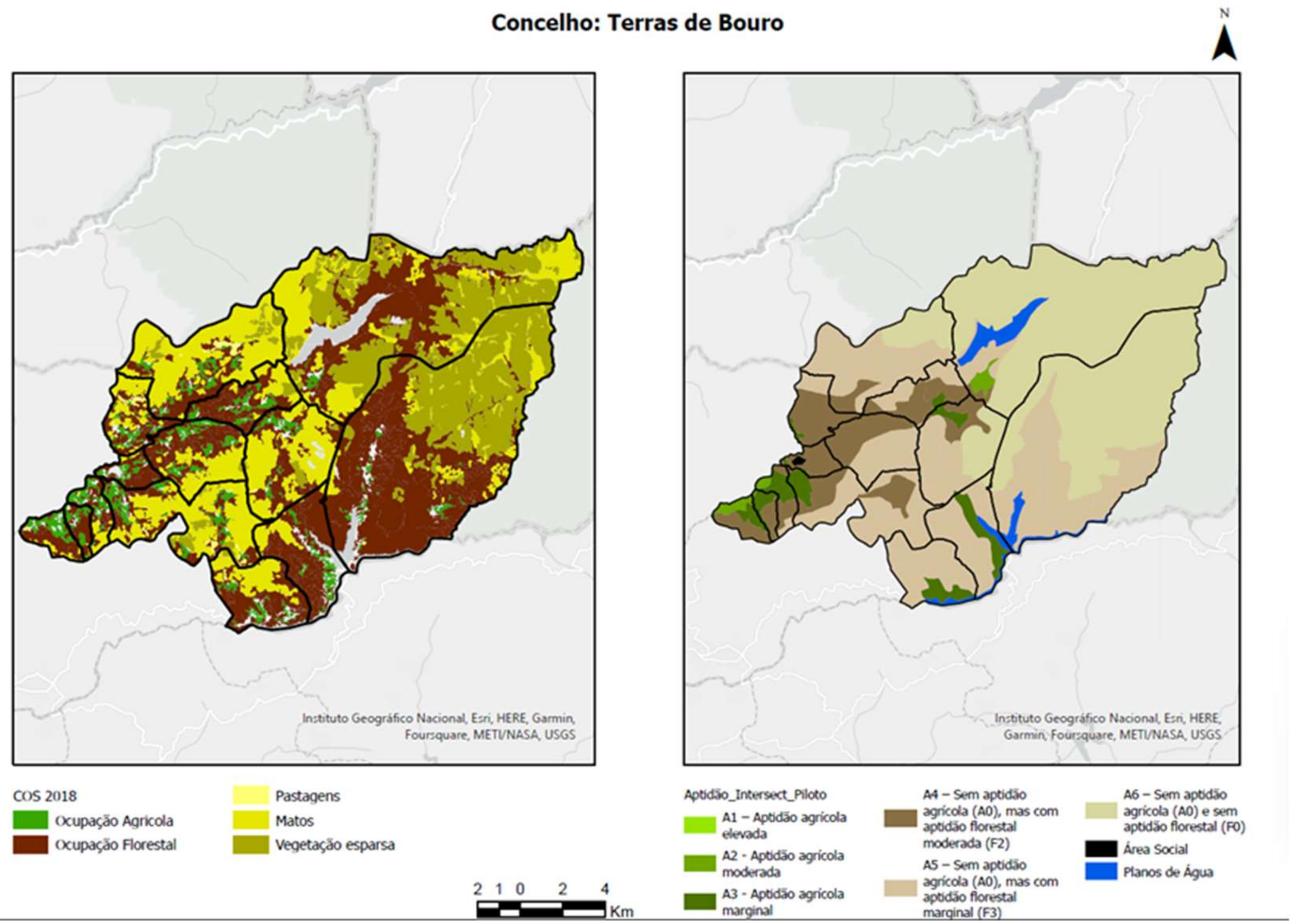
- As opposed to the other three pilot areas, where one can find differences, in **Idanha-a-Nova** one finds:
    - forest coverage (LCM) in areas with marginal or no forest suitability (ASM).



DELIVERABLE 3 | SPATIAL ANALYSIS UNDERTAKEN

Confronting parishes with Land Cover and Agriculture Suitability: Side-by-side Map

- As opposed to the other three pilot areas, where one can find differences, in **Terras de Bouro** one finds:
  - agriculture coverage (LCM) in areas with no agriculture suitability (ASM).



Deliverable 3 | Spatial Analysis Undertaken

These differences might be related to several factors:

- **Land Aptitude Map's** small scale leading to missing smaller areas with greater aptitude (for both Agriculture or Forestry) or **other factors** might explain why there is use where there is no aptitude.
    - **Understanding** this, requires finding the **correlating variables**.
    - The Project Team is currently waiting for complementary datasets in these areas, namely **Agriculture Income**.

Spatial analysis contributes to identify and understand cause/effect relation.

Deliverable 3 | Spatial Analysis Undertaken

Geographically Weighted Regression (GWR), is a local form of linear regression used to **model spatially varying relationships:**

- Make use of this technique to understand the relation **between income, occupancy, suitability and the available datasets** that might explain the classification.

- **Finding correlated variables** will enable to establish a base from which to **feed and find tune a model** to calculate a land valuation.

Deliverable 3 | Spatial Analysis Undertaken

GWR can be used for a **variety of applications**:

- Is the relationship **between agriculture/forest production and income consistent across the pilot areas?**
- Do certain **occurrences increase with proximity to urban areas**?
- What are the **key variables** that explain **high forest productivity frequency**?
- Which **occupation** should be encouraged to **foster rural land development**?
- Where are the areas in **which we find higher production**? What characteristics seem to be associated? Where is each characteristic most important?
- Are the factors **influencing productivity rate consistent across** the **pilot areas**?

Using **location analytics** one can enrich the data **made available and uncover trends** and patterns. This shall enable to **detect errors and outliers**, refining the valuation model to achieve better results.

Deliverable 3

Deliverable 3 will unfold into three fundamental phases:

1. Identification and distribution of land systems (at parish level)

- Phase 1 will allow the finding of homogeneous areas that share the same agricultural and forestry land use systems.

2. Determination of the standard value of the reference units

- Phase 2 will reflect income based on the value in €/ha and in the proportion of each component of each land system.

It will be linked to the Official Land Cover Map classes, which allows for the estimation of the global value in the spatial reference units.

3. Modelling of the global standard value for each land system as a function of available biophysical/landscape/territorial data

- Phase 3 is based on the modeling of the distribution of global value based on available data *(e.g., land suitability, Natura 2000 Network, bioclimatic data),* allowing its determination at different scales and contexts.

DELIVERABLE 3

1. Identification and distribution of land systems (at parish level)

The suggested identification is based on model-based cluster analysis, implying variable selection and determination of the optimal number of clusters.

A: Agriculture

Initial set of variables → (% of) Utilized Agricultural Area by technical-economic guidance OTE →

R Packages/functions/steps:

- *clustvarsel:* variable selection
- *statmatch:* Gower's distance (dissimilarity coefficient)
- *corrplot:* distance plot
- *mclust:* model-based clustering + BIC
- *fpc:* determining the optimal number of clusters
- Model parameters will be fitted through maximum likelihood estimation using an expectation-maximization algorithm
- *factoextra:* cluster plot

Hierarchy	Categories of farm and forest land use systems	Abbreviation
1	Specialized farm systems – Vegetation production	EE_PV
1.1	Annual crops	EE_CA
1.1.1	Cereal, oilseeds and protein crops	EE_COP
1.1.2	Other anual crops	EE_OCA
1.2	Intensive horticulture and floriculture	EE_HIF
1.2.1	Intensive horticulture and floriculture in greenhouse/low shelter	EE_HIFEAB
1.2.2	Intensive horticulture and outdoor floriculture	EE_HOIFAL
1.2.3	Other intensive vegetables, flowers and ornamental plants	EE_OHI
1.2	Permanent crops	EE_CP
1.2.1	Vineyards	EE_VIN
1.2.2	Fresh fruits and citrus	EE_FF
1.2.3	Olive groves	EE_OL
1.2.4	Other permanente crops	EE_DCP
2	Specialized farms - animal products	EE_PA
2.1	Herbivores	EE_HER
2.1.1	Dairy cattle	EE_BL
2.1.2	Beef cattle	EE_BC
2.1.3	Dairy and beef cattle	EE_BLC
2.1.4	Sheep, goats and other herbivores	EE_OCDH
2.2	Granivores	EE_GRA
2.2.1	Swine	EE_SUI
2.2.2	Poultry	EE_AVE
2.2.3	Other granivores	EE_DGRA
3	Mixed-type farms	EM
3.1	Mixed cultivars	EM_POL
3.2	Mixed-type livestock systems	EM_POLP
3.2.1	Mixed-type livestock systems with herbivores	EM_POLPH
3.2.2	Mixed-type livestock systems with granivores	EM_POLPG
3.3	Mixed crops and livestock	EM_CGG
3.3.1	Mixed arable crops and herbivores	EM_CAHER
3.3.2	Mixed with various combinations of crops and livestock	EM_DCDG

Source: INE

DELIVERABLE 3

1. Identification and distribution of land systems (at parish level)

B: Forest

Initial set of variables → Distribution of the species included in the Official Land Cover Maps →

Hierarchy	Categories of farm and forest land use systems	Abbreviation
4	Forest stands	PF
4.1	Silvopastoral/agroforestry systems with cork and holm oaks	PF_CHO
4.2	Other oaks	PF_OO
4.3	Castanea sativa	PF_CAS
4.4	Other broadleaved trees	PF_OF
4.5	Eucalyptus	PF_EUC
4.6	Maritime pine	PF_PB
4.7	Stone pine	PF_PM
4.8	Other conifers	PF_OR

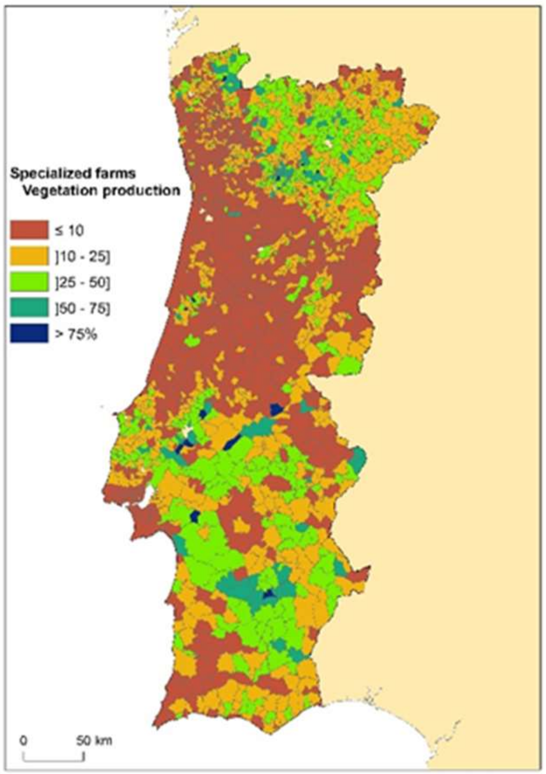
Source: INE

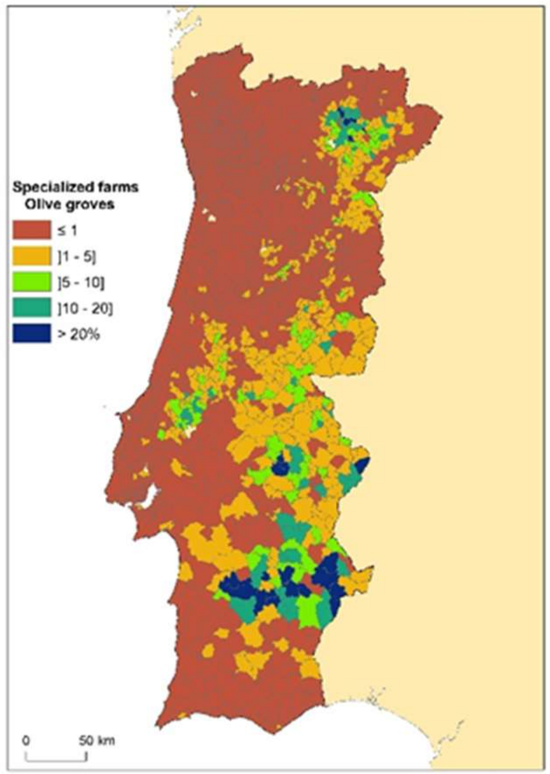
R Packages/functions/steps:

