Photo: Escaroupim, Salvaterra de Magos. Fonte: CCDR-LVT

ECOSTYSTEM SERVICES IN LISBON AND TAGUS VALLEY REGION

Contribution to mapping, valuing and integration into the Land Planning System

2021

ROBUST receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 727988

DATASHEET

Title

Ecosystem Services in Lisbon and Tagus Valley Region - Contribution to mapping, valuing and integration into the Land Planning System

Entity responsible for editing

Comissão de Coordenação e Desenvolvimento Regional de Lisboa e Vale do Tejo

General Coordination
Teresa Almeida

Authors
Carlos Pina
Isabel Loupa Ramos
Linda Irene Pereira
Mafalda Pedro
Marta Alvarenga

Collaboration
Alexandra Almeida
Joana Lima
Maria Reis Gomes
Maria Rosário Partidário
Margarida Monteiro
Teresa Rego

Digital edition | October 2021

Comissão de Coordenação e Desenvolvimento Regional de Lisboa e Vale do Tejo

Rua Alexandre Herculano, n.º 37, 1250-009 Lisboa

Tel. +351 21 383 71 00 | www.ccdr-lvt.pt | geral@ccdr-lvt.pt

https://rural-urban.eu/

General Index

Picture Index

Table Index

Acronyms

CCDR-LVT – Comissão de Coordenação e Desenvolvimento Regional de Lisboa e Vale do Tejo

CICES - Common International Classification of Ecosystem Services

ES – Ecosystem Services

GI – Green Infrastructure

IST – Instituto Superior Técnico

LOC – Land Occupation Chart

LTV – Lisbon and Tagus Valley

MEA - Millenium Ecosystem Assessment

MES – Municipal Ecological Structure

MMP – Municipal Master Plan

NAR - National Agriculture Reserve

NER – National Ecological Reserve

RFEPE – Regional Framework for Environmental Protection and Enhancement

TEEB - The Economics of Ecosystem and Biodiversity

TGD – Territorial General Directorate

1. PREAMBLE

The occupation and transformation of land use over time has caused a sharp reduction in the extent of natural habitats and a significant increase in their level of fragmentation, which is a threat to biodiversity and has negatively affected the functions performed by ecosystems in the production of goods and services essential to human societies.

These goods and services include soil formation and maintenance, pest and disease control, air and water purification, food production, among others, including climate regulation and carbon sequestration services, which are fundamental in framework of current climate change scenarios.

It will therefore be essential to improve knowledge about ecosystems and their services, carrying out their mapping and assessment and promoting their integration in land use planning processes with a view to their protection and enhancement, including from an economic point of view.

In this perspective, there is a need to establish priorities for the recovery and promotion of the use of green infrastructure as an ecologically coherent and strategically planned network composed of a set of natural and semi-natural areas, rural and urban elements and green, terrestrial and freshwater, coastal and marine waters, which together improve the conservation status of ecosystems and their resilience and contribute to the conservation of biodiversity and benefit populations.

In this context, the CCDR-LVT prepares this document, which is organized into three parts. The first part is dedicated to contextualizing the theme of ecosystem services, clarifying concepts and typologies for classifying these services. The second part seeks to explain the objective and methodology of the mapping project of ecosystem services for the Lisbon and Tagus Valley region, which is based on an expert analysis based on a correlation matrix between the land cover typologies and the different types of ecosystem services, following Burkhard's methodology (Burkhard *et al*, 2009). In the third part, the integration of ecosystem services in territorial management instruments is addressed, with particular focus on the Municipal Master Plan with indication of integration guidelines considering the material and documental content of that planning figure, with some clues to funding and implementation in the municipal planning of actions for the valorisation and remuneration of ecosystem services.

The CCDR-LVT expresses special thanks to the specialists in the various areas who contributed with their knowledge to completing the ES weighting matrix that allowed the mapping of ecosystem services. Many thanks to: Ana Galvão, André Mascarenhas, António Lopes, António Mexia, Catarina Fonseca, Eduardo Brito Henriques, Helena Freitas, José Luís Zêzere, José Miguel Cardoso Pereira, Manuel Madeira, Nuno Cortez, Pedro Cabral, Rodrigo Oliveira, Rosário Oliveira, Teresa Melo and Vasco Raminhas.

2. CONTEXT

Mafra
Source: CCDR-LVT

2.1. Ecosystem Services Concept

There are several authors who have studied the subject and countless definitions of Ecosystem Services (ES) have been published over the years. However, the present work is essentially based on the concept generalized by Costanza et al. In 1997, the authors defined ES as the benefits that the human population derives, directly or indirectly, from ecosystem functions, which, according to the authors, are defined as ecosystem processes that lead to services (Costanza *et al*. 1997).

Between 2001 and 2005, following the creation by the United Nations, of the global initiative Millennium Ecosystem Assessment (MEA), greater interest on the subject was triggered, several articles were published on the subject and the most widely used definition emerged today, in which ES are defined as the "benefits people obtain from ecosystems", with an ecosystem being a "dynamic complex of communities of plants, animals and microorganisms, and the abiotic environment interacting as a functional unit" (MEA 2005).

Recently, and given the proliferation of new concepts of SE, Costanza *et al*. (2017) updated the definition of ES as the ecological characteristics, functions and processes that directly or indirectly benefit human beings.

Table 1 - Selected Ecosystem Services for the LTV mapping exercise

Author	Ecosystem Services concepts
Costanza *et al*. (1997)	The benefits that the human population derives, directly or indirectly, from ecosystem functions.
Millennium Ecosystem Assessment (2005)	The benefits people derive from ecosystems, with an ecosystem being a "dynamic complex of communities of plants, animals and microorganisms, and the abiotic environment interacting as a functional unit".
Costanza *et al*. (2017)	The characteristics, functions and ecological processes that directly or indirectly benefit human beings.

2.2. Classification of Ecosystem Services

The classification of ES allows their valuation and monitoring based on particular functions and processes associated with ecosystems.

The classification of ecosystem services is a conceptually and technically difficult task. This is because there is no single, fully accurate and accepted definition of the term capable of capturing the full range of ways in which ecosystems sustain human life and contribute to human well-being, and because there is a wide range of purposes or applications with different requirements in terms of levels of spatial and thematic resolution (de Groot et al. 2010, Haines-Young & Potschin 2013, cited by Rodrigues 2015).

Due to the growing interest in the subject, there are currently several proposals for the classification of Ecosystem Services, which are adopted by different entities and authors.

The characteristics and differences of the main classification systems adopted internationally are presented below, namely the MEA, TEEB and CICES.

In 2005, the ***Millennium Ecosystem Assessment*** (**MEA**) adopted a classification system based on four groups: supply, regulation, cultural and support services. This classification scheme for ecosystem services was considered to be very operational, accessible and easily

understandable by decision-makers and non-scientific communities and is therefore one of the most generalized and used types of classification (Fisher et al. 2011).

However, with the course of its application in decision processes, the classification of the MEA approach presents some weaknesses regarding the categories of SE types, because it does not distinguish between intermediate processes of ecosystems and services that are directly used or consumed by people (Fisher & Turner 2008), which can lead to overlapping of support service estimates (Ojea *et al*. 2012, Marta-Pedroso *et al*. 2014).

These weaknesses led to emergence of new classifications such as the one proposed by ***The Economics of Ecosystems and Biodiversity*** (**TEEB**), an initiative that started in 2007 when G8+5 environment ministers called for a global study on the economic benefits of biodiversity and the costs of its loss. Its main objective was to recognize the value of ecosystems and biodiversity (whether they have market value or not), demonstrate that value in economic terms and thus help capture that value in decision-making processes (Duarte 2019).

In addition, TEEB created the designation of "habitat services", which is not included in any of the original ES categories proposed by the MEA, and eliminated support services (considered intermediate services), as it focuses on services that have economic value, that is, in the final services (Haines-Young et al.2012).

In 2013, based on the environmental accounting work of the European Environment Agency (EEA), the first complete operational version of **CICES** - ***Common International Classification of Ecosystem Services*** appeared, with the aim of facilitating the comparison of assessments with different systems, of contributing to standardization of classification and to make ES accounting clearer. However, this version has been revised based on user experience, and there is already a new version (V5.1) that was released in 2018 (Haines-Young & Potschin 2018).

This classification organizes the different kinds of ES into three major sections: procurement, regulation and cultural services (Haines-Young & Potschin 2018).

Table 2 – Ecosystem Services according to CICES

ES Sections	Concept
Supply	Covers all nutritional, non-nutritional and energy products from living systems as well as abiotic products (including water).
Regulation and maintenance	It includes all the ways in which living organisms can mediate or moderate the environment that affects human health, safety or comfort, along with abiotic equivalents..
Cultural	It encompasses all non-material, and normally non-consumable outputs from ecosystems (biotic and abiotic) that affect people's physical and mental states.

Source: Adapted by Duarte (2019) de Haines-Young & Potschin (2018)

CICES considers that habitat services provided for in the MEA classification are already part of everything underlying ecosystems (structures, processes and functions), and are therefore indirectly consumed or used, in addition to simultaneously contributing to many goods and benefits finals (CICES, 2019a).

In this work, the CICES classification was used as it is the most operationally oriented and allows for a high level of detail.

This classification system uses a five-level hierarchical structure: section, division, group, class, and class type. Thus, each level is progressively more detailed and specific, providing a greater degree of definition of the ES considered (Haines-Young & Potschin 2018).

Table 3 – Classification of Ecosystem Services according to MEA (Alcamo *et al*. 2003), TEEB (De Groot *et al*. 2010) and CICES (Haines-Young & Potschin 2013) initiatives

MEA	TEEB	CICES
Supply services Products obtained from ecosystems whose availability depends heavily on support and regulatory services		
- Food - Drinkable water - Fibres and wood - Firewood and wood - Genetic resources - Biochemical and pharmaceutical products - Ornamental resources (craft, fashion, decoration products)	- Food - Water - Raw materials (fibre, firewood, fodder, wood, fertilizers) - Genetic resources - Medicinal resources (biochemical, pharmaceuticals) - Ornamental resources (craft, fashion, decoration products)	- Nutrition (eg agricultural crops, livestock breeding and their by-products, wild plants, algae) - Materials (eg fibres and other raw materials from plants, algae or animals, genetic material, surface and underground water for other uses) - Energy (eg energy resources from biomass of animal or plant origin, mechanical energy of animal origin)
Regulation services Ecological services provided by ecosystems, being intimately interconnected with each other and with other service categories		**Regulation and maintenance services**
- Air quality regulation - Climate regulation - Regulation of water flows - Erosion regulation - Pollination - Regulation of pests and diseases - Regulation of human diseases	- Air purification - Climate regulation (carbon sequestration, climate stability) - Moderation and prevention of extreme events (eg floods and fires) - Regulation of water flows - Water treatment and purification - Erosion prevention - Maintenance of soil fertility - Pollination - Biological control (disease and pest control, seed dispersal)	- Mediation of waste, toxic products and other pollutants (bioremediation/filtration/accumulation by microorganisms, algae, plants and animals, filtration/sequestration/accumulation by ecosystems, mediation of visual, acoustic and olfactory impacts) - Flow mediation (stabilization and control of erosion rates, maintenance of water flows and hydrological cycle, protection against storms) - Maintenance of physical, chemical and biological conditions (pollination and seed dispersal, maintenance of habitats and breeding populations, pest and disease control, soil composition and formation, chemical conditions of fresh and salt water bodies, regulation of changes climate and greenhouse effect, climate regulation at regional and local level)
Support services Services required for the production of other goods or services and whose benefits to human well-being are indirect and long-term	**Habitat services**	
- Nutrient cycle - Primary production - Photosynthesis - Soil formation	- Maintenance of life cycles - Maintenance of genetic diversity	
Cultural services Intangible benefits obtained from ecosystems that contribute to spiritual and emotional well-being		
- Aesthetic, spiritual and religious values - Recreation and ecotourism - Cultural diversity - Education and knowledge systems	- Aesthetic information - Recreation and tourism - Inspiration for culture, art and design - Spiritual experiences - Information for cognitive development (intellectual stimulation)	- Physical and intellectual interactions with the biota, ecosystems and landscapes (eg experiences in the use of plants, animals and landscapes, scientific, educational, aesthetic or entertainment interactions) - Spiritual, symbolic and other interactions with the biota, ecosystems and landscapes

Source: Adapted from Rodrigues (2015)

3. Ecosystem Services in Lisbon and Tagus Valley Region

Arrábida mountain
Source: CCDR-LVT

3.1. Ecosystem Services Mapping Exercise

The Goal

This work aims to improve knowledge about ecosystems and their services, mapping them and promoting their integration in land use planning processes with the aim of protecting and enhancing them.

This goal meets the principle: we only value what we know and what we can measure. Therefore, it is essential to know the ecosystem services potentially existing in the Lisbon and Tagus Valley Region.

Mapping ecosystem services consists of placing the capacity, flow or benefit of ecosystem services on a map in a spatially explicit way (Maes *et al*. 2013). Maps facilitate communication, as they make it possible to visualize the capacity of ecosystems to produce services. In this way, mapping can contribute to the identification, planning and management of conservation areas and, implicitly, their ecosystem services (Maes *et al*. 2013).

To fulfil this objective, the Comissão de Coordenação e Desenvolvimento Regional de Lisboa e Vale do Tejo (CCDR-LVT), together with Instituto Superior Técnico (IST), developed an exercise to map ecosystem services for the Lisbon and Tagus Valley Region (LTVR).

The Origin of the Project

CCDR-LVT and IST have been involved, since June 2017, in the ROBUST Project (https://rural-urban.eu) financed in H2020 and whose essential objectives are: a) to increase knowledge of the interactions and dependencies between rural, peri-urban and urban areas and b) identify and promote policies, governance models and practices that promote mutually beneficial relationships.