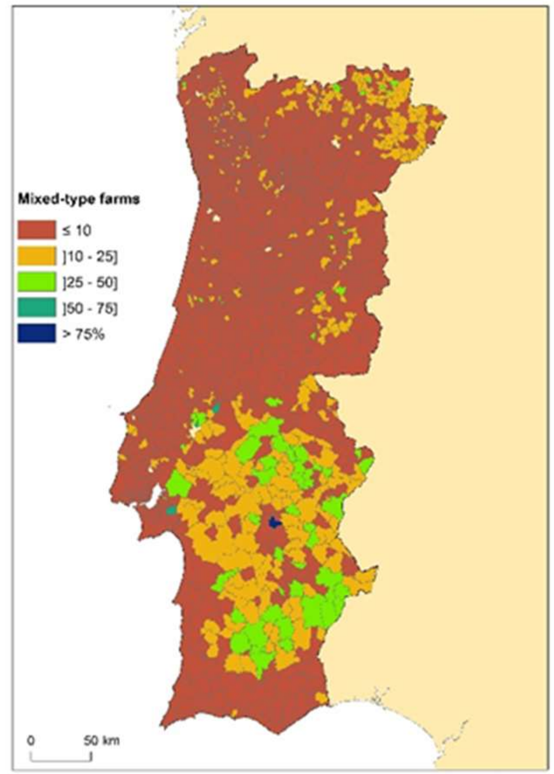
- *clustvarsel:* variable selection
- *statmatch:* Gower's distance (dissimilarity coefficient)
- *corrplot:* distance plot
- *mclust:* model-based clustering + BIC
- *fpc:* determining the optimal number of clusters
- Model parameters will be fitted through maximum likelihood estimation using an expectation-maximization algorithm
- *factoextra:* cluster plot

Deliverable 3

1. Identification and distribution of land systems (at parish level)







DELIVERABLE 3

2. Determination of the standard value of the reference units

A: Agricultural areas

- Determination is based on the **RICA-GPP database**, which provides information on income and the economy of agricultural holdings.
- The reference values will be provided by GPP (**€/ha** per parish per technical-economic guidance OTE)

⇒ The final value per unit area will express the proportion of the different components of the land systems, and the global value based on the linkage between the components of each land system and the related land cover types from the Official Land Cover Map.

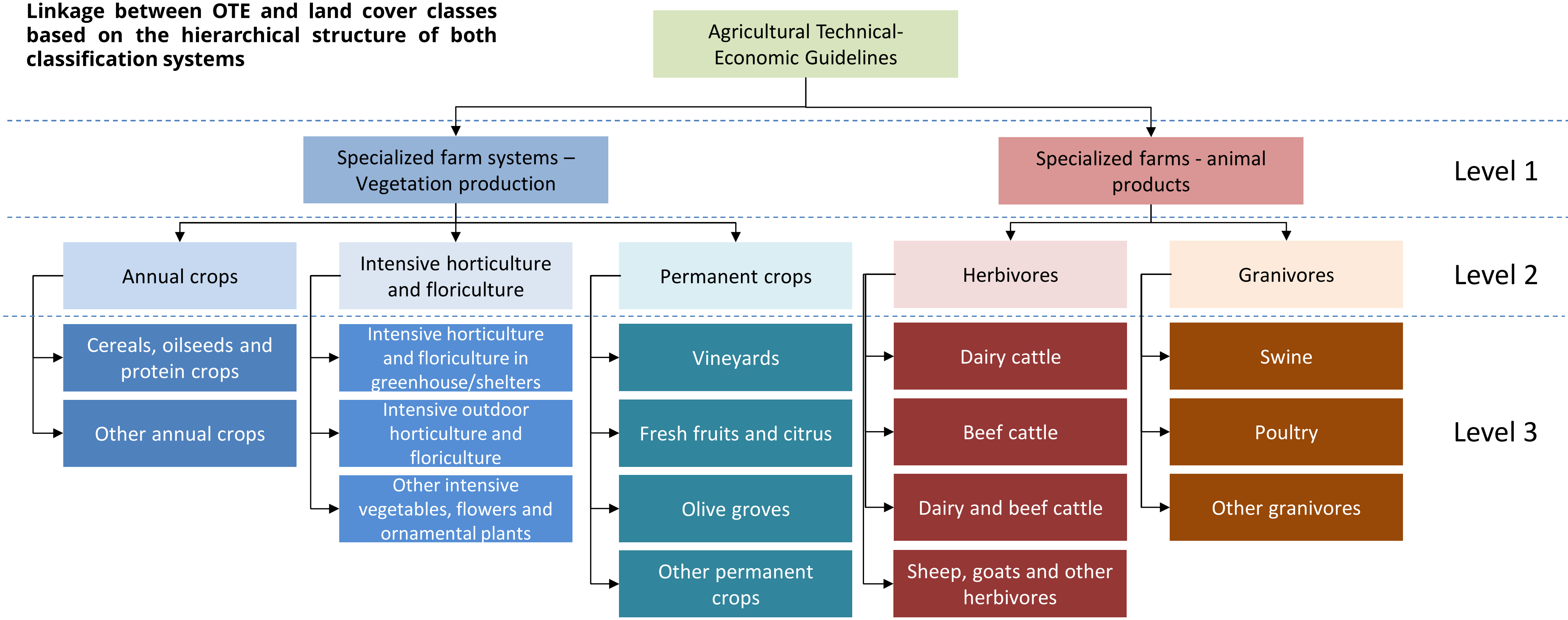
B: Forest areas

- Determination is based on annual growth (**m3/ha/year**)
- ICNF suggested the use of the **Paterson Index** I as an indicator for the productive potential for woody material – which is presented in the next slide

DELIVERABLE 3

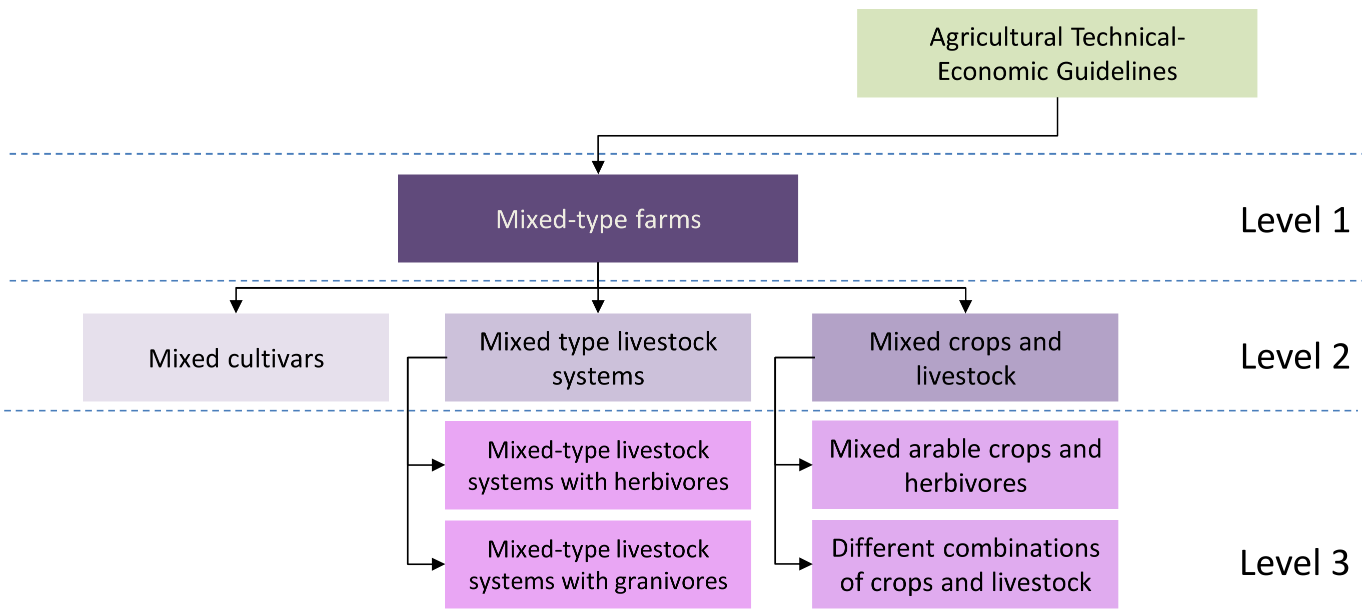
2. Determination of the standard value of the reference units

Linkage between OTE and land cover classes based on the hierarchical structure of both classification systems



DELIVERABLE 3

2. Determination of the standard value of the reference units



DELIVERABLE 3

2. Determination of the standard value of the reference units

$$I = \frac{T_v}{T_a} . P . E . \frac{G}{12} . \frac{1}{100}$$

HR-VPP products of the Copernicus Land Monitoring Service

1961-1990 historical climate data based on the CRU-TS 4.05 dataset (Harris et al, 2020, Scientific data 7: 109)

Operational solar radiation data set provided by the Climate Monitoring Satellite Application Facility

The values of I (CVP) thus determined are translated into average annual increments through the expression:

$$y = 5.2 \times \log x - 7.25$$

Where x is the value of I (CVP) and y the corresponding value in m^3/ha/year

$\boldsymbol{I}$**:** Paterson Index

$\boldsymbol{T_v}$**:** Average temperature of the warmest month (*ºC*)

$\boldsymbol{T_a}$**:** Difference between T_v and the average temperature of the coldest month (*ºC*)

$\boldsymbol{P}$**:** Average annual precipitation (*mm*)

$\boldsymbol{G}$**:** Duration in months of the vegetation's active period

$\boldsymbol{E}$**:** Quotient between the global radiations at the pole and at the station considered (*%*)

DELIVERABLE 3

2. Determination of the standard value of the reference units

***I*:** Paterson Index

T_v: Average temperature of the warmest month (*ºC*)

T_a: Difference between T_v and the average temperature of the coldest month (*ºC*)

***P*:** Average annual precipitation (*mm*)

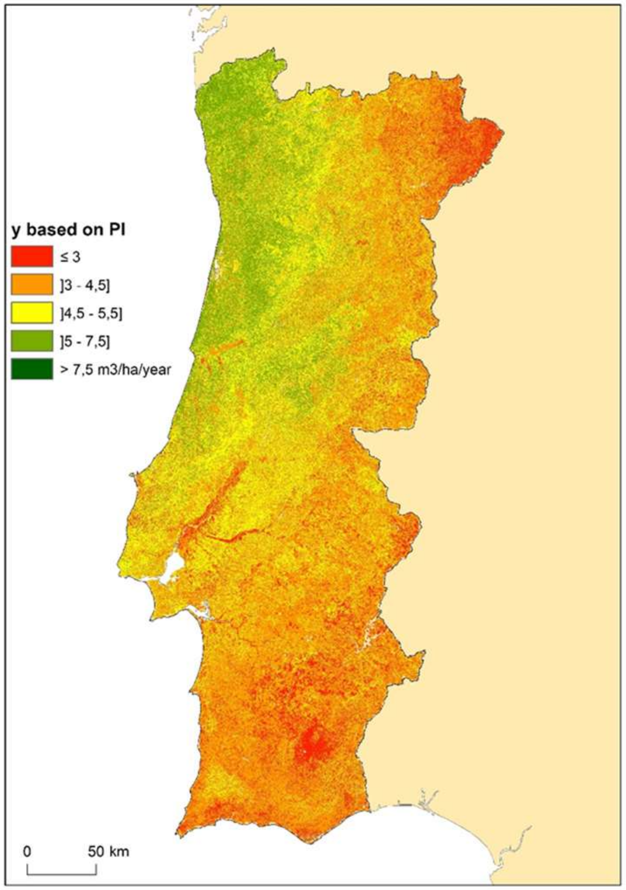
***G*:** Duration in months of the vegetation's active period

***E*:** Quotient between the global radiations at the pole and at the station considered (*%*)

- The values of I are determined by:

$$I = \frac{T_v}{T_a}.P.E.\frac{G}{12}.\frac{1}{100}$$

With I being translated into **average annual increments.**



Deliverable 3

3. Modelling of the global standard value for each land system as a function of available biophysical/landscape/territorial data

1. Compute profitability by parish

$$Profitability_i = f(COS_i, Culture\ Profitability\ )$$

2. Use variability between parishes to establish relationship between profitabilities, aptitudes, majorants and minorants

$$Profitability_i = \alpha + \beta_1 Aptitude_i + \beta_2 Majorants_i + \beta_3 Minorants_i + \varepsilon_i$$