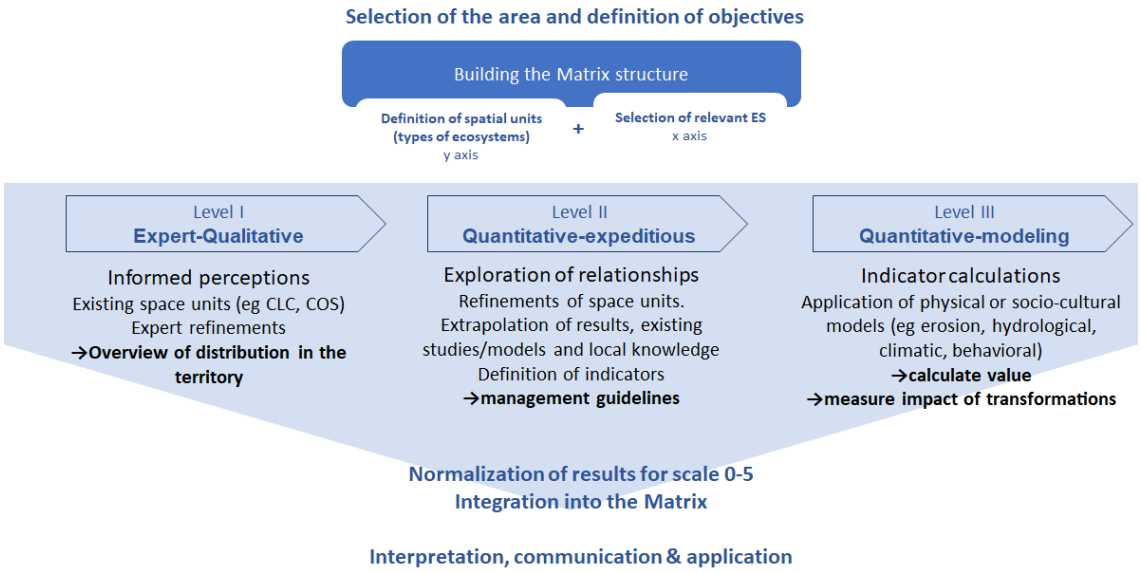
Within the framework of this project, CCDR-LVT and IST understood as a relevant product of this project the production of a mapping of ecosystem services at the scale of the Lisbon and Vale do Tejo Region, as an instrument to support strategic and territorial planning processes region to be developed or monitored by the CCDR-LVT.

The Methodology

There are several approaches to mapping ecosystem services as systematized by Burkhard and Maes in 2017, using different kinds of data, services and methodologies to identify their occurrence and assess their intensity. Among these existing approaches, it is necessary to choose the one best suited to territorial objectives, existing data, processing capacity and stage of the mapping process. The methodology developed by Burkhard *et al*. (2009) became popular for allowing the use of spatial data made available in a systematic way (i.e. Corine Land Cover) and the use of expert knowledge.

In 2012 Burkhard *et al* updated the methodology by introducing the perspective of mapping demand for ecosystem services, aiming to identify areas that provide services (supply) and areas that benefit (or demand) for ecosystem services.

Despite the development of other more quantitative methodologies based on biophysical models, the methodology of Burkhard *et al* has proved to be useful at an early stage of the



Picture 1 - Methodology for mapping ecosystem services, approach staged by levels of improvement
Source: Layout made by Isabel Loupa Ramos inspired by Grêt-Regamey, Adrienne & Weibel, Bettina & Rabe, Sven-Erik & Burkhard, Benjamin. (2017). A tiered approach to ecosystem services mapping.

Despite its formal simplicity, the Expert-Qualitative approach based on Burkhard's Matrix has specific challenges related to the capture of expert knowledge and its integration (Campagne & Roche 2018).

The mapping exercise elaborated was based on the methodology of Burkhard *et al*. 2009 - *Landscapes Capacities to Provide Ecosystem Services - the Concept for Land-Cover Based Assessments* - which explores the potential of the landscape to provide ecosystem services and focuses on an expert analysis based on a weighting matrix that crosses the Land Occupation Chart (LOC) and ecosystem services, and using the international classification of CICES (The Common International Classification of Ecosystem Services). In the process of mapping ES in LTVR, the highest level of disaggregation of CICES was used, that is, the type of class. The nomenclature of services presented in this classification is not always intuitive, so it was simplified / adapted for use in this work.

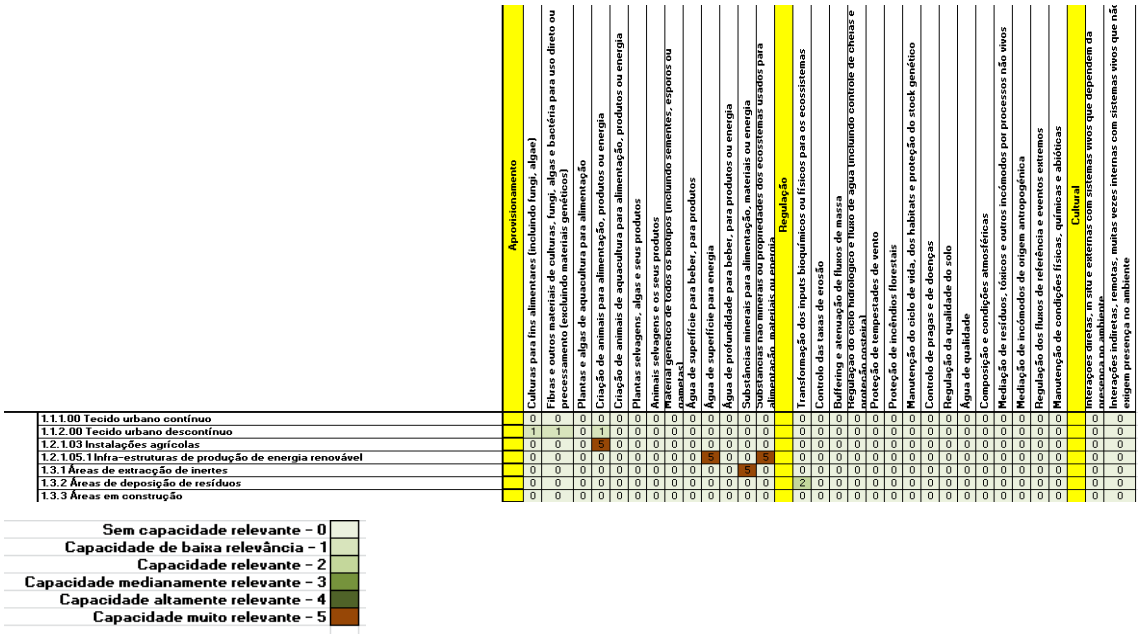
In Burkhard's methodology, the available land cover data is used in a systematic way (such as Corine Land Cover), and the capacity of different land cover types to provide the various ecosystem services is submitted to the appreciation of specialists. .

To assess this capacity, a matrix is used that inserts the classes of land cover on the y axis and the ecosystem services under analysis on the x axis. In the interaction cells, the capacities of different land cover classes to provide the specific service are evaluated on a scale from 0 to 5. Burkhard *et al*. (2009) used 44 land cover classes and 29 ecosystem services.

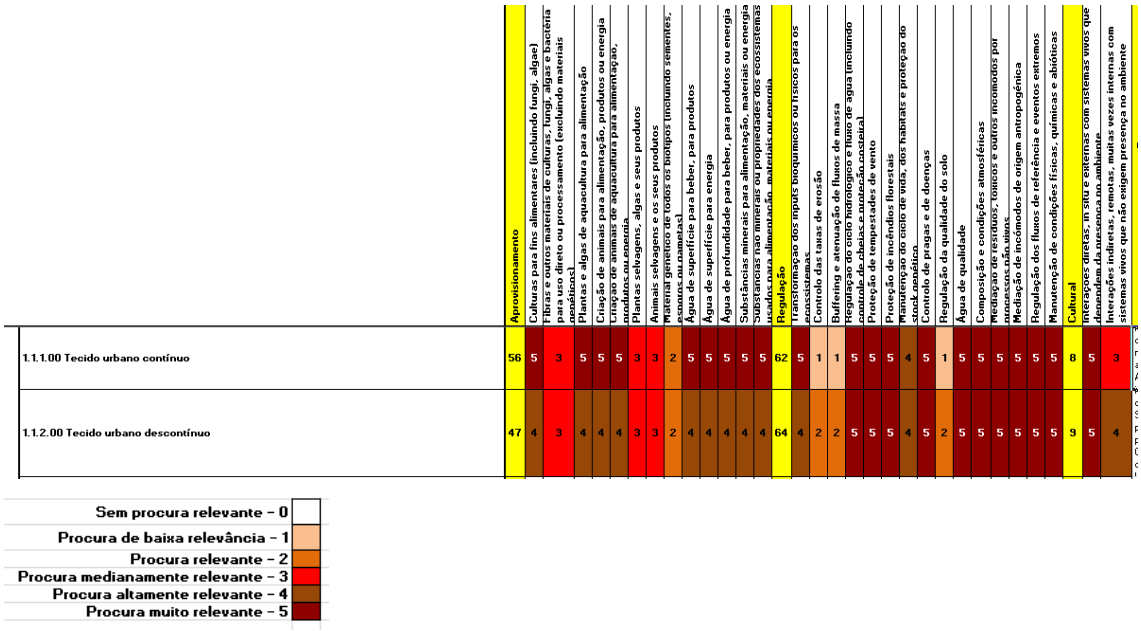
Table 4 – Selected Ecosystem Services for exercise and mapping in LTVR

CICES Section	Class Type	Nomenclature Adopted in this Report
Supply	Crops for food purposes (including fungi, algae)	**Crops for food purposes**
	Fibres and other material from crops, fungi, algae and bacteria for direct use or processing (excluding genetic materials)	**Fibres production**
	Livestock breeding for food, products or energy	**Raising (intensive and extensive) of livestock for food**
	Aquaculture raising for food, products or energy	**Aquaculture raising**
	Genetic material from all biotypes (including seeds, spores or gametes)	**Genetic material**
	Surface water for drinking, for products	**Surface water for drinking and other uses**
	Surface water for energy	**Surface water for energy (water, waves and tides)**
	Deep water for drinking, for products or energy	**Deep water for drinking and other uses**
Regulation	Transformation of biochemical or physical inputs to ecosystems	**Waste decomposition, odour and noise reduction**
	Control of erosion rates	**Control or prevention of soil loss**
	Regulation of the hydrological cycle and water flow (including flood control and coastal protection)	**Flood control and coastal protection**
	Forest fire protection	**Forest fire protection**
	Maintenance of life cycle, habitats and protection of the genetic stock	**Habitat maintenance (includes pollination)**
	Pest and disease control	**Pest and disease control**
	Soil quality regulation	**Soil quality regulation**
	Quality water	**Water quality control (fresh and salty)**
	Composition and atmospheric conditions	**Global climate and air quality regulation**
	Regulation of reference flows and extreme events	**Regulation of extreme events**
Cultural	Direct, in situ and external interactions with living systems that depend on presence in the environment	**Research and experimentation**
	Indirect, remote, often internal interactions with live systems that do not require presence in the environment	**Biodiversity, Identity and Legacy**

To complete the classification weighting matrix for the Lisbon and Tagus Valley Region (LTVR), the technical specifications of the Land Use and Occupation Charter (TGD, 2018 and 2019) were considered, assigning a classification from zero (without relevant capacity) to five (with very high capacity relevant) for each land use class, from a perspective of supply of ecosystem services and from a perspective of demand for ecosystem services, attributing the same rating scale - zero (no relevant demand) to five (very relevant demand).



Picture 2 – Extract from the CICES/COS2015 ecosystem service offer classification matrix (see Annex 3)



Picture 3 – Extract from the classification matrix of demand for ecosystem services CICES/COS2015

The exercise for LTVR was developed in two stages: the first took place in the second half of 2019 and the second in 2020.

Table 5 - Update of LOC (Land Occupation Chart) levels considered in the Ecosystem Services weighting matrix from 1st to 2nd stage

LOC 2015 varied levels (used in the 1st grading exercises)	LOC 2018 at 2 levels – used in updating the Stage 1 and Stage 2 matrices -
1.1.1.00 Solid urban fabric	1.1 Edified fabric
1.1.2.00 Discontinuous urban fabric	
1.2.1.03 Agricultural facilities	1.2 Industry, commerce and agricultural facilities
1.2.1.05.1 Renewable energy production infrastructure	1.3 Infrastructures
	1.4 Transports
1.3.1 Aggregate extraction areas	1.5 Aggregate extraction areas, waste disposal areas and construction sites
1.3.2 Waste disposal areas	
1.3.3 Areas under construction	
1.4.2.01 Golf courses	1.6 Equipment
1.4.2.02 Other sports and leisure facilities	
1.4.2.03 Other cultural facilities and historic areas	1.6 Equipment
1.4.1.01 Parks and gardens	1.7 Parks and gardens
2.1.1 Rain fed Temporary Crops	2.1 Temporary crops
2.1.2 Temporary Irrigation Crops	
2.1.3 Rice paddies	
2.2 Permanent cultures	2.2 Permanent cultures
2.4 Heterogeneous agricultural areas	2.3 Heterogeneous agricultural areas
	2.4 Protected Agriculture and Nurseries
2.3 Permanent pastures	3.1 Pastures
3.2.1 Natural herbaceous vegetation	
3.1.1.00 Hardwood forests (except 3.1.1.01.5 Eucalyptus forests and 3.1.1.01.6 Invasive species forests)	5.1 Forests
3.1.1.01.5 Eucalyptus forests and 3.1.1.01.6 Invasive species forests	
3.1.2 Resinous forests	
3.1.3 Mixed forests	4.1 Agroforestry surfaces
3.2.2 Bushes	6.1 Bushes
3.2.3 Sclerophilic vegetation	
3.3.1 Beaches, dunes and sands	7.1 Uncovered spaces or with little vegetation
3.3.2 Bare rock	
3.3.3 Sparse vegetation	
4.1 Inland wetlands	8.1 Wetlands
4.2 Coastal wetlands	
5.1.1 Water courses	9.1 Inland water bodies
5.1.2.01 Inland lakes and ponds	
5.1.2.02 Dam reservoirs	
5.1.2.03 Other artificial water planes	
5.1.2.03.3 Inland Aquaculture	9.2 Aquaculture
5.2 Marine and coastal waters	9.3 Transitional and coastal water bodies
Total classes 35	Total classes 21

In the **first stage**, the weighting matrix was filled in by 6 experts (including 2 from the CCDR-LVT), from the perspective of the offer of services and the existing demand in each land use class for a given ecosystem service.

At first, 30 ecosystem services were worked on based on the territorial specificities of the Region, and 35 classes of land occupation, with different levels of disaggregation, seeking to list occupation classes that, at the outset, were considered to have a high capacity to provide certain ecosystem services (eg parks and gardens, dam reservoirs, various types of forests). To date, LOC 2015 was used - as LOC 2018 was not yet available - at a varied level of disaggregation, approximating the *Corine Land Cover* classes used by Burkhard *et al*. in 2009.

In the course of the work, the weighting matrix was updated taking into account COS 2018, using the single criterion of disaggregating the LOC into 2 levels, avoiding detail only in certain classes and seeking a macro reading at the regional level of the capacity of the land cover classes provide a certain Ecosystem Service. In this correspondence exercise, two classes that had not been considered before (Transport and Nursery Agriculture) were added to the initial matrix and that were added to ensure full land cover avoiding "gaps" in the final SE classification maps. With the aggregation of LOC at 2 levels, Agricultural Installations became part of the Industry, Commerce and Logistics class. Following these adjustments, the classification then assigned in the ES matrices was revised by the CCDR-LVT, considering the changes introduced.

As an approximation to the ecosystem services used by Burkhard in his methodology, 30 ES were initially considered in the classification matrix. However, over the course of the work, having as reference the territorial specificities of the LTVR, 20 ecosystem services were selected and worked, listed in Table 4.

In the **second stage**, in order to increase the level of expert knowledge, a panel of 12 experts from different areas of specialization in the scientific domain[1] was used to, through an approach inspired by a Delphi process; enable the filling of the matrix to be strengthened supports the mapping of macro-scale ecosystem services in the region. Since the objective was not to reach consensus but only to gather the perceptions of the various experts on a given topic / ES, it was decided to restrict the consultation process to experts to a round of responses. Bearing in mind their technical and scientific knowledge, each expert filled the matrix only in the ES related to their specialty. In some ES, opinions were received from several experts on that topic or service (3 to 5 responses). In these cases, it was decided to perform an average of the ratings assigned in order to obtain only one value per cell.

The contributions received at this stage focused only on the perspective of offering ecosystem services.

In this stage, the 20 Ecosystem Services were worked (Table 4) and the 21 occupation classes of LOC 2018 were used, resulting from their disaggregation into 2 levels (Table 5).

In both stages, a weighted average was applied to the results of the experts' perspectives, materialized in the matrix, in order to obtain a single value per cell. The COS was categorized (attributing a colour) according to the obtained matrix (0 to 5), which allowed mapping each of the ecosystem services in the LTVR.

[1] Water, hazards, soil, food systems, landscape, biodiversity, climate and climate change, recreation, leisure and tourism.

3.2. Summary of Results

The maps obtained in this exercise map the perception of the potential of ecosystem services, which could/should be strengthened at the municipal scale or with a focus on case studies (representative of each ecosystem service), using modelling, and statistical data or based on expert reviews.

As reported by Burkhard *et al*. (2009), the mapping of ecosystem services from expert analysis matrices has the benefit of:

- Obtain an overall view of the distribution of the capacity to provide SE in the territory;
- Allow the identification of areas with the greatest offer of services, potential conflicts, etc.;
- Only need information on land use and occupation and expert opinions;
- Easy to apply.

However, this method also has some limitations:

- The validity of the results depends on the expert views, which are not always coincident;
- It only considers the use and occupation of the land, neglecting other aspects that occur, for example, at an atmospheric or subsoil level;

Even so, the mapping of Ecosystem Services in the Lisbon and Tagus Valley Region constitutes an important and innovative support for the planning work, not only from the perspective of its identification, but also from the perspective of valorisation, contributing to a more cohesive territory (attributing value and remunerating territories) and for adaptation/mitigation to climate change.

This exploratory mapping exercise resulted in 69 maps:

- 20 supply and 20 demand for the 1st stage;
- 20 SE offer referring to the 2nd stage;
- 9 relating to an aggregated reading of the supply, regulation and cultural ES (3 for supply and 3 for demand from the 1st stage and 3 from the supply of the 2nd stage).

At this point, only the maps with the aggregated data are presented, and the rest are available in the Annex, leaving brief notes on the interpretation of the results obtained here.

In general terms, the results obtained, both in the 1st and 2nd stage of expert consultation, show some concentrations of high capacities to provide a wide range of ecosystem services in different types of forest cover, agricultural areas, bushes, zones wet or water bodies.

On the other hand, land cover types highly modified by man, such as urban fabric, industrial or commercial areas and inert extraction sites, have very low or non-existent capacities to provide ecosystem services, but high levels of demand for several ES. It is in territories with greater human occupation that there are higher levels of demand for the various ES. Exceptions from this dominant pattern are the demand for surface or deep water supply services for drinking and other uses, which include irrigation, with higher levels of demand also being highlighted in the types of agricultural occupation.

Forest show a relevant capacity to offer ecosystem services, especially in terms of regulation, which assume greater expression in the map resulting from the 2nd stage of expert consultation.

In cultural services, water bodies and wetlands stand out for their high capacity to provide services, while forestry and agricultural areas are also highlighted. The demand for this type of service is concentrated in urban areas with greater human occupation.

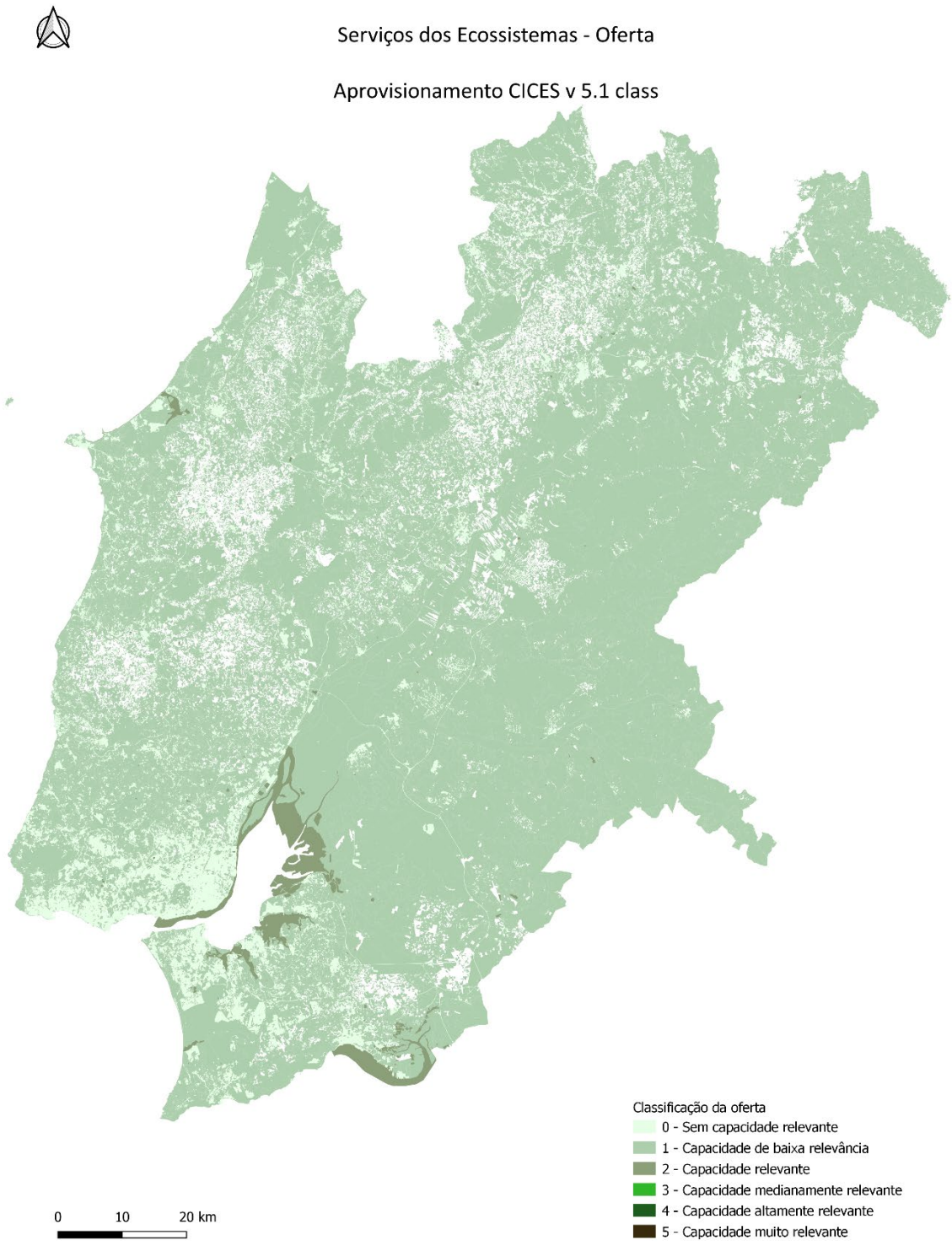
From the 1st stage of mapping services to the 2nd stage, there are some differences in the maps obtained, recording in the 2nd moment of ES weighting the recognition of greater capacity to provide ES by certain categories of land occupation, thus obtaining greater cartographic expression. This increased recognition can be seen, namely in the supply of deep water supply for drinking and other uses (namely irrigation), in the raising of animals for food and in the production of fibre.

In the regulation of the global climate and air quality, as well as in the habitat maintenance service (including pollination) in the 1st stage, greater capacity for regulation is attributed to forest occupations (higher value), registering values higher than those attributed by the experts of the 2nd classification stage.

As for the regulation of extreme events - which includes, for example, sand ridges for coastal protection, topographic elevations for wind control - the difference between the 1st and 2nd stage of mapping is significant, with more increased values attributed by the experts of the 2nd stage.

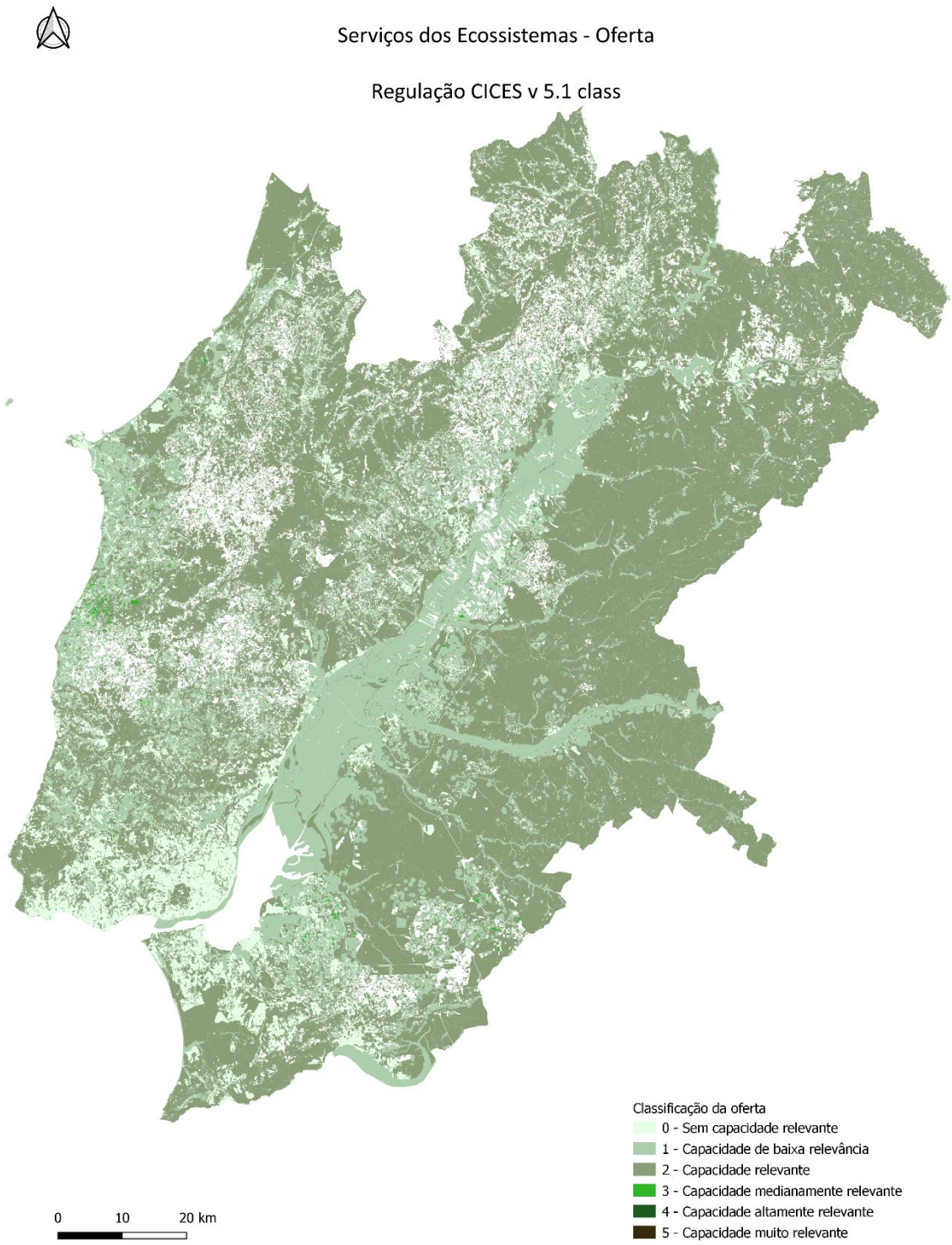
In cultural services, the classifications given in the 1st and 2nd mapping stages are identical. Note that the category of cultural ecosystem services is distinct from the others because these services are not always directly related to land use classes, that is, the service is provided in a specific place (eg, in a pine forest) and not by that typology of land occupation (eg, in all pine forests), thus being associated with distinct cultural practices that are dynamic in space and time. The mapping of cultural services, as well as other services, must therefore be measured and complemented using other methods of analysis and perception[2].