3. Use this relationship to evalute rustic terrains (?) at sub-parish level through capitalization method

1. $Profitability_j = \alpha + \beta_1 Aptitude_i + \beta_2 Majorants_j + \beta_3 Minorants_j$
2. $\boldsymbol{VPT_j} = \sum_{t=1}^{+\infty} \beta_i^{t-1} profitability_{j,t} = \frac{\mathbf{Profitability_j}}{\mathbf{1-\beta}}, \ \beta = \frac{1}{1+r}$ where r is a social rate of interest

$$Aptitude_i = \sum_{i=1}^{A-1} \alpha_i A_i$$

$$Majorants_i = \sum_{i=1}^{N} \gamma_i M_i$$

$$Minorants_i = \sum_{i=1}^{n} \gamma_i m_i$$

$$i = parish_i$$

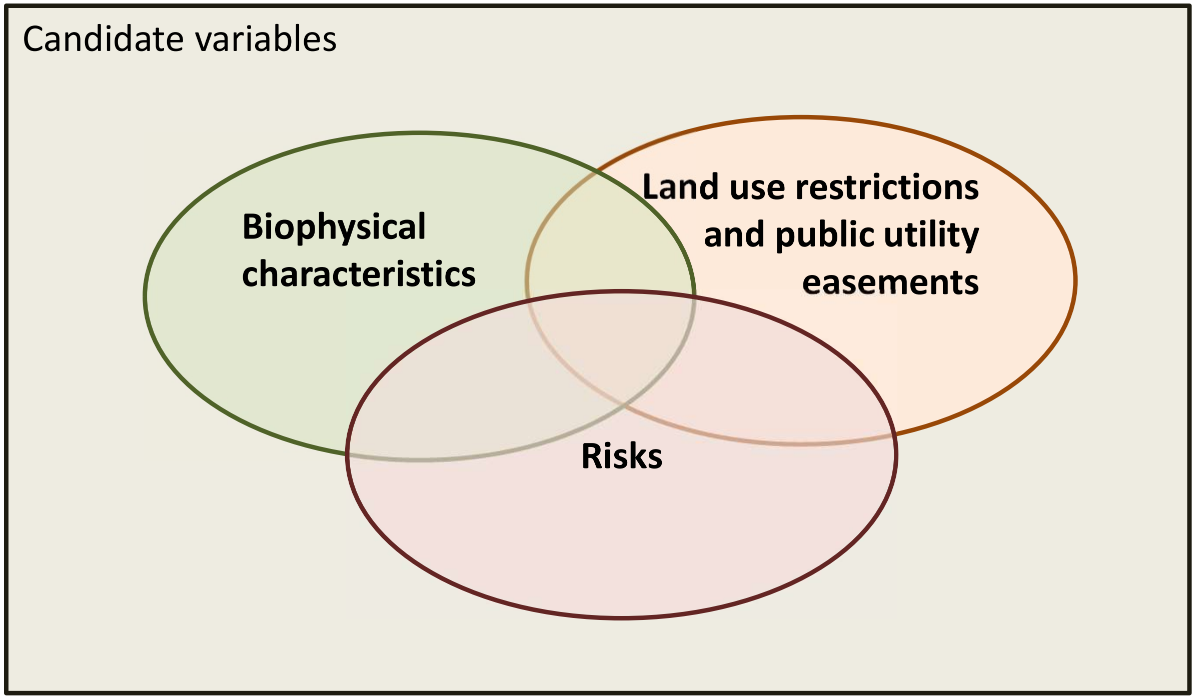
DELIVERABLE 3

3. Modelling of the global standard value for each land system as a function of available biophysical/landscape/territorial data

$$Y = a + bX_1 + cX_2 + \ldots + dX_n$$

- Biophysical characteristics: affecting primary productivity
- Land use restrictions and public utility easements: legal constraints to land use or land use intensity
- Risks (natural, socio-ecological): affecting agricultural and silvicultural activities

Main sources: ICNF, DGADR, DGT, EPIC-WEB GIS, ISA-UTL, JRC



DELIVERABLE 3

3. Modelling of the global standard value for each land system as a function of available biophysical/landscape/territorial data

$Y = a + bX_1 + cX_2 + ... + dX_n$

Biophysical characteristics

Land suitability maps (categorical variable)
- % of suitability categories

Morphometry (continuous variables; indicators derived from Digital Elevation Models)
- Elevation
- Slope Angle (Horn, Sharpnack & Akin, Fleming & Hoffer/Zevenbergen & Thorne)
- Slope Aspect (idem)
- Ruggedness (Dissection, TRI, VRM, Surface-Area Ratio, Surface Relief Ratio, Shannon Diversity Index)
- Curvature (longitudinal, profile, plan, tangential, cross-sectional, total, general, Bolstad)
- Slope Position
- Proxy of radiation exposure (e.g., Heat Load Index)
- Proxy of soil wetness (e.g., Compound Topography Index, Terrain Wetness Index)

Soil-based indicators (categorical variables)
- pH, soil thickness, soil parente materials

Deliverable 3

3. Modelling of the global standard value for each land system as a function of available biophysical/landscape/territorial data

$Y = a + bX_1 + cX_2 + \ldots + dX_n$

Biophysical characteristics

Bioclimatic indicators (continuous variables)

- Temperature: mean temperature of the coldest and warmest months of the year, annual positive temperature, mean maximum and minimum temperatures of the coldest month, simple and compensated thermicity indexes;
- Precipitation: positive precipitation, annual positive precipitation in dry and wet years;
- Ombrothermic index of the summer quarter plus the previous month, Shoulder ombrothermic index of the warmest bimonth of the summer quarter, ombrothermic index of the summer quarter, annual ombrothermic index, equivalent ombrothermic index in dry and wet years, ombrothermic index anomaly for dry and wet years;
- Simple continentality index;
- Aridity index.

Bioclimatic indicators (categorical variables)

- macrobioclimates, macrobioclimates and bioclimatic variants, bioclimates, macrobioclimates (highlighting vernal-aestival indices compensation), macrobioclimates (highlighting vernal-aestival indices compensation considering the annual ombrothermic index), simple continentality, thermotypes, ombrotypes, equivalent shoulder types in a dry year, equivalent ombrotypes in wet and dry years.

DELIVERABLE 3

3. Modelling of the global standard value for each land system as a function of available biophysical/landscape/territorial data

$Y = a + bX_1 + cX_2 + \ldots + dX_n$

Land use restrictions and public utility easements

Nature conservation areas

- Natura 2000 network (Special Protection Areas, Sites of Community Importance, Special Areas of Conservation)
- Portuguese Network of Protected Areas
- RAMSAR
- Biogenetic Reserves
- Portuguese network of Biosphere Reserves
- Geo-sites
- Public Interest Trees

Regimes Territoriais Especiais

- National Agricultural Reserve
- Hydro-Agricultural Areas
- Forest Regime areas

National Ecological reserve

Fuelbreaks and land mosaics of fuel management (fire management system)

Easements associated with infrastructure (e.g., powerline network, gas pipelines, oil pipelines)

DELIVERABLE 3

3. Modelling of the global standard value for each land system as a function of available biophysical/landscape/territorial data

$Y = a + bX_1 + cX_2 + \ldots + dX_n$

Risks

Susceptibility to Desertification (categorical)

Drought risk (based on SPI) (continuous)

Wildfires

- Fire regime (categorical)
- Fire probability (continuous)
- Fire recurrence (continuous)
- Annual burned area (continuous)
- Annual burned area by mega-fires (> 2500 ha) (continuous)

Land abandonment

(…)

Next Steps

- Defining the *Majorants* and *Minorants* in close cooperation with the Beneficiary.
- Identifying possible issues concerning the model specification.
- Run the necessary regressions in accordance with the model.
- Use a capitalization method to evaluate rustic terrains.

Discussion
DLV3

This project is carried out with funding by the European Union via the Technical Support Instrument and in cooperation with the Directorate General for Structural Reform Support of the European Commission

Coffee Break

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5. Presentation of Deliverable 4

(Capacity Building (Training and User Guide) in Use of the Valuation Model)

Overview of DLV4: Capacity Building (Training and User Guide) in use of the Valuation Model

- **OBJECTIVES:** Create capacity within the Entities expected to use the proposed Valuation Model, ensuring the sustainability of the project's results.

- **TASKS:**

T4.1: Drafting of the step-by-step Technical Manual on the Valuation Model.

T4.2: Hold Workshops on the General aspects of the Model.

T4.3: Hold targeted Specific and Technical Training sessions on the Model.

Targeted Specific and technical Training Sessions

MODULE CONTENT: 1 – 3

- **Module 1: Introduction to R** (4 hours)
  - What is R?
  - How to install and set up R.
  - Basic syntax and commands.
  - Data types, objects and classes.

- **Module 2: Data Management/Treatment in R** (4 hours)
  - Importing data into R.
  - Understanding data structures and subsetting
  - Data cleaning: missing values, outliers and transformations.
  - Merging datasets.

- **Module 3: Basic Statistics in R** (8 hours)
  - Descriptive statistics: measures of central tendency, variation and shape.
  - Probability distributions: discrete and continuous variables.
  - Hypothesis testing.

Focus on **tidyverse** packages (add-ons to R), designed to be **accessible for users with little programming experience**

TARGETED SPECIFIC AND TECHNICAL TRAINING SESSIONS

MODULE CONTENT: 4 – 5

- **Module 4: Linear Regression** (12 hours)
  - Simple linear regression model.
  - Estimation of parameters using OLS method.
  - Hypothesis testing: significance of coefficients and goodness-of-fit measures.
  - Multiple linear regression model.
  - Assumptions checking: multicollinearity, heteroscedasticity, normality of residuals.
  - Model selection criteria.

- **Module 5: The Model** (32 hours)
  - Model structure and assumptions – Understanding the Model (4 Hours).
  - Data employed and treatment (4 Hours).
  - Model Walkthrough (4 Hours).
  - Application of the Model to each Pilot (12 Hours).
  - Independent application of the model to a region (8 Hours).

Targeted Specific and technical Training Sessions

SESSIONS ONGOING (MAY – JULY 2023)

- 14 experts from AT are attending
- 8 hours delivered to date, covering basic skills in R
- Mix of brief presentations and hands-on training
- Well received so far - attendees have shown interest and enthusiasm

All attendees use computers with the necessary software and go through exercises in class

Module	Module 1 (4 hours)	Module 2 (8 hours)	Module 3 (8 hours)	Module 4 (12 hours)	Module 5 (32 hours)
Day	04/05	05/05 + 14/06	15/06 + 16/06	22/06 + 23/06+ 27/06	29/06 + 04/07 + 06/07 + 07/07
Month	May		June		July
Module Completed?	Yes	No	No	No	No

Discussion DLV4

This project is carried out with funding by the European Union via the Technical Support Instrument and in cooperation with the Directorate General for Structural Reform Support of the European Commission

6. Concluding Remarks and Next Steps

Thank you for your Participation

This project is carried out with funding by the European Union via the Technical Support Instrument and in cooperation with the Directorate General for Structural Reform Support of the European Commission

DESIGNING A NEW VALUATION MODEL FOR RURAL PROPERTIES IN PORTUGAL

2nd Workshop of the Advisory Group

September 6th, 2023

This project is carried out with funding by the European Union via the Technical Support Instrument and in cooperation with the Directorate General for Structural Reform Support of the European Commission

AGENDA

	TIME	ENTITY I SPEAKER	CONTENT
WORKSHOP AGENDA (ROOM E006)	09h45 – 09h50	Project Team	• Welcome & Opening Session
	09h50 – 10h00	Beneficiary & DG Reform	• Introductory Remarks
	10h00 – 11h00	Project Team (i) – All (ii)	• Presentation (i) & Discussion (ii) of Deliverable 3 (New Valuation Model)
	11h00 – 11h15	All	• *Coffee Break*
	11h15 – 12h00	Project Team (i) – All (ii)	• Presentation (i) & Discussion (ii) of Deliverable 4 (Capacity Building)
	12h00 – 12h45	Project Team (i) – All (ii)	• Challenges Faced, Lessons Learnt & Recommendations (i) & Discussion (ii)
	12h45 – 14h30	All	• Lunch
	14h30 – 16h00	DG Reform, Beneficiary, Project Team	• Final Steering Committee Meeting

Introductory Remarks

Presenter: Beneficiary

Project Context

Presenter: Project Team

AARC

NOVA
NOVA SCHOOL OF BUSINESS & ECONOMICS

LOBO VASQUES

esri

INNERLANDS

Project Overview

- **DLV1:** Kick-off and Inception Report.
- **DLV2:** Assessment Report with International Good Practices on Valuation Models.
- **DLV3:** New Valuation Model and Technical Specifications for Documentation of the Model.
- **DLV4:** Capacity Building (Training and User Guide) in use of the Valuation Model.

} **Completed**

- **DLV5:** Final Report and Closure of the Project.

} **Under Development**

The New Valuation Model

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LOBO VASQUES

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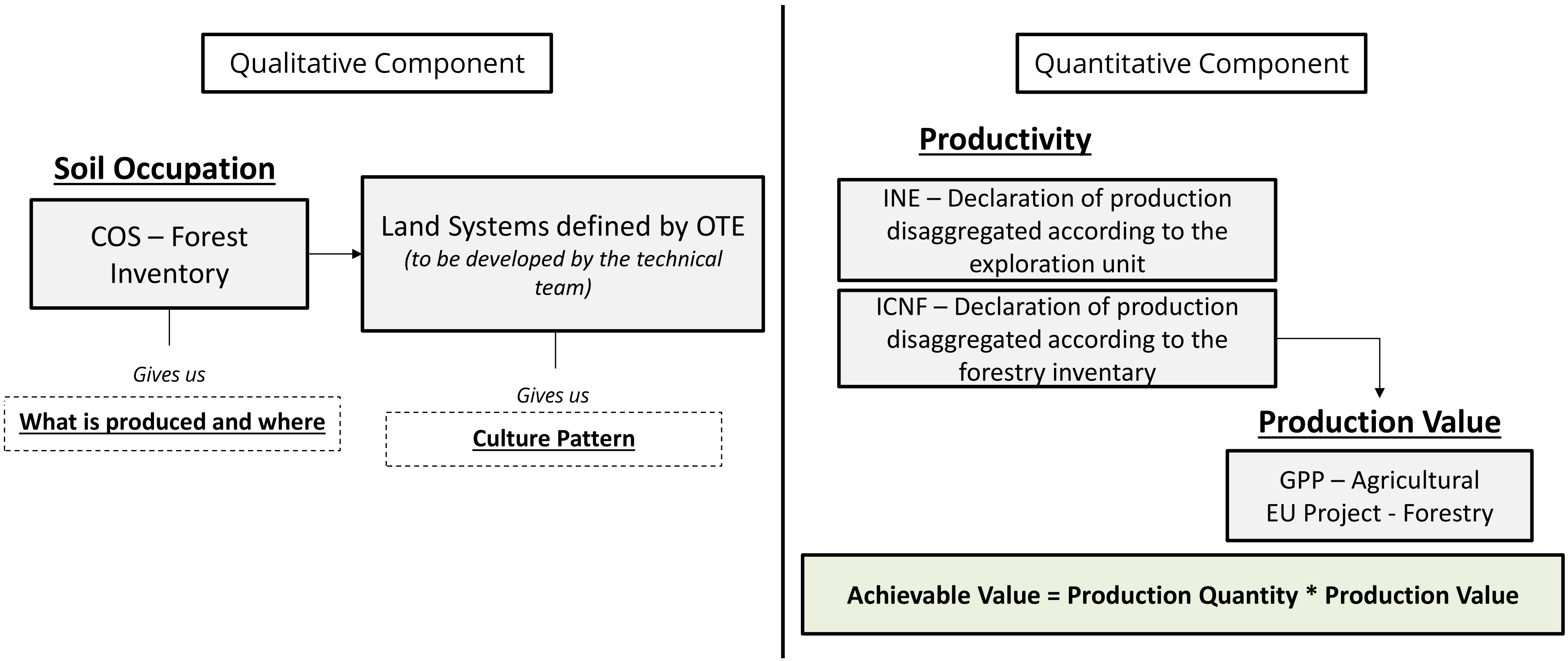
INNERLANDS

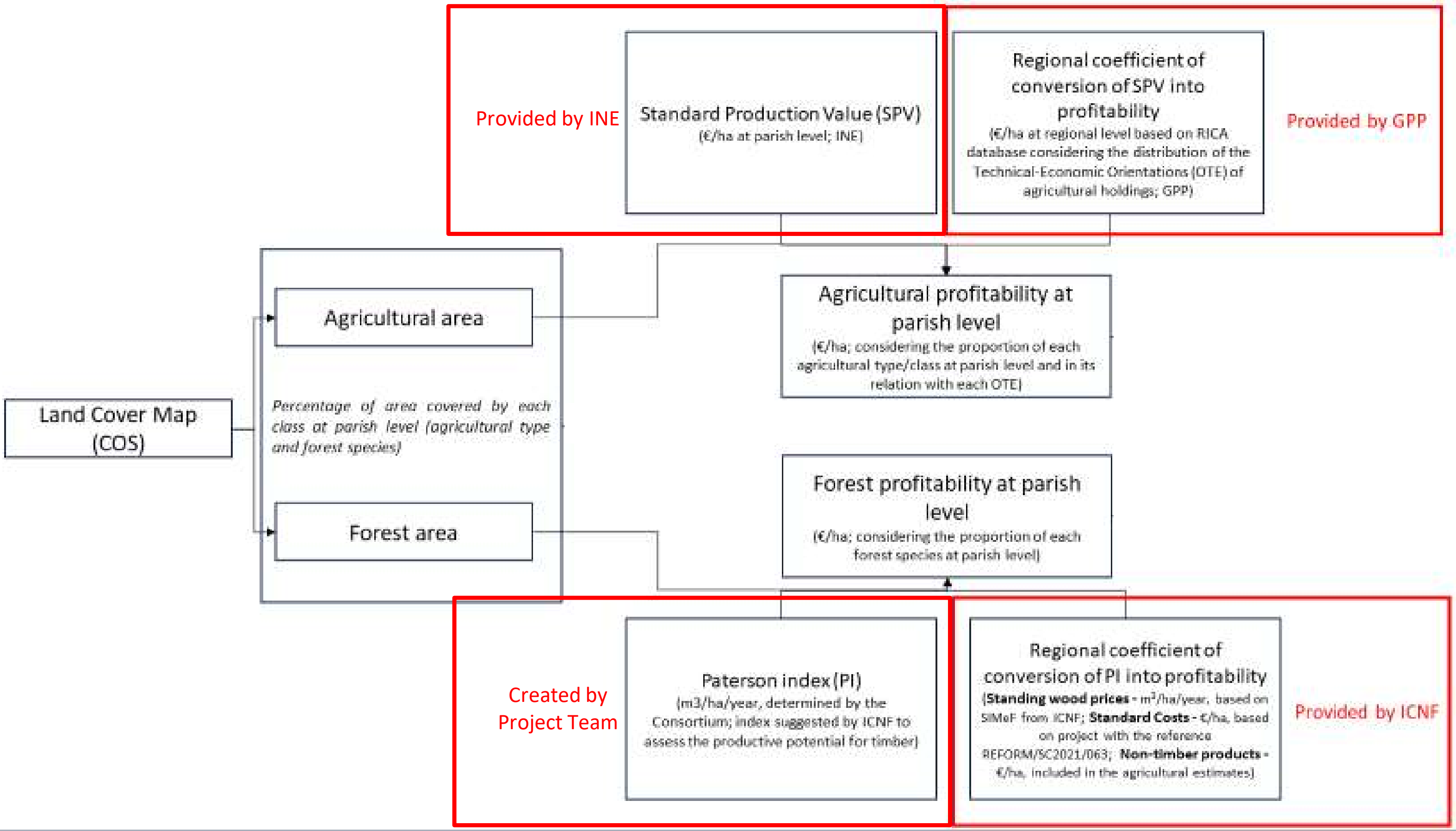
New Valuation Model Overview



Data Requests

Main Goal	Datasets	Source
Land Cover and Land Use characterization	Land Cover Map (COS)	DGT (Directorate General for Territorial Development)
	National Forest Inventory	ICNF (Institute for Nature Conservation and Forests)
	Agricultural Technical-Economic Orientations (OTE)	INE (Statistics Portugal)
Production quantification and valuation	Agricultural Standard Production Value	INE (Statistics Portugal)
	Agriculture Income (RICA)	GPP (Design, Policy, and General Administration Office of the Ministry of Agriculture)
	Simplified Market Quotation System for Forest Products (SIMeF)	ICNF (Institute for Nature Conservation and Forests)

CALCULATING THE DEPENDENT VARIABLE



Calculating the Dependent variable

Agricultural profitability at parish level **x** Agricultural production area

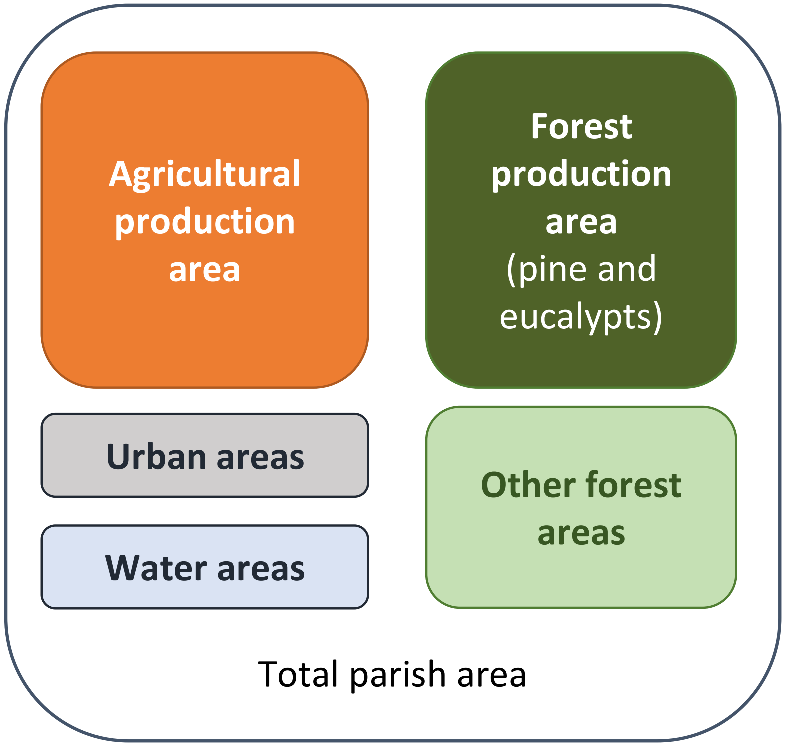
+

Forest profitability at parish level **x** Forest production area

=

Average profitability of parish (€/m2)

$$Profitability_i$$



Agricultural profitability

(produced by GPP and discussed with the Project Team)

Data sources:

- Standard Production Value by Technical-Economic Orientation at parish scale (produced by INE each 10 years)
- Agricultural Accounting Information Network - RICA (data production and management by GPP)
- Land Cover Map - COS (produced by DGT; at 1:25.000 scale)

The estimation was carried out in **three stages**:

1. **Establishment of a conversion factor between production and agricultural income**, on a regional scale and by type of Technical-Economic Guidance;
2. **Calculation of income per parish** through the standard values of agricultural production and this conversion factor, by type of Technical-Economic Guidance;
3. **Estimation of the final profitability**, through the adjustment of the previous value according to the relationship between the Technical-Economic Guidelines and the classes of land occupation.

AGRICULTURAL PROFITABILITY

a) Establishment of the coefficient factor RT/VP

- RICA data were used to establish a conversion coefficient from VPP to profitability (RT/VP), at regional scale.