[2] See more information at: https://www.researchgate.net/publication/315066978_Mapping_Ecosystem_Services. Chapter 5.5.3. Cultural mapping ecosystem services (p. 197)



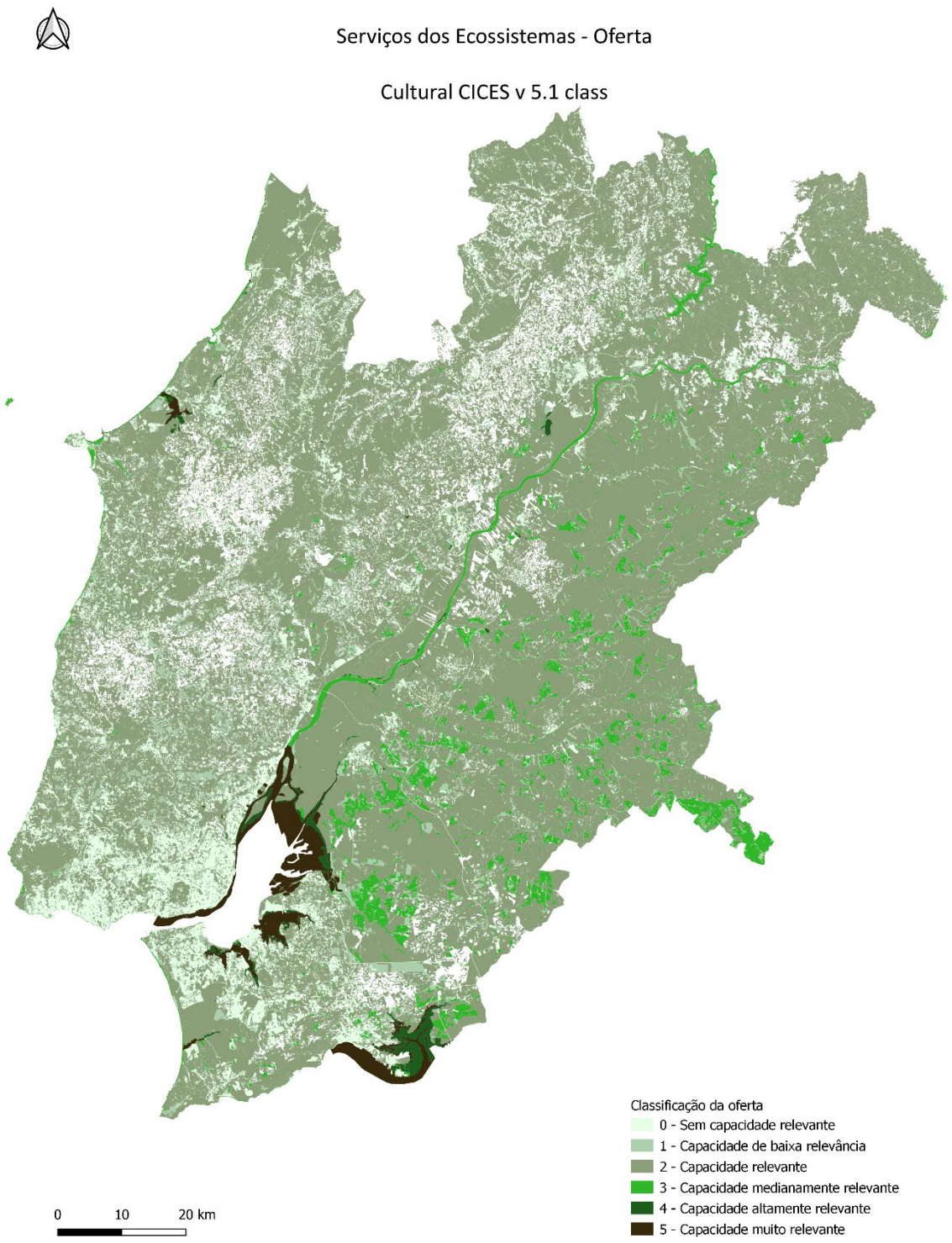
Picture 4 – Supply of Ecosystem Services at LTVR - Supply (1st stage, aggregated data)[3]

[3] Map caption: no relevant capability; low relevance ability; relevant capacity; moderately relevant capacity; very relevant ability; highly relevant capability.



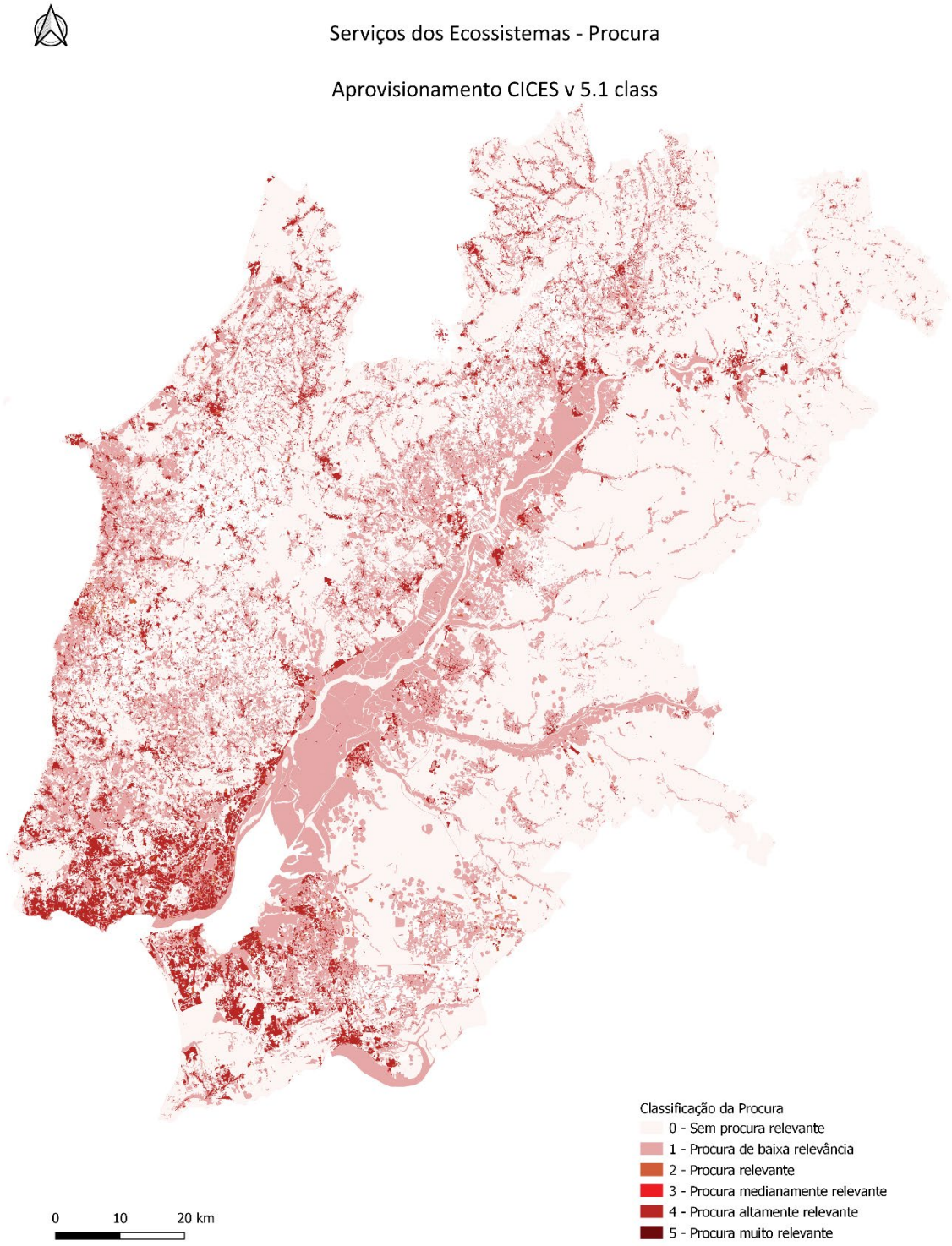
Picture 5 – Supply of Ecosystem Services in LTVR - Regulation (1st stage, aggregated data)[4]

[4] Map caption: no relevant capability; low relevance ability; relevant capacity; moderately relevant capacity; very relevant ability; highly relevant capability.



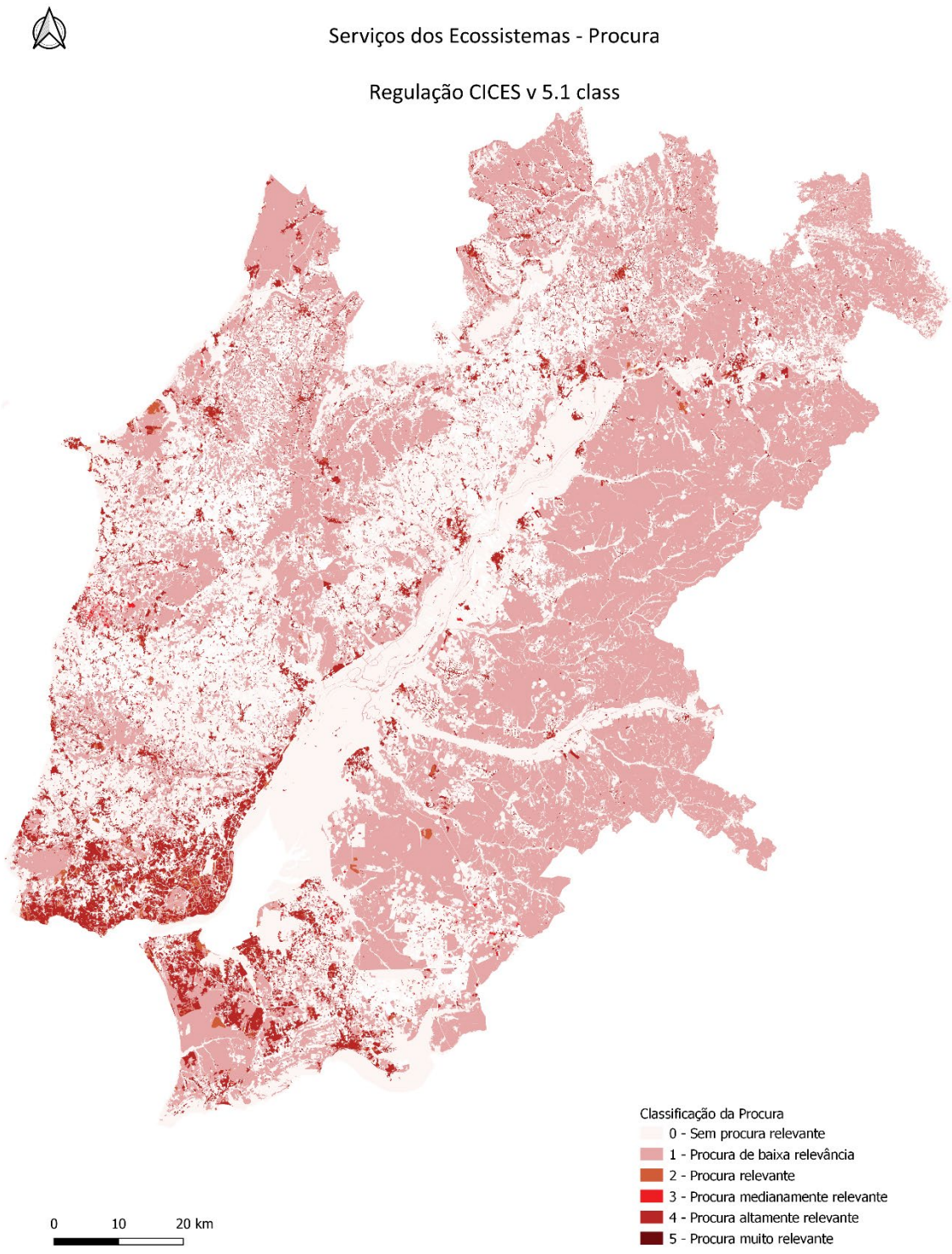
Picture 6 – Supply of Ecosystem Services in LTVR – Cultural (1st stage, aggregated data)[5]

[5] Map caption: no relevant capability; low relevance ability; relevant capacity; moderately relevant capacity; very relevant ability; highly relevant capability.



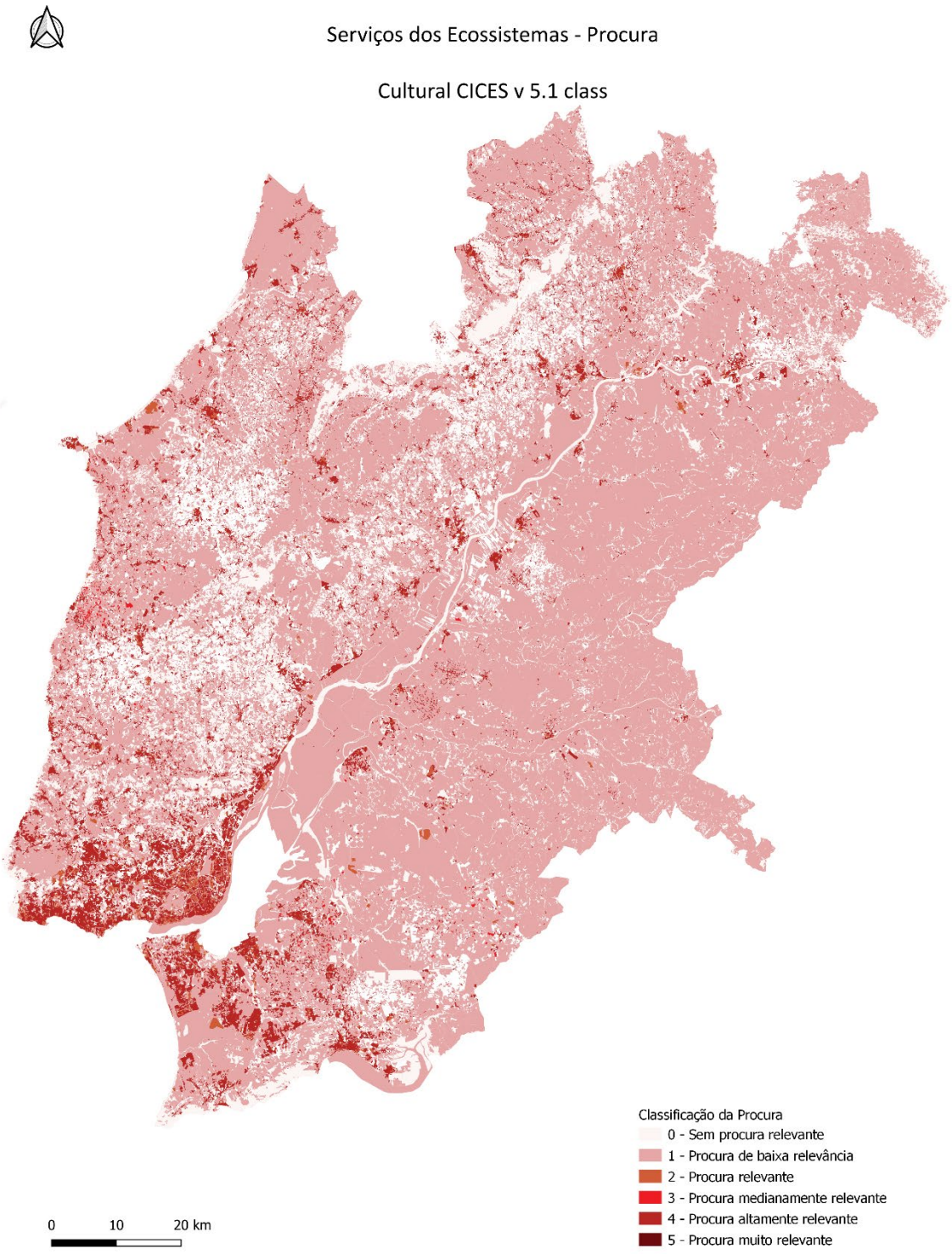
Picture 7 – Demand for Ecosystem Services in LTVR - Procurement (1st stage, aggregated data)[6]

[6] Map caption: no relevant capability; low relevance ability; relevant capacity; moderately relevant capacity; very relevant ability; highly relevant capability.



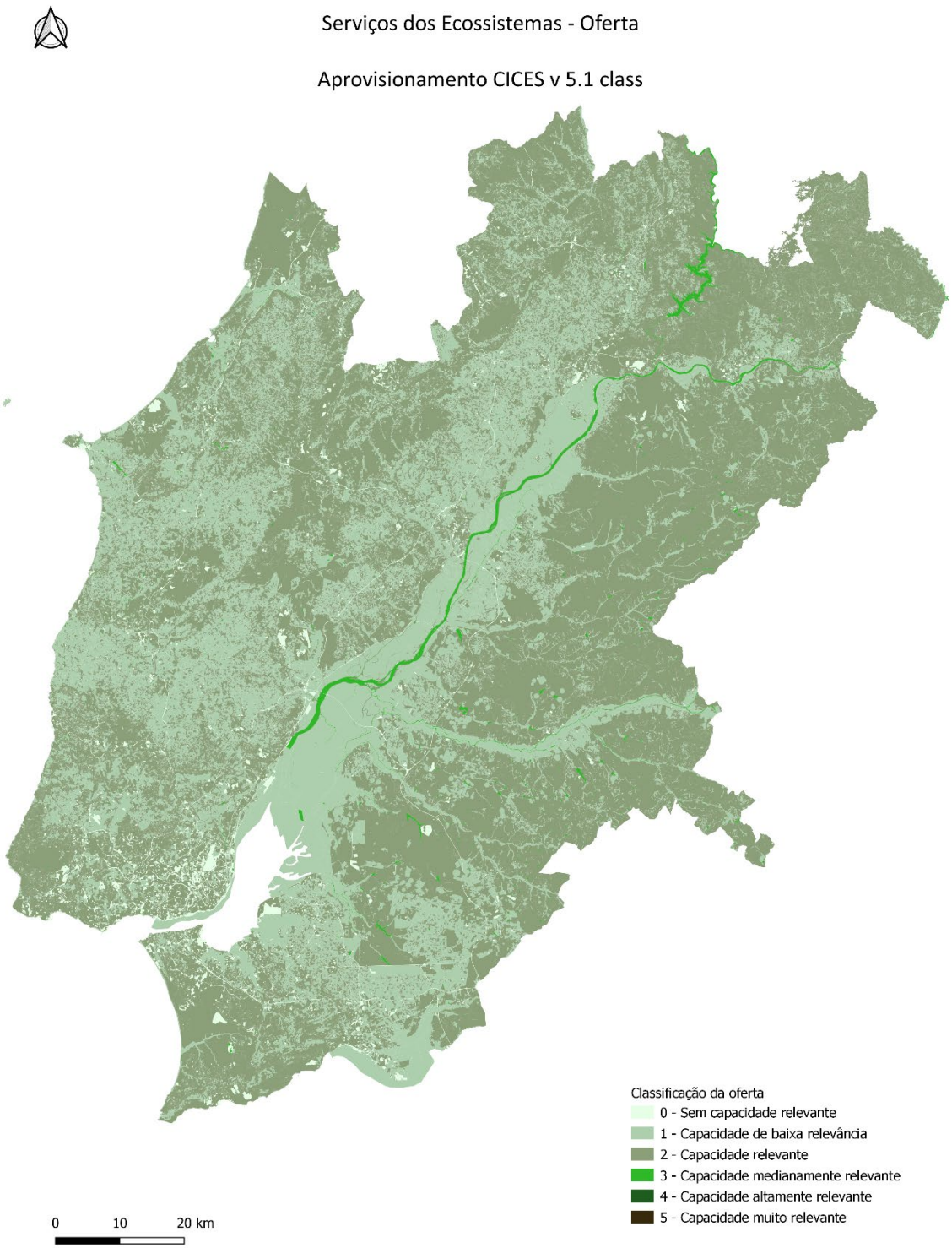
Picture 8 – Demand for Ecosystem Services in LTVR - Regulation (1st stage, aggregated data)[7]

[7] Map caption: no relevant capability; low relevance ability; relevant capacity; moderately relevant capacity; very relevant ability; highly relevant capability.



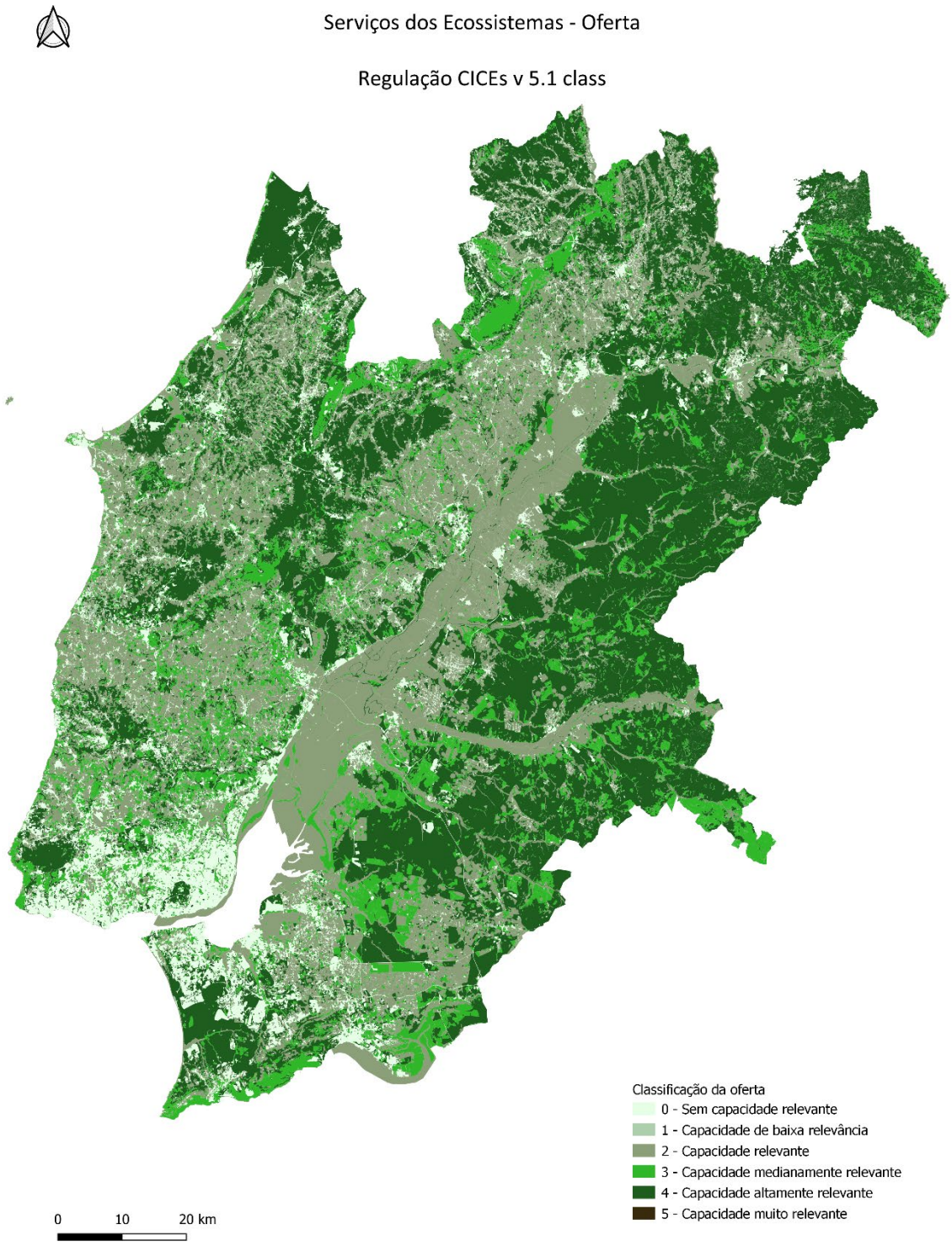
Picture 9 – Demand for Ecosystem Services in LTVR - Cultural (1st stage, aggregated data)[8]

[8] Map caption: no relevant capability; low relevance ability; relevant capacity; moderately relevant capacity; very relevant ability; highly relevant capability.



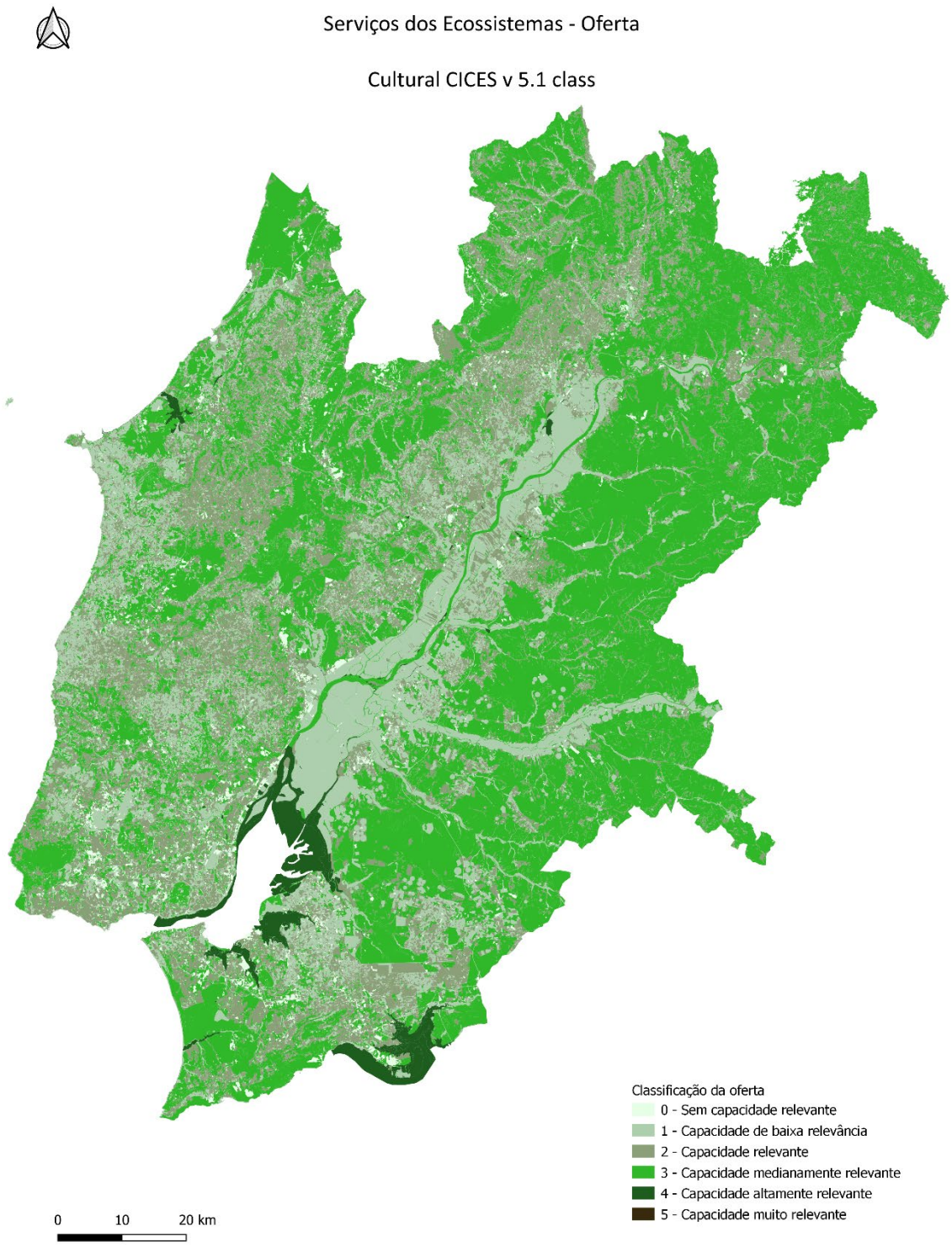
Picture 10 – Supply Ecosystem Services at LTVR - Supply (2nd stage, aggregated data)[9]

[9] Map caption: no relevant capability; low relevance ability; relevant capacity; moderately relevant capacity; very relevant ability; highly relevant capability.