Regions	Arable and extensive crops	Intensive horticulture	Wines	Fresh fruits	Dry fruits	Olives	Dairy cattle	Beef cattle	Sheep and goats	Mixed crops and livestock
Entre Douro e Minho	46%	31%	40%	36%	101%	75%	17%	22%	117%	48%
Trás-os-Montes	61%	44%	59%	73%	94%	140%	15%	64%	109%	79%
Beira Litoral	45%	39%	53%	41%	80%	75%	10%	10%	52%	26%
Beira Interior	30%	30%	73%	35%	80%	75%	53%	89%	93%	59%
Ribatejo e Oeste	23%	26%	52%	49%	80%	75%	15%	62%	91%	34%
Alentejo	46%	30%	57%	48%	80%	71%	15%	81%	105%	61%
Algarve	31%	39%	53%	52%	54%	75%	15%	66%	103%	74%

Minimum number of observations: 20 | Source: RICA - average for 2017, 2018, 2019, 2020, 2021

b) Estimation of the average profitability at parish scale

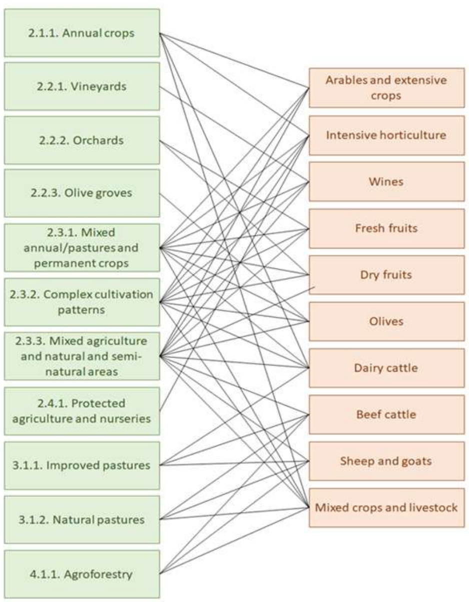
- Based on data from the 2019 Census of Agriculture, the VPP/ha of Utilized Agricultural Area (UAA) was determined for each parish and for each Technical-Economic Orientation (TEO), which multiplied by the respective coefficient RT/VP gives an estimate of the average agricultural profitability per hectare for each Technical-Economic Orientation.

$$\frac{Standard\ prodution\ value\ of\ TEO}{UAA\ of\ the\ TEO} \times Coef.$$

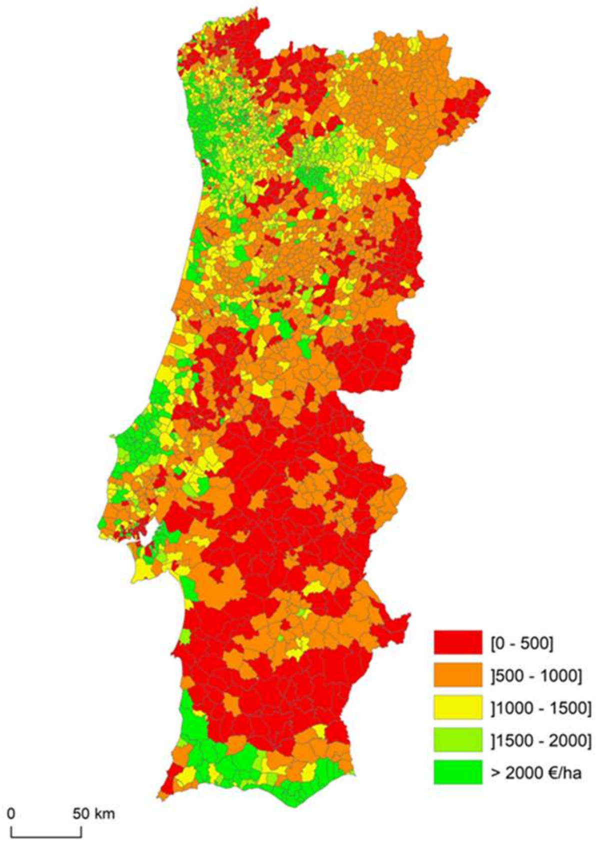
AGRICULTURAL PROFITABILITY

c) Adjustment based on land cover classes

This step was based on an **empirical association made between the TEO that are represented in each of the COS land cover types**: the logics of the two systems are quite different, so the more aggregated the classes are, the easier it will be the association and how they will be weighted by the respective areas.



The relation is according with the description of each land cover class in the technical guide of COS



Forest profitability

(produced by the Project Team based in the suggestions of ICNF)

For forest areas, the process was different and was based on the:

- Estimation of the productive **potential for wood**;
- **Average value of quotations for wood** extracted from the Simplified System of Market Quotations for Forest Products (SIMeF; managed and updated by ICNF);
- Costs of **forestry operations** associated with a standard management model for the species considered (based on the CAOF tables made available by the DGADR);
- **Wildfire-related history**.

Forest profitability

a) Estimation of the productive potential for wood

- We used the Paterson Index (Paterson, 1956) as suggested by ICNF (Institute for Nature Conservation and Forests) as an indicator of the productive potential for woody material. The Paterson Index was determined by the following formula:

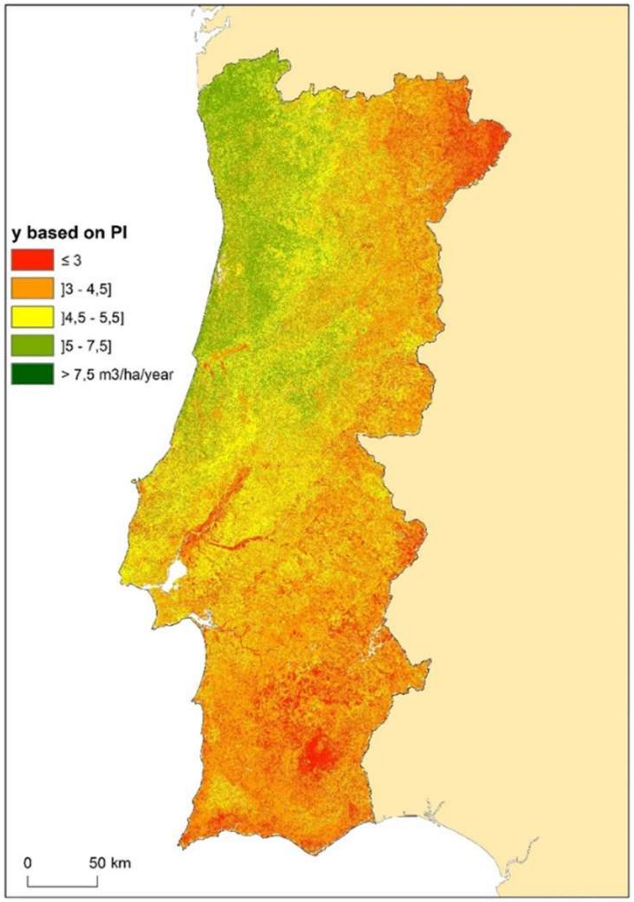
$$I = \frac{T_v}{T_a}.P.E.\frac{G}{12}.\frac{1}{100}$$

Where:
Tv – Average temperature of the warmest month (°C);
Ta – Difference between Tv and the average temperature of the coldest month (°C);
P – Average annual precipitation (mm);
G – Duration in months of the vegetation's active period;
E – Quotient between the global radiations at the pole and at the station considered (%).

- The values of I (CVP) were converted into average annual increments through the expression:

$$y = 5.2 \times \log x - 7.25$$

Where x is the value of I (CVP) and y the corresponding value in m^3/ha.year.



FOREST PROFITABILITY

b) Estimate the wood value for the most representative species

To estimate the economic value we used weighted average wood quotations calculated from the data available in SIMeF, by tree species.

Produto: Madeira | Espécie: Pinheiro-bravo
Sistemas de certificacação: -- Escolha da lista -- | Unidade Saída: m3 cc

Nº Amostras	Produto	Espécie	Sist. Certificação	Trimestre	Preço Médio Un.	Qde. Total
1	Madeira cortes fitossanitários	Pinheiro-bravo	FSC	1T	22,30	111,30
4	Madeira cortes fitossanitários	Pinheiro-bravo	FSC	2T	30,74	1121,86
7	Madeira queimada	Pinheiro-bravo	Não aplicável	1T	30,00	750,00
1	Madeira verde Corte Cultural	Pinheiro-bravo	FSC	1T	27,03	433,27
5	Madeira verde Corte Cultural	Pinheiro-bravo	FSC	2T	69,19	1699,86
1	Madeira verde Corte Cultural	Pinheiro-bravo	FSC	3T	65,68	4016,92
2	Madeira verde Corte Cultural	Pinheiro-bravo	Não aplicável	4T	53,65	60,27
3	Madeira verde Corte Final	Pinheiro-bravo	FSC	1T	61,17	871,63
17	Madeira verde Corte Final	Pinheiro-bravo	Não aplicável	1T	57,47	9474,57
9	Madeira verde Corte Final	Pinheiro-bravo	FSC	2T	39,10	2480,94
9	Madeira verde Corte Final	Pinheiro-bravo	Não aplicável	2T	48,05	1409,94
2	Madeira verde Corte Final	Pinheiro-bravo	Não aplicável	3T	25,68	693,52

1 2

c) Estimate management costs

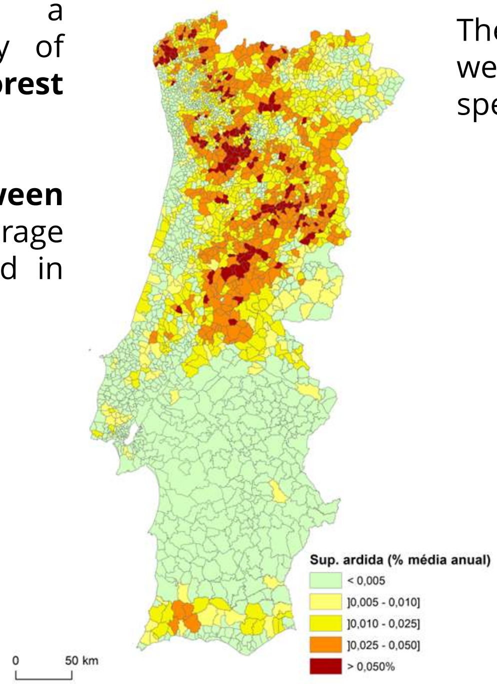
We **did not include planting or seeding costs** (installation of forest stands), nor logging costs (including transport), **only management cost**. The total cost associated with each management model was **divided by the time elapsed until the final cut**, to establish an **average annual cost.**

			Direct costs (€/ha)		
			CAOF (min-max)	REFORM	
	Year	Operation		Coimbra	Monchique
Coppice	2	Understory management and hand grinding	444,80 – 1344,40[9]	1450	-
		Understory management	444,80 – 1344,40[9]	-	424
		Selection of sticks	228,00 – 528,00[10]	500	-
		Fertilisation	120,00 – 144,00[8]	370	242
	3	1st selection of sticks	228,00 – 528,00[10]	-	588
	4	Fertilisation	120,00 – 144,00[8]	-	242
	5	Understory management	444,80 – 1344,40[9]	-	424
		2nd selection of sticks	228,00 – 528,00[10]		588
	6	Improvement of divisional network	136,70 - 182,26[5]	-	150
	12	Improvement of divisional network	136,70 - 182,26[5]	-	150

Forest profitability

d) Including a risk-related factor - wildfires

- Since fire is the **ecological process** with the **highest impact on forest productivity,** we calculated a coefficient based on the history of burned areas to **adjust forest profitability to this factor.**
- We used the **Burned Areas between 1975 and 2022** to calculate the average annual proportion of area burned in each parish (pMA_AA).



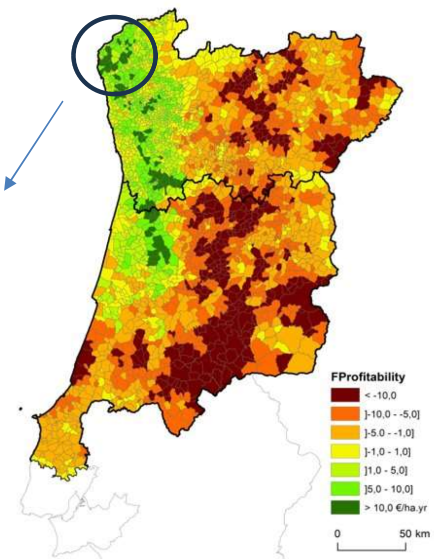
$$FP_{sp1} = (y_{PI}.Quot_{sp1}) - Costs_{sp1}$$

The adjusted forest (timber/wood) profitability value for each tree species results from the following formula:

$$FP_{sp1\_c} = FP_{sp1} - (|FP_{sp1}|.mpBA)$$

The final forest (timber/wood) profitability value results from the weighted sum of the individual profitability established for each tree species considering the area covered by each one in each parish.

Example: According to our estimates, if a large fire consumes, with high severity, 5000 ha of maritime pine ~30 years old in this area, it will generate direct losses of approximately €1,500,000



Forest profitability | remarks to improve the estimate

- To date, we have only included the value associated with the **logging from forest stands of Ec and Pb**;
- Project Team is searching for data to **include cork** (we already have regional estimations of cork production, cork value (€/@) between 2008 and 2022, mean value of cork extraction (€/@) between 2009 and 2022);
- **Resin could also be integrated**, but since its exploitation is far below the overall potential, we will probably overestimate the global value;
- **Dried fruits and** the value of **pastures in silvo-pastoral systems** were already considered when estimating **agricultural profitability;**
- **Ecosystem services must be considered** in the future;
- The functions of the **forest areas** included in the **PROF** could possibly help to **discriminate forest stands exclusively installed to guarantee soil protection;**

Forest profitability | remarks to improve the estimate

- It would be relevant to find a way to give a **spatial dimension to the forest quotations data** and, no less important, it would be the consideration of the **forest management models included in the PROFs**, instead of having a standard model – this would allow obtaining **regional variations both in costs and the economic value** of tradable products associated with the forest patches;

- **Costs per unit area are affected by spatial scale** (*it would be reasonable to consider a % reduction in cost in ZIF areas or areas subject to the forestry regime?*)

- Since the **variation between the extremes of cost** estimates published by CAOF are related to **biophysical factors** (slope angle, soil stoniness), it also would be possible to **obtain spatial variations** in these values through **spatial analysis processes in GIS;**

- The estimate of the **Paterson Index can be improved**, especially that of the G value, which should result from an average of a data series to avoid noise resulting from wildfires.

DATA SOURCES FOR MAJORANTS/MINORANTS

Variables	Description
Thermicity index	The thermicity index (It = (T + m + M) × 10) evaluates the intensity of the cold as a limiting factor for the development of many plants and plant communities. http://home.isa.utl.pt/~tmh/aboutme/Informacao_bioclimatologica_files/RMWBC_TMH_V1.0.zip.
Annual ombrothermic index	The annual ombrothermic index (Io = (Pp/Tp) × 10) provides an indication of the amount of water and is positively related with yield. http://home.isa.utl.pt/~tmh/aboutme/Informacao_bioclimatologica_files/RMWBC_TMH_V1.0.zip.
Elevation	In meters, derived from ASTER images (APA has also a numeric model, and there are other sources, such the SRTM images; in the near future Portugal will have a DEM derived from LiDAR). Available to download at https://search.earthdata.nasa.gov/search/
Terrain ruggedness index (5-cell window)	Is one of the most used metrics to assess surface complexity and represents the roughness in a continuous raster within a specified window. It can be computed from a DEM through the Geomorphometry and Gradient Metrics Toolbox for ArcGIS (available to download at https://evansmurphy.wixsite.com/evansspatial/arcgis-gradient-metrics-toolbox)
Cropland Productivity Index	Tóth et al. (2013). Data available by filling in a form in https://esdac.jrc.ec.europa.eu/content/soil-biomass-productivity-maps-grasslands-and-pasture-coplands-and-forest-areas-european
All conservation areas	All areas mentioned above are available in shapefile at https://geocatalogo.icnf.pt/catalogo.html. Its aggregation in a single shapefile was carried out with the Union geoprocessing function. In the future, it would be ideal to consider only the effective restrictions within these areas, which in the case of the ZEC will soon be published in their management plans.
National Agricultural Reserve	The shapefiles are available at https://www.dgadr.gov.pt/cartografia/reserva-agricola-nacional,and can be added using the Merge geoprocessing function. The dataset is incomplete (36 municipalities are missing), and it would be relevant for the DGADR to produce a unique shapefile for the country, ensuring its constant updating.
Primary Network of Fuel breaks	The shapefile is available at https://geocatalogo.icnf.pt/catalogo.html, but should be updated with the publication of the Regional Action Programs.

Methodology | Land Base Value

3. Modelling of the global standard value for each land system as a function of available biophysical/landscape/territorial data

Model estimation: **parish** level

1. Compute average profitability by parish:

$$Profitability_i = f(COS_i, Culture\ Profitability)$$

2. Establish relationship between profitability, aptitudes, majorants and minorants:

$$Profitability_i = \alpha + \beta_1 Aptitude_i + \beta_2 Majorants_i + \beta_3 Minorants_i + \varepsilon_i$$

➡ **Uncover estimates for coefficients** $\hat{\alpha}, \hat{\beta}_1, \hat{\beta}_2, \hat{\beta}_3$

Model application: **parcel** level

3. Use this relationship to predict potential profitability at parcel level:

$$\widehat{Profitability}_j = \hat{\alpha} + \hat{\beta}_1 Aptitude_j + \hat{\beta}_2 Majorants_j + \hat{\beta}_3 Minorants_j$$

4. Use predicted profitability to evaluate rural land through capitalization method:

$$\widehat{LBV}_j = \frac{\widehat{Profitability}_j}{r}$$

where r is a social rate of interest

Model Specification | From The Base Model to The Complete Model

⇨ To test out the methodology, a **Base Model** was first considered.

The Base Model tried to explain profitability **only by five aptitude** classes[1] and a variable that **captures the distance** to the nearest urban centre.

$$Profitability_i = \alpha + \beta_1 A1B + \beta_2 A2B + \beta_3 A3B + \beta_4 F1B + \beta_5 F2B + \beta_6 DIST\_CONC\_KM + \varepsilon_i$$

- This model was already able to explain a relevant fraction (Adjusted R2 = 19,35%) of variability in profitability across parishes.

⇨ In order to obtain the **Complete Model**, there was a need to conduct **model specification**.

Test variables by adding them into the model one by one

- Analyse contribution to regression R2 and statistical significance of coefficients.

+ Drop variables with low data availability at the parcel level

- To ensure applicability of the complete model to parcel level data.

Model Specification | Phase 1 – Variables Suggested by Beneficiary (from a list of 175 provided by the project team)

Procedure

- Starting with the **base model:**
  1. Introduce variables one by one and reestimate model
  2. Analyze results to check if variable coefficient is significant at 10% level and adjusted R2 increases vs. base model
  3. Check if variable has sufficient data in parcel level database

  If 2 and 3 ok, include variable in **complete model**

Results

VARIABLE CODE	VARIABLE NAME	STAT. SIGNIFICANCE	ADJ. R^2
CAALL	All conservation areas	SIGNIFICANT AT 1%	↑
TI_M	Thermicity index	SIGNIFICANT AT 1%	↑
OI_M	Annual ombrothermic index	SIGNIFICANT AT 10%	↑
ELE_M	Elevation	SIGNIFICANT AT 1%	↑
TRI5_M	Terrain ruggedness index (5-cell window)	SIGNIFICANT AT 5%	↑
SRR25_M	Surface relief ratio (25-cell window)	NOT SIGNIFICANT	↓
TPI5_M	Topographic position index (5-cell window)	NOT SIGNIFICANT	↓
TPI15_M	Topographic position index (15-cell window)	NOT SIGNIFICANT	↓
TPI25_M	Topographic position index (25-cell window)	NOT SIGNIFICANT	↓
GPIN_M	Grassland Productivity Index	SIGNIFICANT AT 10%	↓
CPIN_M	Cropland Productivity Index	SIGNIFICANT AT 1%	↑
N2ALL	All Natura 2000	NOT SIGNIFICANT	=
NAR	National Agricultural Reserve	NOT SIGNIFICANT	↑
PNF	Primary Network of Fuelbreaks	SIGNIFICANT AT 1%	↑
HAA	Hydro-Agricultural Areas	NOT SIGNIFICANT	=

Complete Model

- In summary, the complete model includes:
  - **The 5 aptitude class variables**
  - **Minorants**: distance to urban center, Thermicity Index (TI_M); Annual Ombrothermic Index (Oi_M); Elevation (ELE_M); Presence in a conservation area (CAAll).
  - **Majorants:** Terrain Ruggedness Index (5−cell window) (TRI5_M).

$$\boldsymbol{Log}Profitability_i = \alpha + \beta_1 A1B + \beta_2 A2B + \beta_3 A3B + \beta_4 F1B + \beta_5 F2B + \\ + \beta_6 DIST\_CONC\_KM + \beta_7 Ti\_M + \beta_8 Oi\_M + \beta_9 ELE\_M + \beta_{10} TRI\_M + \beta_{11} CAAll + \varepsilon_i$$

Log transformation of profitability was used, to normalize it as it is a highly skewed variable. This allows the model to achieve higher explanatory power.

DISCUSSION ON THE NEW VALUATION MODEL

This project is carried out with funding by the European Union via the Technical Support Instrument and in cooperation with the Directorate General for Structural Reform Support of the European Commission

COFFEE BREAK

This project is carried out with funding by the European Union via the Technical Support Instrument and in cooperation with the Directorate General for Structural Reform Support of the European Commission

Capacity Building: Application of the New Valuation Model

COMPLETE MODEL | RESULTS OBTAINED

$$LOGProfitability_i = \alpha + \beta_1 A1B + \beta_2 A2B + \beta_3 A3B + \beta_4 F1B + \beta_5 F2B + \beta_6 DIST\_CONC\_KM + \beta_7 Ti\_M + \beta_8 Oi\_M + \beta_9 ELE\_M + \beta_{10} TRI\_M + \beta_{11} CAAll + \varepsilon_i$$

One more p.p in area covered by A1B increases, on average, profitability by 2.69 percent.

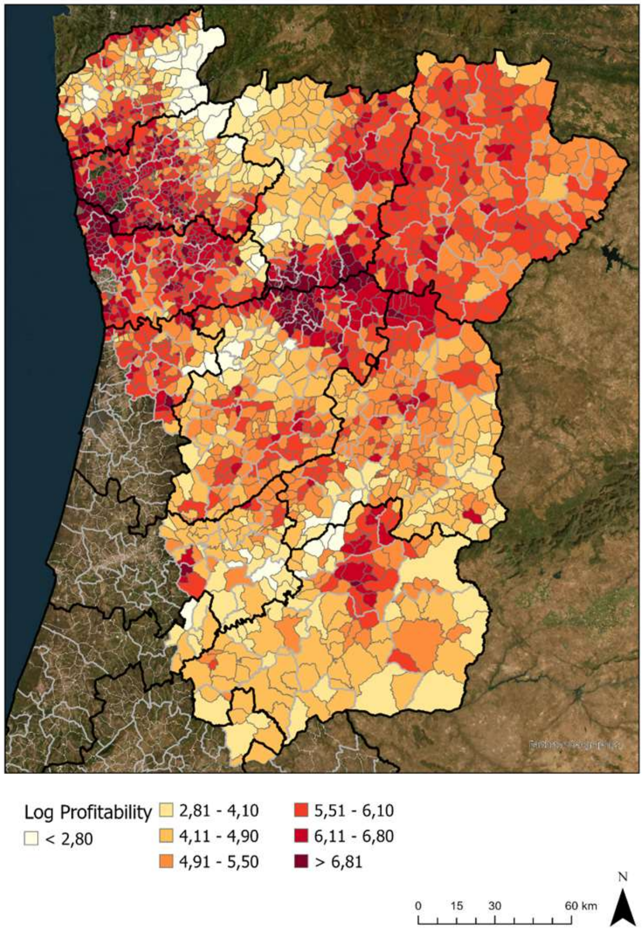
One more kilometer further away from the municipality decreases, on average, profitability by 3.08 percent.

	Adjusted R-squared
Base model	0.1935
Intermediate model	0.2818
Complete model	**0.5368**

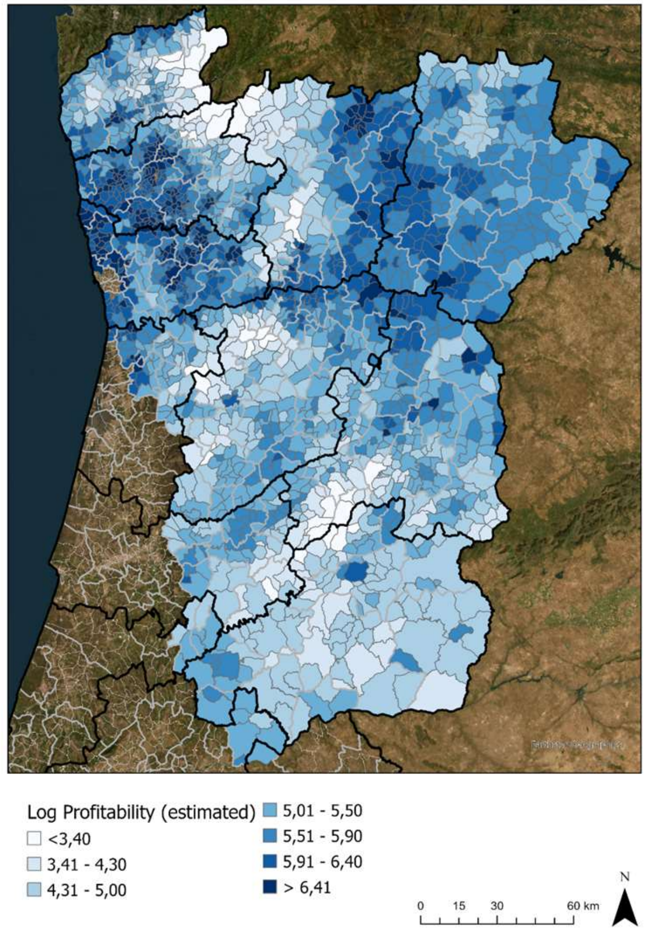
```
Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)   12.1538966  0.4940530  24.600  < 2e-16 ***
A1B            2.6872496  0.2295021  11.709  < 2e-16 ***
A2B            2.4921787  0.1651556  15.090  < 2e-16 ***
A3B            1.7419809  0.1454634  11.975  < 2e-16 ***
F1B            1.3008397  0.1353513   9.611  < 2e-16 ***
F2B            0.5885002  0.1232795   4.774 1.94e-06 ***
DIST_CONC_KM_M -0.0308139  0.0036007  -8.558  < 2e-16 ***
Ti_M          -0.0207722  0.0012243 -16.967  < 2e-16 ***
Oi_M          -0.1121466  0.0056465 -19.861  < 2e-16 ***
ELE_M         -0.0037249  0.0002369 -15.721  < 2e-16 ***
TRI5_M         0.1737448  0.0325264   5.342 1.03e-07 ***
CAAll         -0.2818232  0.0482962  -5.835 6.26e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7284 on 1984 degrees of freedom
  (8 observations deleted due to missingness)
Multiple R-squared:  0.5393,    Adjusted R-squared:  0.5368
F-statistic: 211.2 on 11 and 1984 DF,  p-value: < 2.2e-16
```