Picture 11 – Supply of Ecosystem Services in LTVR - Regulation (2nd stage, aggregated data)[10]

[10] Map caption: no relevant capability; low relevance ability; relevant capacity; moderately relevant capacity; very relevant ability; highly relevant capability.



Picture 12 – Supply of Ecosystem Services at RLVT - Cultural (2nd stage, aggregated data)[11]

[11] Map caption: no relevant capability; low relevance ability; relevant capacity; moderately relevant capacity; very relevant ability; highly relevant capability.

4. Ecosystem Services in Land Use Planning

Sorraia Valley
Source: CCDR-LVT

As, or more, important than mapping the ES is to value them and integrate them into the practices of land use planning and regular urban management in the municipalities. Aware of this, this chapter presents some guidelines to support the integration of ecosystem services in the MDPs and clues for their financing and implementation.

In these guidelines, relevance is given to the Municipal Green Infrastructure, the Municipal Ecological Structure and the National Ecological Reserve as connectivity networks that bring together ecosystems that provide not only environmental, but also economic and social services.

In this framework, it is important to make explicit the relationship between ecosystem services and municipal ecological structures, in order to progress towards multifunctional green infrastructures.

4.1. From Ecosystem Services to Green Infrastructure: The Contribution of Spatial Planning

Recognizing the importance of integrating the ES in the practice of Spatial Planning, it is essential to know the mechanisms and legal framework that the Public Administration has at its disposal to carry out this integration and enhancement in the planning instruments.

Thus, starting from the principle that the Municipal Ecological Structure (MES) can be constituted as the backbone for the implementation of an ecologically based territorial model, it is important, in the first instance, to highlight the concept and the normative foreseen for the MES in the Legal Regime of the Territorial Management Instruments (LRTMI), understood as a crucial tool for the integration of ES in Spatial Planning.

MUNICIPAL ECOLOGICAL STRUCTURE - LEGAL FRAMEWORK

The Municipal Ecological Structure became mandatory in 1999, with the approval of Decree-Law No. 380/99 of September 22, which regulates the regime applicable to territorial management instruments. The MES is mandatory in the various levels of planning, namely in the Municipal Master Plans.

Under the new Legal Regime of Territorial Management Instruments (LRTMI), defined by Decree-Law Nº. 80/2015 of May 14, the Ecological Structure is understood as a territorial resource to be identified by the programs and territorial plans. Municipal plans aim to establish the definition of the ecological structure for the purposes of municipal environmental protection and enhancement and the Municipal Master Plans must identify the MES and the criteria to be adopted, as well as the available means and the proposed actions, which are necessary to protect the values and natural resources, water, cultural, agricultural and forestry resources. MES is defined as the "*set of soil areas that, by virtue of their biophysical, cultural or landscape characteristics, their ecological continuity and their planning, have its main function is to contribute to the ecological balance and to the protection, conservation and environmental and landscape enhancement of rural and urban spaces*". The same decree also adds that the MES exists in continuity in the rural and urban land, and may integrate different spaces, and in the rustic soil the MES comprises the areas affected by the Fundamental Nature Conservation Network in the municipality's territory, the subject natural areas to risks and vulnerabilities and also other land areas that are selected and delimited according to the municipal interest, namely for reasons of environmental, landscape and natural heritage

protection and enhancement, and ecosystem services. Within urban perimeters, MES comprises green spaces for collective use and other spaces, of a public or private nature, which are necessary for the balance, protection and enhancement of the environment, landscape and the natural heritage of the urban space, particularly with regard to regulation of the hydrological cycle, bioclimatic regulation of the city, improvement of air quality, conservation of biodiversity and ecosystem services.

In short, the MES is an instrument for environmental planning and land use planning that recognizes ecosystem services, territorial ecological systems and guides the occupation and transformation of the territory in a sustainable way.

REGIONAL ECOLOGICAL STRUCTURES

It would not be coherent to refer to Municipal Ecological Structures without addressing their regional framework, specifically the Regional (or Metropolitan) Structure of Environmental Protection and Enhancement defined in the Regional Land Use Plans.

The LTVR is covered by two Regional Land Use Plans - the West and Tagus Valley and the Lisbon Metropolitan Area - which establish, in an articulated manner, the regional ecological structure for environmental protection and enhancement. The combination of the two structures forms the Ecological Structure of the Lisbon and Tagus Valley, which is subsequently transposed to the Municipal Master Plans at the time of their elaboration or revision.

Lisbon Metropolitan Area

The Regional Ecological Structure is a system of areas and connections that integrate, involve and cross territorial units and the urban system as a whole, being hierarchical in three levels.

A. ***Primary Network***. Four primary structural areas are established with their respective primary structural links/corridors and which include the following territories - Serra de Sintra and Litoral de Colares to Cascais; Tagus Estuary; Sado Estuary; Arrábida – Espichel – Sesimbra Woods – Lagoa de Albufeira; Corridors and Primary Structuring Links.

B. ***Secondary Network***. Areas not yet predominantly occupied by buildings or infrastructure and with ecological biodiversity (in most cases, deciduous or evergreen forests or alluvial valleys and lowlands). These areas are significantly related to hydrological systems, being important in flood control and in the quality of the metropolitan environment.

C. ***Key areas and connections***. The concept of key areas and corridors stems from the fact that in consolidated, unstructured, fragmented and disorderly urban areas of the metropolitan territory, free, unbuilt space is already of a dimension and configuration that refers to residual space, even if in some cases of apparently significant size.

West and Tagus Valley

The Regional Structure for Environmental Protection and Enhancement is a structure supported by a set of territorial areas and corridors that represent and include areas with greater natural value or with greater ecological sensitivity. This structure should allow the maintenance of the biodiversity characteristic of the Region and of the ecological processes that are fundamental for the integrity of its sensitive ecosystems.

This Regional Structure consists of a hierarchical network of systems and subsystems implemented in a set of nuclear and complementary areas and ecological corridors, organized into three levels:

A. Primary Network. It includes the main ecological units that have a high natural and landscape value and whose conservation priorities are relevant on a European and national scale. It is made up of Structuring Nuclear Areas articulated with each other through Structuring Ecological Corridors of regional and national dimension.

B. Secondary Network. It comprises Secondary Nuclear Areas and Secondary Ecological Corridors. The former encompass areas identified as areas of high ecological value, which include the most significant scrubland and wetlands, with the Cesaredas Plateau, the Óbidos Lagoon, and the Paúl da Tornada and the Cannhão da Ota which, along with most Secondary Nuclear Areas, constitute spaces of high value for the conservation of biodiversity and landscape, and unique in terms of regional identity.

C. Complementary Network. It results from the existence of a relevant set of natural values associated with agricultural and forestry activities and very humanized landscapes with high landscape value.

In both Regional Plans, a set of specific guidelines and norms relating to the Regional or Metropolitan Ecological Structure were defined, aimed at Management and Territorial Planning Instruments, at Central and Local Administration, with the aim of supporting the transposition to other scales.

The transposition of the Regional Ecological Structure to the PDM has followed different methodological approaches: in some municipalities, EEM followed a methodology more focused on legal conditions and its specific regulation; in other municipalities, the Ecological Structure was considered an instrument for valuing the territory, updating the PROT guidelines with the most recent concepts for valuing ecosystem services and green infrastructure.

ECOSYSTEM SERVICES AND GREEN INFRASTRUCTURES

The concept of Ecological Structure that has been used in the Municipal Plans has a strong bearing on environmental sustainability, the protection and enhancement of biodiversity and habitats, and the territory's natural values, usually mapped in the form of ecological areas and corridors.

However, other environmental, social and economic issues are added to the planning and management of the territory, such as mitigation and adaptation to climate change, the maintenance of agricultural and forestry production or flood control and fire risk management, among others.

It is in this context that the relationship between human well-being, ecosystems and biodiversity emerges more clearly, operationalizing the concept of ecosystem services – the benefits that people obtain from ecosystems. In many respects, the ideas underlying this concept were already part of spatial planning practices, but were not clarified (MEA 2005).

The European Commission (EC), which has been supporting projects for the implementation of Ecological Networks, through the LIFE program, also recognizes the potential of Green Infrastructures. From promoting the functional connectivity of ecosystems, containing fragmentation and promoting resilience, to mitigating and adapting to climate change, Green Infrastructure helps to increase the value of goods and services provided by ecosystems and, in the long term, also helps to improve the ecological status of habitats and to conserve threatened species, protecting biodiversity (European Commission, 2010).

The “Biodiversity Strategy for 2030” adopted in May 2020, a central element in the European Ecological Pact where one of the objectives is precisely the “greening of urban and peri-urban areas” (2.2.6), states that the promotion of healthy ecosystems, Green infrastructure and nature-based solutions must be systematically integrated into urban planning, namely in public spaces, infrastructure and in the design of buildings and areas.

The concept of Green Infrastructure, as introduced by Benedict & McMahon (2006), differs from traditional conservation strategies, adopting a more comprehensive and utilitarian view of the multiple functions of high ecological value spaces, creating multifunctional sustainable management strategies over the long term deadline. According to the authors, green infrastructure constitutes a "network of spaces relevant to the ecological balance of the territory", which may include natural, semi-natural or naturalized areas: water lines, wetlands, forests, agricultural soils, coastal zones, urban parks and other open spaces that contribute to maintaining ecological and biophysical processes, in rural and urban land.

From the European Commission point of view, the identification of green infrastructure is conceptually linked to the identification of ecosystem services, since the mapping of ecosystem services exposes the areas where green infrastructure has the greatest potential for obtaining environmental and economic benefits (Padrão 2016).

Ecosystem services have environmental value, and the goods and benefits provided by these services can have economic and social value, where social value can include cultural and aesthetic value for human well-being, considering non-materials. Thus, for the design of a green infrastructure, it is essential to bear in mind the two components, so the development and planning of a green infrastructure should not be restricted to the existing environmental quality, but also to the understanding of its multifunctionality, as well as the underlying economic value (Mell *et al*.2013)

When planning a green infrastructure it is necessary to identify and map existing ecosystem services and their benefits. On the other hand, through the benefits of ecosystem services it is possible to economically value the benefits of green infrastructure (Constanza *et al*. 1997)

According to the European Commission, the integration of green infrastructure in planning processes should be considered, allowing the analysis of relevant aspects, and taking decisions that allow obtaining the maximum benefit possible for the same investment (European Commission, 2013a). Thus, spatial planning can help to identify the best location for projects, according to the needs and perspectives of decision-makers, for example, the restoration of habitats, or the improvement of connectivity between protected areas, support for the development of green infrastructures taking into account the sensitivity of the areas where they are located and the possibility of contributing to the identification of multifunctional spaces, where land use is allocated according to their potential (European Commission, 2013b).

Spatial planning intervention for green infrastructure can operate at different scales, from local to national. According to the Landscape Institute (2008), in a smaller scale intervention, an analysis of strategic planning integrated into local planning can be carried out, considering the characteristics of the landscape, microclimate and topography, contributing to maximize benefits and minimize impacts.

On a more detailed scale, green walls or roofs can be installed, improving the thermal efficiency of buildings and reducing the risk of flooding. These interventions all together and

Typical GI assets and their associated scales		
Local, neighbourhood and village scale **Town, city and district scale** **City-region, regional and national scale**	**Town, city and district scale**	**City-region, regional and national scale**
Street trees, verges and hedges	Business settings	Regional parks
Green roofs and walls	City/district parks	Rivers and floodplains
Pocket parks	Urban canals	Shoreline
Private gardens	Urban commons	Strategic and long distance trails
Urban plazas	Forest parks	Forests, woodlands and community forests
Town and village greens and commons	Country parks	Reservoirs
Local rights of way	Continuous waterfront	Road and railway networks
Pedestrian and cycle routes	Municipal plazas	Designated greenbelt and Strategic Gaps
Cemeteries, burial grounds and churchyards	Lakes	Agricultural land
Institutional open spaces	Major recreational spaces	National Parks
Ponds and streams	Rivers and floodplains	National, regional or local landscape designations (e.g. AONBs, NSAs and AGLVs) Canals
Small woodlands	Brownfield land	Common lands
Play areas	Community woodlands	Open countryside
Local nature reserves	(Former) mineral extraction sites	
School grounds	Agricultural land	
Sports pitches	Landfill	
Swales, ditches		
Allotments		
Vacant and derelict land		

Picture 13 - Possible typology of components or elements of Green Infrastructures at different scales
Source: Landscape Institute (2009)

Green Infrastructures are thus a means of facilitating language and greater consensus between "conservationists" and "developmentalists" - considering not only the ecological values involved, but also the present economic dynamics and the needs of local communities (recreational, leisure, aesthetic, social , economic or health). Green Infrastructures make nature conservation compatible with other activities, promoting sustainable growth adaptable to local realities (Correia 2012).

Finally, it is important to emphasize that, for reading and interpreting this Report, it is considered that the definition of Ecological Structure is capable of integrating the concept of green infrastructure, as the legal framework for spatial planning allows for the concept to ecological structure can evolve in the integration of the operational and valorisation principles of the ES underlined by the concept of green infrastructure, which has a more operative character.

NATIONAL ECOLOGICAL RESERVE AND ECOSYSTEM SERVICES

National Ecological Reserve was created in 1983 by the then Ministry of Quality of Life (VIII Constitutional Government) and its legal system, established by Decree-Law No. 321/83, of July 5, intended to safeguard "*all essential areas to the ecological stability of the environment*

and the rational use of natural resources, with a view to the correct planning of the territory" (cf. Article 1).

Following the publication of the Basic Environmental Law (Law nº. 11/87, of 7 April), the XI Constitutional Government published Decree-Law nº. 93/90, of 19 March, which revoked the diplomas precedent legislation and established a new legal regime for National Ecological Framework, which reformulated several of the aspects of the precedent diploma without changing its fundamental principles.