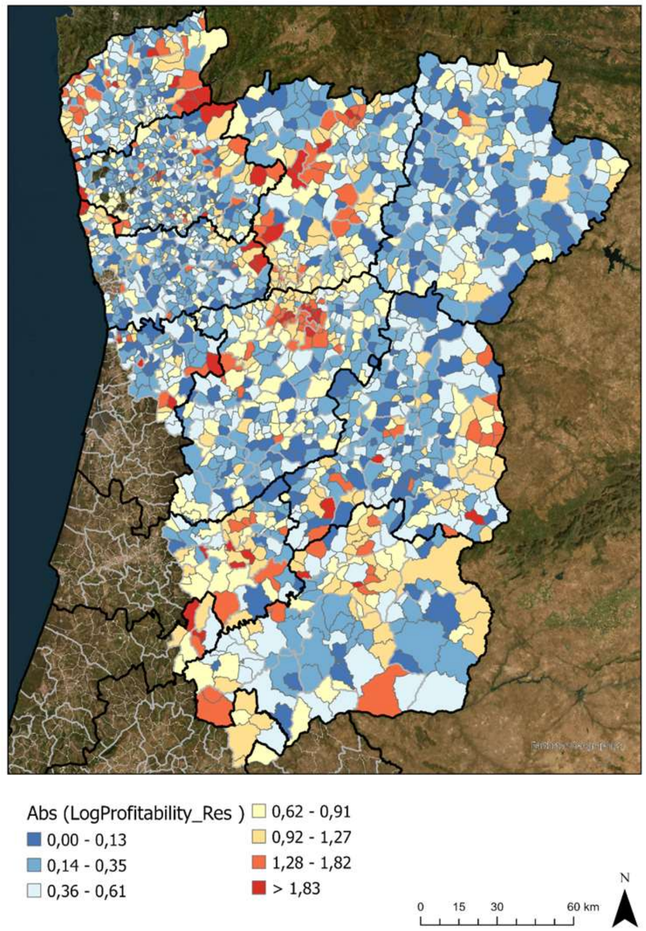
VALUES OF PROFITABILITY OBSERVED



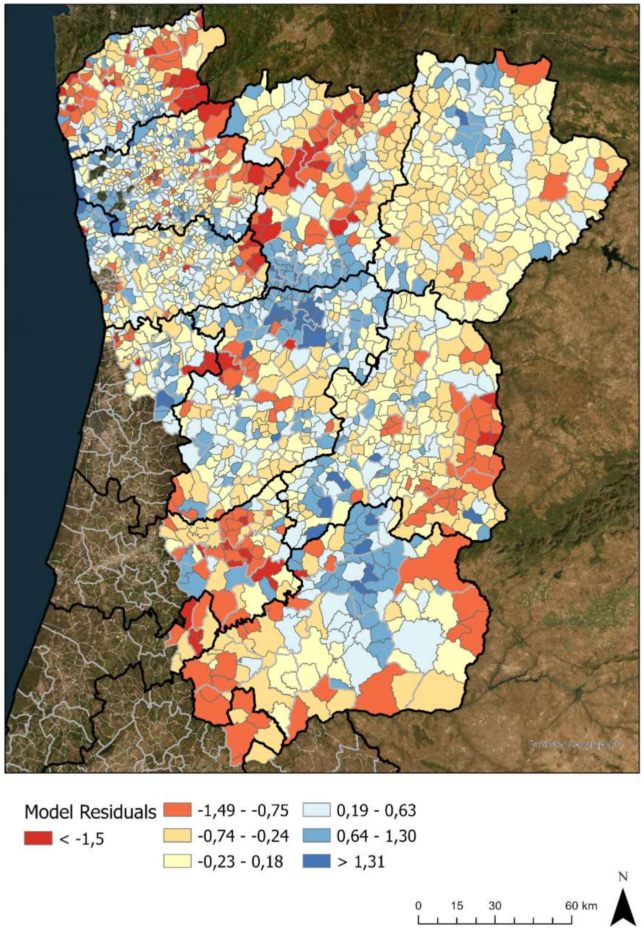
VALUES OF PROFITABILITY OBTAINED BY THE MODEL



Absolute difference between observed values and model values



DIFFERENCE BETWEEN OBSERVED VALUES AND MODEL VALUES



Exercise 1 | Comparison with IMT transaction values

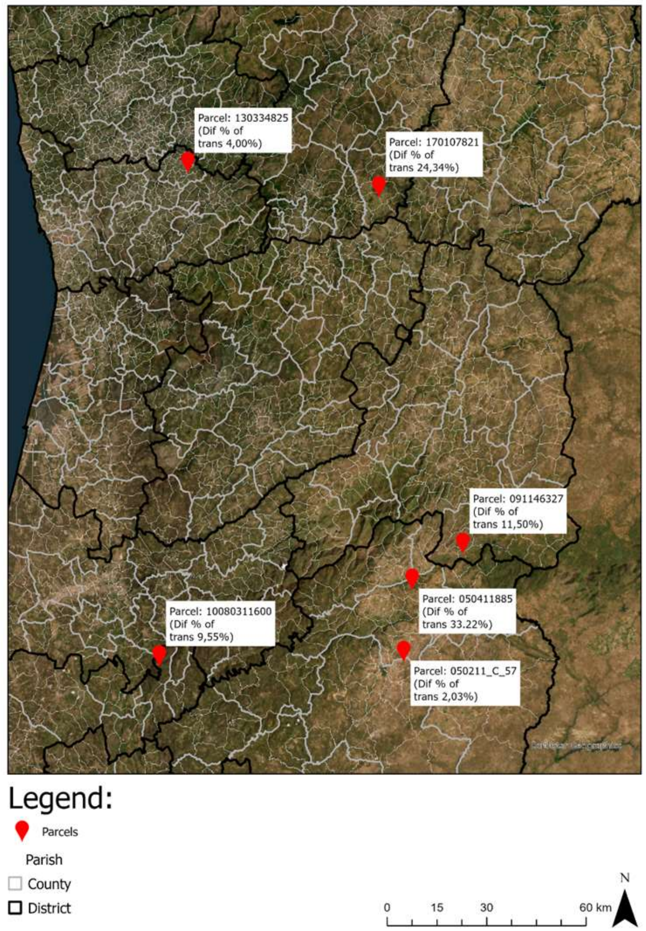
Parcel ID	Parish ID	Size (ha)	LBV/ha (Obtained from the model)	Transaction Value/ha (IMT)	LBV for parcel (Obtained from the model)	Transaction Value for parcel (IMT)	Difference per ha	Difference for whole parcel	Difference in % of transaction
166435	130334	1,16423	**19 307,28 €**	**19 300,30 €**	**22 478,13 €**	**22 470,00 €**	**6,98 €**	**8,13 €**	**0,04%**
800818	50211	3,082453	**3 972,11 €**	**3 892,94 €**	**12 243,85 €**	**11 999,82 €**	**79,17 €**	**244,03 €**	**2,03%**
64572	100803	0,311537	**3 280,72 €**	**3 627,19 €**	**1 022,07 €**	**1 130,00 €**	**346,46 €**	**107,94 €**	**9,55%**
301148	91146	0,724755	**1 831,67 €**	**2 069,67 €**	**1 327,51 €**	**1 500,00 €**	**238,00 €**	**172,49 €**	**11,50%**
482217	170107	0,395708	**26 481,72 €**	**35 000,54 €**	**10 479,03 €**	**13 850,00 €**	**8 518,83 €**	**3 370,97 €**	**24,34%**
358325	50411	5,683517	**1 468,79 €**	**2 199,34 €**	**8 347,88 €**	**12 500,00 €**	**730,55 €**	**4 152,12 €**	**33,22%**

- LBV was obtained using a 5% social rate of interest.

- Correlation between **LBV** and **Transaction Value**: 0,189
- **Spearman** correlation between **LBV** and **Transaction Value**: 0,246

- Greatest differences found between the model and the transactions are explained by parcels that were sold below 1000€ or above 100€/m2.

EXERCISE 1 | COMPARISON WITH IMT TRANSACTION VALUES



Exercise 2 | Assessing how regressions of IMT values vary with variable distance

Distance to Municipality (km)	Observations	Correlation LBV and Transaction	Spearman Corr LBV and Transaction	Adjusted R2
Any	25369	0,189	0,246	0,2106
Above 1	25231	0,187	0,245	0,2097
Above 3	23982	0,186	0,244	0,2103
Above 5	21177	0,232	0,240	0,2102
Above 7	17030	0,230	0,235	0,2151
Above 10	10212	0,199	0,189	0,2168
Above 15	3435	0,172	0,088	0,1902
Above 20	1085	-0,080	-0,040	0,0805

- Transactions below 1000€ were removed.
- The sample contains only observations whose transactions are between **0,20€/m2** and **100€/m2**.
- Total size of the sample: 25369 transactions since 2018.

Exercise 2 | Assessing how regressions of IMT values vary with variable distance

- Dependent Variable - Log Transaction
- Significance - 0% "***" ; 0,1% "**“ ; 1% "*“ ; 5% "."

Distance to Municipality (km)	A1B	A2B	A3B	F1B	F2B	DIST_CONC_KM	Ti_M	Oi_M	ELE_M	TRI5_M	CAAll
Any	0,1448	0,5549***	0,4121***	0,0312	0,0972	-0,023***	-0,002***	0,0873***	-0,002***	-0,158***	0,0088
Above 1	0,1405	0,5441***	0,4081***	0,0275	0,0967	-0,023***	-0,002***	0,0872***	-0,002***	-0,159***	0,0077
Above 3	0,1535 .	0,5512***	0,4260***	0,0474	0,1173	-0,023***	-0,002***	0,0880***	-0,002***	-0,160***	0,0147
Above 5	0,1207	0,5163***	0,4015***	-0,015	0,0878	-0,023***	-0,001***	0,0883***	-0,002***	-0,157***	0,0352
Above 7	0,0987	0,4712***	0,3478***	-0,089	0,0445	-0,019***	-0,001***	0,0920***	-0,002***	-0,152***	0,0487 .
Above 10	-0,020	0,3871***	0,2963**	-0,187 .	0,0247	-0,020***	-0,001	0,0989***	-0,002***	-0,143***	0,1007**
Above 15	0,1183	0,1661	0,1850	-0,255	-0,047	-0,025***	0,0007	0,1153***	-0,001***	-0,135***	0,0971*
Above 20	0,3086	0,0512	0,1468	0,0851	0,1010	-0,030**	0,0042 .	0,1337***	7,6562	-0,105*	-0,195*

Exercise 3 | Finding the discount rate that minimizes the difference

$$LBV_i = \frac{\mathbf{Profitability}_i}{r}$$

$$min \sum_{i=1}^{j} |Transaction\ Value_i - LBV_i|$$

- The social rates of interest tested range from 1% to 20%
- The discount rate that minimizes the sum of absolute differences is **2%.**

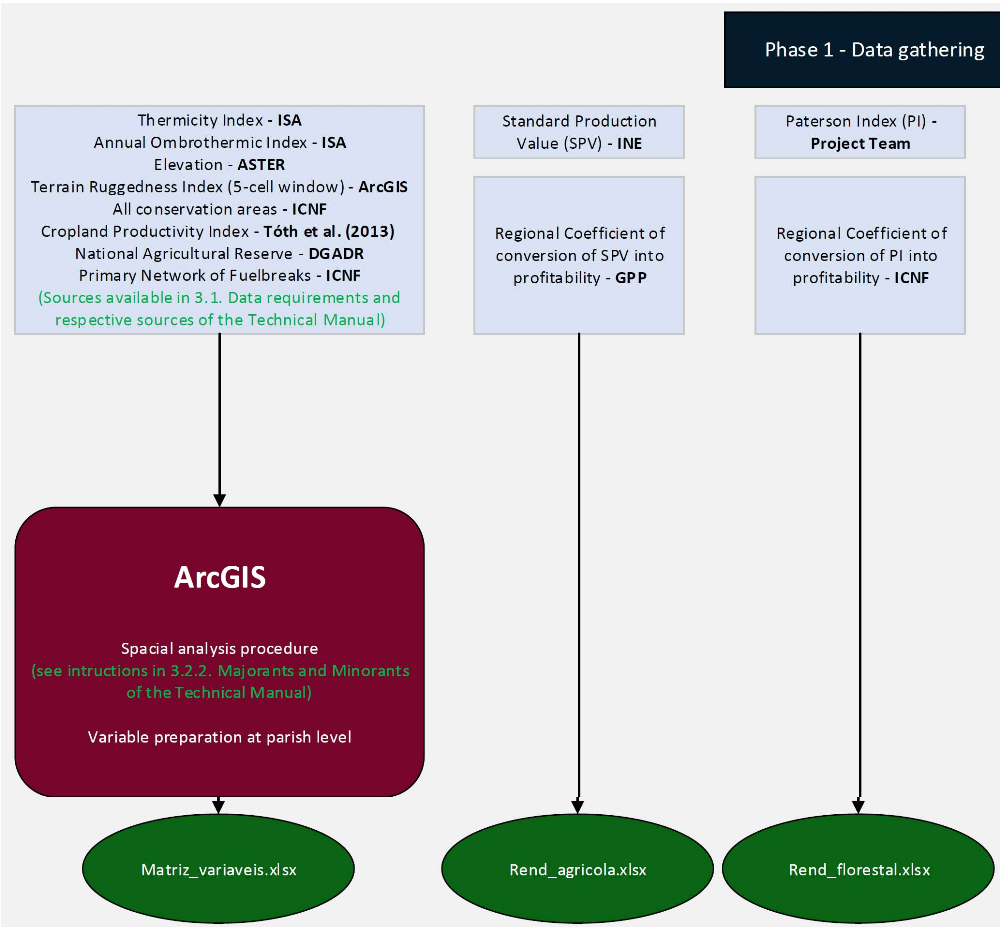
EXERCISE 4 | ESTIMATING THE MODEL ACCOUNTING FOR SPECIFIC REGIONS (NUT II)

- In the sample there are only 2 NUT II available: *Norte* and *Centro*.
- Dummy variable **NUTII_Norte = 1** if parish is in the NUT II *Norte*.
- Coefficients remain significant and with same order of relative magnitude
- **NUTII_Norte** is significant and has a coefficient of 0,5662.
- **A parish located in the *Norte* region will have, on average, a profitability 56,62% higher than a parish located in the *Centro* region, *ceteris paribus*.**

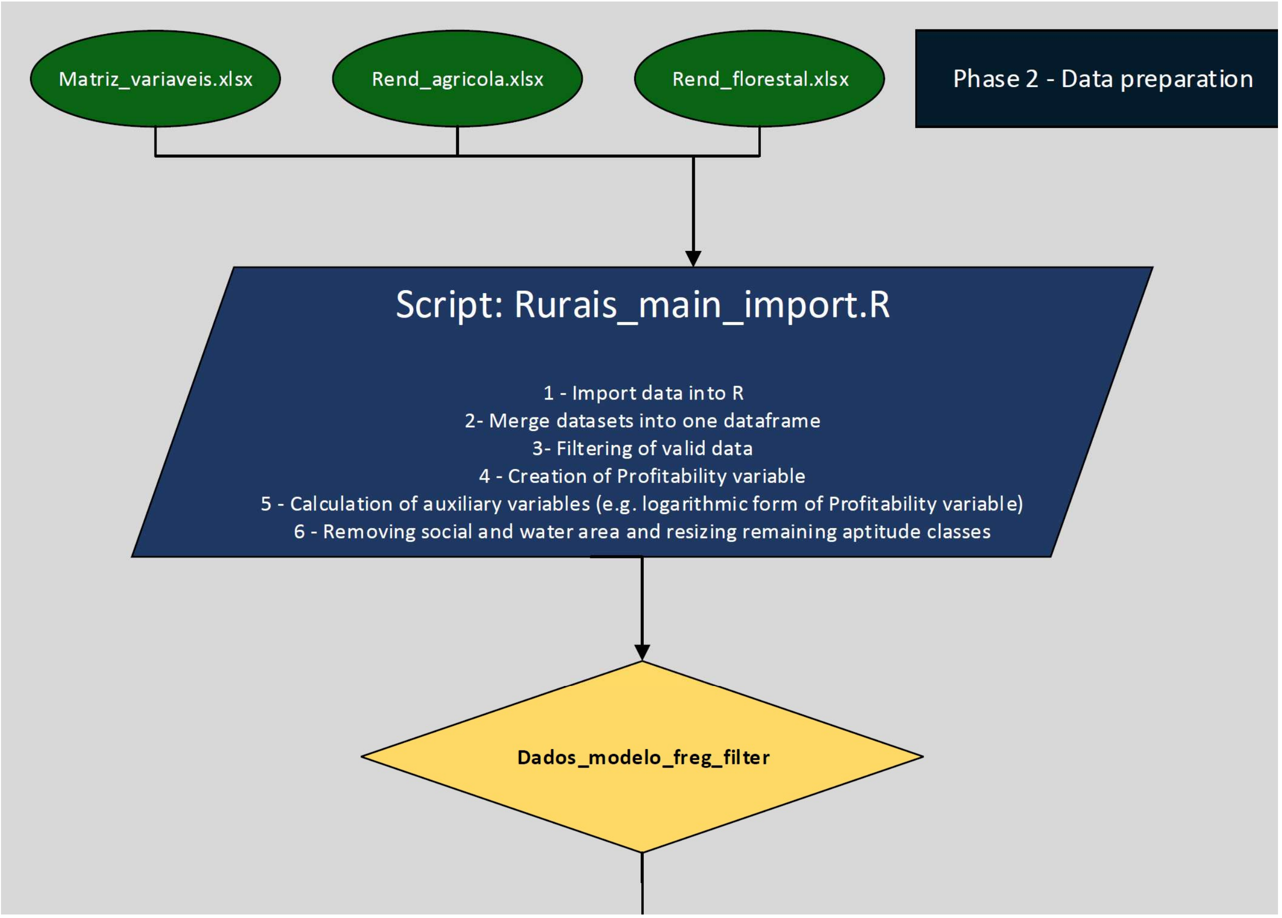
```
Coefficients:
                 Estimate Std. Error t value Pr(>|t|)    
(Intercept)     7.9715471  0.7144939  11.157  < 2e-16 ***
A1B             2.3770711  0.2292601  10.368  < 2e-16 ***
A2B             2.1501747  0.1681377  12.788  < 2e-16 ***
A3B             1.6030265  0.1442640  11.112  < 2e-16 ***
F1B             1.1181324  0.1352039   8.270 2.43e-16 ***
F2B             0.4502484  0.1225985   3.673 0.000247 ***
DIST_CONC_KM_M -0.0312085  0.0035453  -8.803  < 2e-16 ***
Ti_M           -0.0084825  0.0019540  -4.341 1.49e-05 ***
Oi_M           -0.1375372  0.0064031 -21.480  < 2e-16 ***
ELE_M          -0.0015175  0.0003615  -4.197 2.82e-05 ***
TRI5_M          0.1537066  0.0321211   4.785 1.83e-06 ***
CAAll          -0.2851652  0.0475506  -5.997 2.38e-09 ***
NUTII_Norte     0.5662535  0.0708588   7.991 2.24e-15 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.7171 on 1983 degrees of freedom
  (8 observations deleted due to missingness)
Multiple R-squared:  0.5537,    Adjusted R-squared:  0.551 
F-statistic:   205 on 12 and 1983 DF,  p-value: < 2.2e-16
```

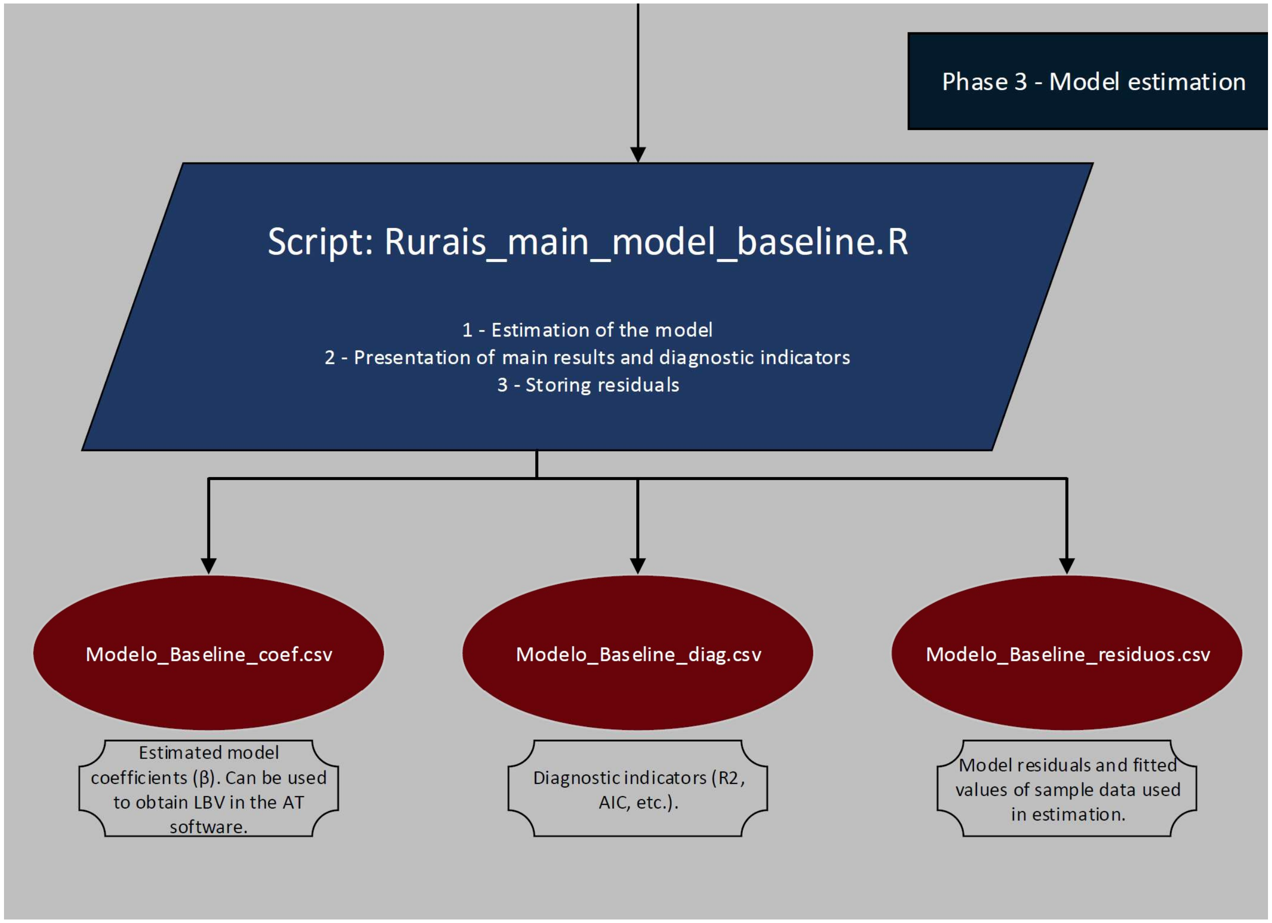
FLOWCHART – PHASE 1



FLOWCHART – PHASE 2



FLOWCHART – PHASE 3



Challenges Faced, Lessons Learnt & Recommendations

RECOMMENDATIONS

- Elaboration of the **new regulatory model** for the development of agricultural and forestry activities at parcel level.
- Improving the **characterisation of cultural themes**, particularly with regard to **forestry** and **agriculture.**
- Realising the **cadastral land registry.**
- Drawing up the **aptitude map.**
- Ensure a **smooth relation** with **income tax.**

Discussion on Challenges Faced, Lessons Learnt & Recommendations

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Lunch

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THANK YOU FOR YOUR PARTICIPATION

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