Decree-Law Nº. 93/90 intended to "*safeguard, at once, ecological values and man, not only in their physical integrity, but also in the fruitful framework of their economic, social and cultural activity, as highlighted in the European Charter for Spatial Planning*" (cf. Preamble). National Ecological Framework then began to constitute itself as "*a basic and diversified biophysical structure which, by conditioning the use of areas with specific ecological characteristics, guarantees the protection of ecosystems and the permanence and intensification of biological processes essential to the balanced framing of human activities*" (cf. article 1).

Decree-Law nº. 93/90 underwent several changes during its period of validity, with emphasis on the current Decree-Law nº. 124/2019, of August 28, which amends Decree-Law nº. 166/2008, of August 22, amended by Decree-Laws Nº. 239/2012, of November 2, 96/2013, of July 19, and 80/2015, of May 14.

Recognizing the importance of National Ecological Reserve founding principles, the preamble to the most recent version of the Legal Regime reaffirms its relevance in a "*context of climate change and extreme weather events, lack of water, risks associated with the coastal zone and the occurrence of floods*", underlining its contribution "*to the adaptation of territories and to their greater resilience*".

The National Ecological Reserve aims to contribute to the sustainable occupation and use of the territory and its essential objectives are:

- **Protect** natural **water** and **soil** resources;
- **Safeguarding** biophysical systems and processes associated with the **coast** and the **terrestrial hydrological cycle** that ensure **essential environmental goods and services** for the development of human activities;
- **Prevent and reduce** the effects of the **degradation of aquifer recharge**, the **risks** of **maritime flooding**, **floods**, **soil water erosion** and **mass movements on slopes**, contributing to adaptation to the effects of climate change and safeguarding environmental sustainability and the safety of people and goods;
- Contribute to the **connectivity** and **ecological coherence** of the **Fundamental Nature Conservation Network**;
- Contribute also to the implementation, at national level, of the priorities of the **Territorial Agenda of the European Union** in the ecological and trans-European management of natural risks domains.

National Ecological Reserve is a territorial structure where biological and physical processes deserving of special protection interact, so that the conditions considered adequate to the

sustainability of the territory and the safeguarding of environmental services essential to the development of human activities are applied to each type of area that composes it provides.

Bearing these concerns in mind, it was decided to identify the potential ecosystem services of the National Ecological Reserve (NER) using an exercise in which its functions and the services provided according to the CICES classification were considered. In order not to distort the principles that are at the base of the National Ecological Reserve as a restriction of public utility, no value was attributed to the services provided.

Table 6 - Typologies of National Ecological Reserve and Services

National Ecological Reserve 2019		NER Regional	Functions	CICES	
Coastal Protection	Coastal Protection Maritime Strip	Coastal Protection Maritime Strip	high productivity in terms of biological resources	Supply	Genetic material
			high hydrodynamics responsible for the balance of sandy shores		Fibers and other material from cultures, fungi and algae
			area of occurrence of natural habitats and species of marine flora and fauna		Aquaculture breeding
			coastal dynamics processes		Surface water for energy (water, waves and tides)
			prevention and risk reduction, ensuring the safety of people and goods	Regulation	Flood control and coastal protection
					Maintenance of life cycle, habitats and protection of the genetic stock
					Water quality control (fresh and salty)
					Global climate and air quality regulation
					Regulation of extreme events
				Cultural	Investigation
					Experimentation
					Identity and legacy
	Beaches	Beaches	maintenance of coastal dynamics processes	Supply	Genetic material
			conservation of natural habitats and species of flora and fauna	Regulation	Flood control and coastal protection
			shoreline maintenance		Global climate and air quality regulation
			prevention and risk reduction, ensuring the safety of people and goods		Regulation of extreme events
				Cultural	Investigation
					Experimentation
					Identity and legacy

National Ecological Reserve 2019		NER Regional	Functions	CICES	
Coastal Protection	Detrital barriers	Detrital barriers	barrier against ocean overtopping and erosion caused by sea and wind	Supply	Genetic material
			processes of coastal dynamics and support for the diversity of natural systems, namely the dune structure, vegetation and fauna	Regulation	Flood control and coastal protection
					Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
					Regulation of extreme events
				Cultural	Investigation
					Experimentation
					Identity and legacy
	Tombolo	Tombolo	maintenance of coastal dynamics	Supply	Genetic material
			conservation of natural habitats and species of flora and fauna	Regulation	Flood control and coastal protection
			shoreline maintenance		Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
					Regulation of extreme events
				Cultural	Investigation
					Experimentation
					Identity and legacy
	Salt marshes	Salt marshes	conservation of natural habitats and species of flora and fauna	Supply	Crops for food purposes
			maintenance of balance and fluvial-marine dynamics		Fibres and other material from cultures, fungi and algae
					Genetic material
				Regulation	Waste decomposition, odor and noise reduction
					Flood control and coastal protection
					Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
					Pest and disease control
					Water quality control (fresh and salty)
					Global climate and air quality regulation
					Regulation of extreme events
				Cultural	Investigation
					Experimentation
					Identity and legacy

National Ecological Reserve 2019		NER Regional	Functions	CICES	
Coastal Protection	Islets and rocks immersed in the sea	Islets and rocks immersed in the sea	relevance for the protection and conservation of habitats and species of flora and fauna	Supply	Genetic material
				Regulation	Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
				Cultural	Investigation
					Experimentation
					Identity and legacy
	Estuaries	Estuaries	conservation of natural habitats and species of flora and fauna	Supply	Fibers and other material from cultures, fungi and algae
					Genetic material
				Regulation	Waste decomposition, odor and noise reduction
					Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
					Global climate and air quality regulation
				Cultural	Investigation
					Experimentation
					Identity and legacy
		Estuaries protection areas	maintenance of balance and fluvio-marine dynamics	Supply	Crops for food purposes
					Fibers and other material from cultures, fungi and algae
					Aquaculture animal breeding
					Genetic material
				Regulation	Waste decomposition, odor and noise reduction
					Flood control and coastal protection
					Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
					Pest and disease control
					Regulation of extreme events
				Cultural	Investigation
					Experimentation
					Identity and legacy

National Ecological Reserve 2019			NER Regional	Functions	CICES	
Coastal Protection	Coastal Dunes and Fossil Dunes	Coastal Dunes	Coastal Dunes and Fossil Dunes	barrier against erosion and ocean overtopping, associated with storms or tsunamis, and wind erosion	Supply	Fibers and other material from cultures, fungi and algae
				natural sand storage to compensate for the loss of sediment caused by erosion		Genetic material
				guarantee of coastal dynamics processes and the diversity of natural systems, namely of morphological characteristics, natural habitats and species of flora and fauna	Regulation	Flood control and coastal protection
				expected displacement of the coastline, in a period of 100 years, taking into account the local geological conditions		Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
				prevention and risk reduction, ensuring the safety of people and goods		Soil quality regulation
						Regulation of extreme events
					Cultural	Investigation
						Experimentation
						Identity and legacy
		Coastal Dunes inland		continuity of dune systems, with regard to geological, morphological, ecological and landscape aspects	Supply	Fibers and other material from cultures, fungi and algae
				flora and fauna biodiversity reserve and respective ecosystem services associated with these biotic formations		Genetic material
				prevention and risk reduction, ensuring the safety of people and goods	Regulation	Flood control and coastal protection
						Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
						Soil quality regulation
						Regulation of extreme events
					Cultural	Investigation
						Experimentation
						Identity and legacy

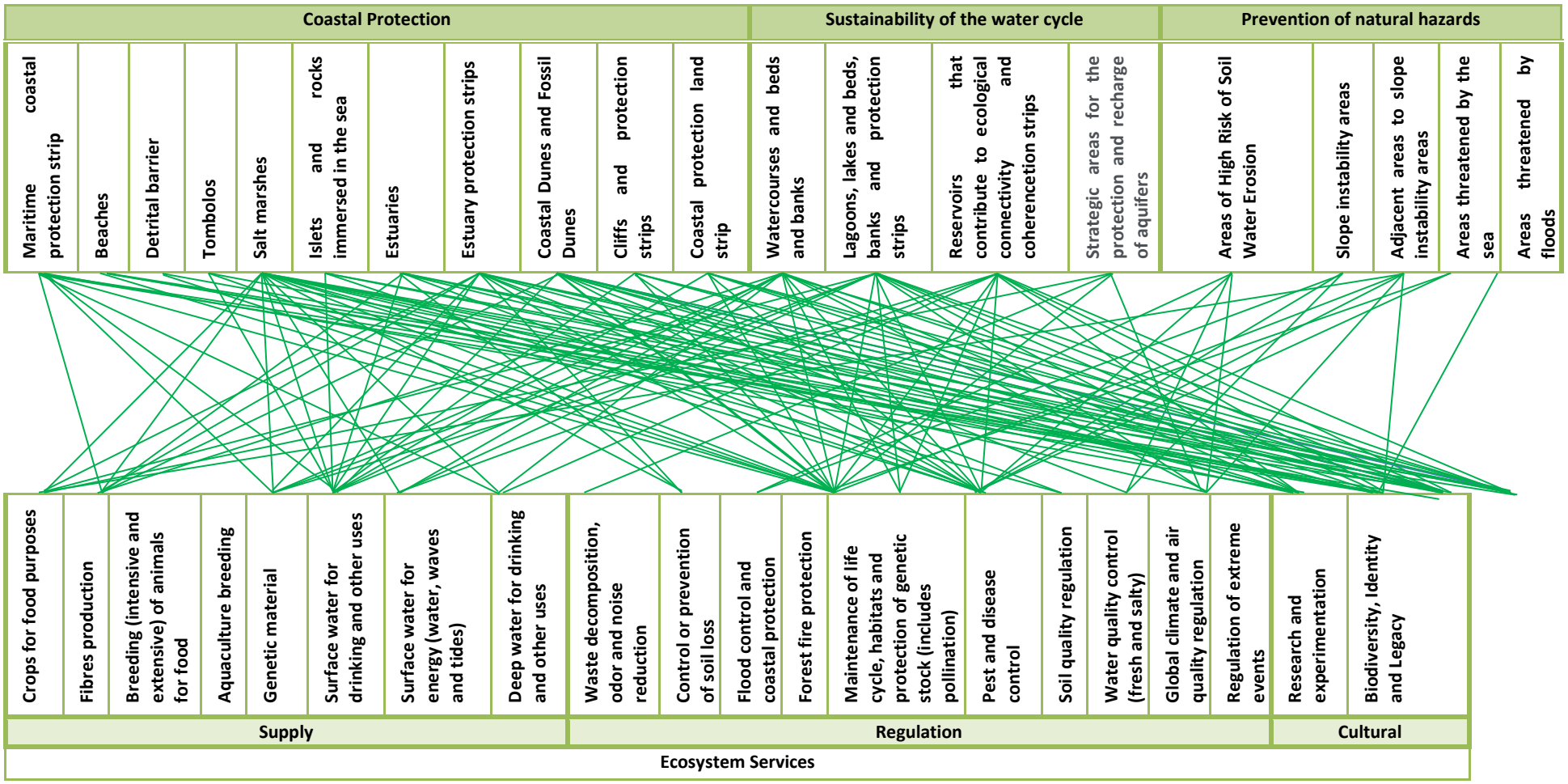
National Ecological Reserve 2019			NER Regional	Functions	CICES	
Coastal Protection	Coastal Dunes and Fossil Dunes	Fossil Dunes	Coastal Dunes and Fossil Dunes	balance of biophysical systems	Supply	Fibers and other material from cultures, fungi and algae
				preservation of geological interest		Genetic material
				conservation of the geomorphological structure of natural habitats and species of flora and fauna	Regulation	Flood control and coastal protection
						Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
						Soil quality regulation
						Regulation of extreme events
					Cultural	Investigation
						Experimentation
						Identity and legacy
	Cliffs and protection areas		Cliffs and protection areas	barrier against oceanic overtopping phenomena	Supply	Genetic material
				guarantee of coastal dynamics processes	Regulation	Flood control and coastal protection
				ensuring the diversity of biophysical systems		Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
				conservation of natural habitats and species of flora and fauna	Cultural	Investigation
				cliff stability		Experimentation
				prevenção e redução do risco, garantindo a segurança de pessoas e bens		Identity and legacy
	Coastal protection land area		Coastal protection land area	prevention and risk reduction, ensuring the safety of people and goods	Supply	Genetic material
				conservation of natural habitats	Regulation	Flood control and coastal protection
				balance of biophysical systems		Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
						Regulation of extreme events
					Cultural	Investigation
						Experimentation
						Identity and legacy

National Ecological Reserve 2019				NER Regional	Functions	CICES	
Sustainability of the water cycle	Beds and banks of water courses			Beds and banks of water courses	continuity of the water cycle	Supply	Fibres and other material from cultures, fungi and algae
					hydraulic and hydrological functionality of watercourses		Aquaculture breeding
					land drainage		Genetic material
					control of river erosion processes (maintenance of riparian vegetation)		Surface water for drinking and other uses
					prevention of flood risk		Surface water for energy (water, waves and tides)
					conservation of natural habitats and species of flora and fauna	Regulation	Flood control and coastal protection
					hydrological-biological interactions between surface and groundwater, namely drainage and physical-chemical processes in the hyporheic zone		Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
							Forest fire protection
							Water quality control (fresh and salty)
							Global climate and air quality regulation
						Cultural	Investigation
							Experimentation
							Identity and legacy
	Lakes and ponds	Bed		Ponds, lakes, beds, banks and protection areas	water reservoir, both in quantity and quality	Supply	Crops for food purposes
					regulation of the water cycle and flood control		Fibres and other material from cultures, fungi and algae
					natural habitats and species of flora and fauna conservation		Aquaculture breeding
		Protection area	Margin		naturalized strip that allows colonization by spontaneous vegetation (faunistic refuge)		Surface water for drinking and other uses
			Contiguous to margin			Regulation	Flood control and coastal protection
							Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
							Forest fire protection
							Water quality control (fresh and salty)
							Global climate and air quality regulation
							Regulation of extreme events
						Cultural	Investigation
							Experimentation
							Identity and legacy

National Ecological Reserve 2019				NER Regional	Functions	CICES	
Sustainability of the water cycle	Reservoirs	Bed		Reservoirs that contribute to the connectivity and ecological coherence of the NEF, with the beds, banks and protection strips	safeguard and protection of stored water resources, in quantity and quality	Supply	Aquaculture breeding
					safeguarding the main functions of reservoirs (public water reservoirs)		Genetic material
					regulation of the water cycle and flood control		Surface water for drinking and other uses
					conservation of fauna species		Surface water for energy (water, waves and tides)
		Protection area	Margin			Regulation	Flood control and coastal protection
							Forest fire protection
			Contiguous to margin				Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
							Water quality control (fresh and salty)
							Global climate and air quality regulation
							Regulation of extreme events
						Cultural	Investigation
							Experimentation
							Identity and legacy
	Strategic area for the protection and recharge of aquifers			Strategic area for the protection and recharge of aquifers	guarantee and maintenance of the availability and quality of renewable water resources	Supply	Crops for food purposes
					sustainability of groundwater-dependent aquatic ecosystems and biodiversity, particularly in the summer period		Deep water for drinking and other uses
						Regulation	Flood control and coastal protection
							Water quality control (fresh and salty)

National Ecological Reserve 2019		NER Regional	Functions	CICES	
Prevention of natural hazards	Areas at high risk of soil erosion	Areas at high risk of soil erosion	soil conservation	Regulation	Control or prevention of soil loss
			maintenance of the balance of morphogenetic and pedogenetic processes		Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
			regulation of the hydrological cycle by promoting infiltration to the detriment of surface runoff		Regulating soil quality
			reduction of soil losses, reducing downstream soil clogging and siltation of water bodies		Water quality control (fresh and salt)
	Slope instability areas	Slope instability areas	stability of biophysical systems	Regulation	Control or prevention of soil loss
			safeguarding on instability phenomena and risk of mass movement on slopes and soil loss		Maintenance of life cycle, habitats and protection of genetic stock (includes pollination)
			prevention and risk reduction, ensuring the safety of people and property		Regulating soil quality
	Adjacent areas to slope instability areas	Adjacent areas to slope instability areas	prevention and risk reduction, ensuring the safety of people and property	Regulation	Controlo de cheias e proteção costeira
			infiltration and water retention		Manutenção do ciclo de vida, dos habitats e proteção do stock genético (inclui polinização)
			regulation of the hydrological cycle by the occurrence of overflow and return movements of water		Controle da qualidade da água (doce e salgada)
			rocky outcrops of scientific interest		Regulação dos efeitos de eventos extremos
	Areas threatened by flooding and the sea	Areas threatened by sea	coastal dynamics processes	Supply	Culturas para fins alimentares
			prevention and risk reduction, ensuring the safety of people and property	Regulation	Controlo de cheias e proteção costeira
			balance of coastal areas		Manutenção do ciclo de vida, dos habitats e proteção do stock genético (inclui polinização)
		Areas threatened by flooding	prevention and risk reduction, ensuring the safety of people and property		Regulação dos efeitos de eventos extremos
			infiltration and water retention		
			regulation of the hydrological cycle by the occurrence of overflow and return movements of water		
			maintaining the fertility and productive capacity of flooded soils		

Based on the above table, the relationships between NER's systems and the identified ecosystem services were systematised, with a stronger relationship with regulatory and cultural services standing out.



Picture 13 - Relationship between NER Systems and Ecosystem Services

4.2. Guidelines for the integration and enhancement of Ecosystem Services in Municipal Master Plans

In order to enhance the integration of ecosystem services in the Territorial Management Instruments and specifically in the municipal master plan, a set of guidelines are listed that could support this mission. The clues presented follow the structure of the material and documental content of the Municipal Master Plan.

Although the guidelines are essentially aimed at the Municipal Master Plans, measures were also included that, in some way, may go beyond the material scope of that plan, but which, given their relevance in the valuation of ecosystem services, may constitute references for other planning and development instruments and financing.

A. Baseline Studies

- **Mapping ecosystem services** in the municipal territory or use and update pre-existing maps for the national or regional territory, namely the following:
  - ✓ Chart of ecosystems, considering the habitats identified in the *European Nature Information Syste*m, based on updated land cover cartography and taking into account the classification of habitats defined in the "Habitats" Directive with the necessary adaptations to the national territory and information on ecological characterization and management sheets for the types of habitats that are available on the Institute for Nature Conservation and Forests website;
  - ✓ Water chart, representative of surface and underground water resources;
  - ✓ Chart of quantification / valuation of ecosystem services following the methodology of Burkhard *et al*, 2009, used in this Report, adapted to the municipal territory, or another methodology that allows mapping existing and/or potential ES. It should be noted that the maps presented in this Report are perceptual cartograms that should be strengthened at the municipal scale or with a focus on case studies (representative of each ecosystem service), using modelling, statistical data or based on expert assessments regarding territorial specificties, namely considering:
    - Serviços de provisão (água doce, solo, produção e segurança alimentar);
    - Serviços de regulação e manutenção (mitigação e adaptação às alterações climáticas – controlo de cheias urbanas, regulação climática e sequestro de carbono, regulação da qualidade da água);
    - Serviços culturais (recreio, bem-estar, cultura e comunidades).
- In the valuation of ecosystem services referenced above, consider **pre-existing information** regarding:
  - ✓ Biodiversity: Habitats protected by national or European legislation (Natura 2000 Network habitats, Ramsar Sites, Biosphere Reserves);
  - ✓ Freshwater: Areas of the surface water regime integrated in the NEF, Strategic areas for the protection and recharge of aquifers of the NEF;
  - ✓ Food production and security: NAF areas, Forest regime areas.
- Assess the **conditions of ecosystems**, the economic value of the services provided and the main threats/opportunities facing climate change, considering action measures.

- Identify **degraded areas and environmental and territorial liabilities**, namely contaminated soils (Portuguese Environmental Agency Soil Atlas), closed quarries not recovered, pollution of water bodies, dumps, degraded areas from the landscape point of view, abandoned built-up spaces, considering measures of action towards its recovery, renaturalization and valorization.
- Identify areas capable of integrating the **municipal green infrastructure / Municipal Ecological Structure**, as priority investment areas to enhance connectivity, protection and enhancement of key ecosystem services, also considering climate change mitigation and adaptation, ensuring the sustainable supply of their goods and services and increasing their resilience.

B. Strategy

- When designing the territorial **development strategy**, consider the need to recover, protect and value, including economically, ecosystem services, establishing priorities for action, models and land use and occupation regimes in line with these objectives and considering the areas to be included in the municipal green infrastructure / Municipal Ecological Structure properly articulated with neighboring municipalities.
- Identify objectives for the municipal green infrastructure / Municipal Ecological Structure and define hierarchical levels and typologies of areas to integrate according to the defined objectives.
- When considering the areas to be included in the municipal green infrastructure / Municipal Ecological Structure, **the following should be considered**:
  - ✓ Conservation Areas, Rede Natura 2000, Ramsar Sites and Biosphere Reserves;
  - ✓ Areas and corridors of the Regional Ecological Structure, with the due adaptations of scale and adjustment of limits;
  - ✓ Ecological corridors defined in the Regional Forest Planning Program, with the necessary scale adaptations and limits adjustment, ensuring compliance with the objectives;
  - ✓ Natural vegetation corridors along the watercourses and around the perennial or temporary springs, in a protection strip of variable width, depending on the ecological characteristics, priority classified habitats and the importance of the sections of the waterline and the spring in question;
  - ✓ Areas with species with legal protection status: holly, holm oak, cork oak and species that must be the object of specific protection measures identified in PROF;
  - ✓ Sensitive areas for the conservation of species (fauna and flora) of community interest or with the presence of natural values that present a threat status defined by the respective Red Books (http://www2.icnf.pt/portal/pn/biodiversidade/parinatur/) or of other relevant species, in particular, contained in the Berne Convention;
  - ✓ Areas occupied with forests of species of the genus *Quercus spp*. and other native hardwoods;
  - ✓ Natural landscape elements such as watercourses, wooded areas, hedges and natural passages that function as ecological corridors;
  - ✓ Areas of recovered habitats with a view to the preservation of certain species, whether by expanding the protected area or areas for feeding, rearing, resting and favoring migration and geographic distribution;

- ✓ Areas subject to forest regime, sensitive forest areas of ecological importance or other areas of ecological value defined in Regional Forest Planning Program;
- ✓ Other healthy ecosystems and areas of high natural value in addition to these, such as ecosystems critical for the provision of freshwater, other forest areas, floodplains, wetlands, coastal areas;
- ✓ Multifunctional areas where agricultural and forestry land use is practiced that enables the maintenance and regeneration of ecosystems, based on the prohibition of practices that lead to its degradation (e.g., HNV - high nature value);
- ✓ Areas subject to application of agro-environmental or agro-forestry measures;
- ✓ Areas with potential for the reestablishment of a native vegetation cover that contribute, together with the previous areas, to reestablish the spatial continuity and connectivity of the components of biodiversity in the territory and the interconnection between protected areas - *continuum naturale*;
- ✓ Areas of susceptibility to risks, namely floods, mass movements of slopes, coastal erosion, dune systems or others, if they constitute important areas to enhance connectivity and the protection and enhancement of ecosystem services, should be integrated into the municipal green infrastructure / EEM, thus safeguarding them from the built-up occupation;
- ✓ Natural areas of high cultural value, relevant to local or regional identity, in great demand for recreational use, of a religious or spiritual nature, or recognized for knowledge (education or research).

Within the scope of this infrastructure, particular emphasis should also be placed on areas that integrate **urban systems**, as a determining factor in mitigating the causes and in adapting to the consequences of climate change, contributing to the reduction of temperature rise and the heat island effect (climate regulation); the reduction of surface runoff with a remarkable contribution to alleviating the intensity of floods; the possibility of proximity agricultural production; the sequestration of greenhouse gases; the connection between fragmented habitats, the reduction of biodiversity loss, natural areas of high recreational or symbolic value, classified arboreal elements, and ensuring good proximity access to green infrastructure (introduction of the 3-30-300 rule - 3 trees visible from the house / 30% tree cover in each neighborhood / 300 m from each park or green area).

C. Territorial Model

- Consider the mapping of ecosystem services in the **land classification and qualification**, through:
  - ✓ Limit new urban developments in areas of value, integrating them into categories of agricultural, forest, natural or urban green space, depending on the value;
  - ✓ Include the areas of greatest ecological value, as well as the fundamental areas for the continuity and connectivity of ecological processes, in the **municipal ecological network** (to be represented in the planning plan), duly articulated between the urban, municipal and supra-municipal levels and in line with the Regional Ecological Network, and with the ecological corridors of Regional Forest Planning Programs, ensuring that these territories are dominantly allocated to uses that respect and promote ecological functions and environmental sustainability;

- ✓ Ensuring the preservation of large-scale forest areas to encourage the increase in carbon sequestration values;
- ✓ Foster the extension, qualification and integration of urban green spaces, enhancing their role as carbon sinks, urban microclimate regulators and promoting urban agriculture, namely ensuring the transfer of green spaces in subdivision operations (avoiding monetary compensation);
- ✓ Ensure the non-occupation of the built-up beds and banks of water lines, in particular those included in the REN or that are fundamental for the functioning of the water system, for the provision of fresh water and for the conservation of nature and biodiversity, as well as all the humid and surrounding areas, whose preservation is essential for the proper functioning and protection of the municipal water system, integrating them into natural space and into the municipal ecological structure;
- ✓ Ensure flexibility and interpenetration of uses and activities between the rustic land space classes (agricultural and forestry), in order to facilitate the implementation and/or relocation of uses and activities related to agricultural or forestry production and enhance the diversification of agricultural production and forestry in the face of changing soil and climatic conditions resulting from climate change;
- ✓ Ensure the existence of agricultural land in the vicinity of urban agglomerations to promote the link between food production and consumption at a local scale.

- Ensure that the definition of the **land use regime** takes into account the need to protect and enhance the values/services provided by the present ecosystems, depending on the predicted climate changes, considering the following criteria:
  - ✓ Ensure that land use regimes established for areas covered by the municipal ecological framework and municipal green infrastructure are in line with its primary objective of recovering, protecting and valuing, including economically, ecosystem services, including regulatory measures that ensure the reconversion of any situations that are incompatible with these objectives;
  - ✓ Restricting the built-up occupation, as well as any type of artificialization, degradation or pollution of areas that are fundamental for the functioning of the water system and provision of fresh water (surface and underground water);
  - ✓ Promote the use of nature-based solutions to water-related problems (such as protection, wastewater purification, water storage);
  - ✓ Establish rules that promote the maintenance and enhancement of riparian galleries;
  - ✓ Establish maximum soil waterproofing rates, particularly in an urban context;
  - ✓ Establishing tree crown index;
  - ✓ Establish, in accordance with the Special Programs, with the Natura 2000 Sector Plan and other legislation, regimes for occupation, use and land transformation compatible with the objectives of protection and enhancement of species and habitat;
  - ✓ Establish, in accordance with the Regional Forest Planning Program and other legislation, regulations for forests so that they effectively contribute to sustainable development, considering their unique potential to support a green economy, provide livelihoods, mitigate changes climate, biodiversity conservation, improving water quality and combating desertification;
  - ✓ Limit afforestation or reforestation with fast-growing species under the terms established in current legislation and in the Regional Forest Planning Program and considering nature and biodiversity conservation, landscape, fire risk, soil conservation, water availability, among others;

- ✓ Establishing parameters for the occupation of National Agricultural Reservation Area compatible with the need to preserve and enhance the value of land with greater agricultural value;
- ✓ Promote the multifunctional use of agricultural land, provided it is considered adequate in light of a reasoned analysis of this potential, ensuring that the additional uses are compatible and subject to existing uses and do not threaten the long-term agricultural quality of the land;
- ✓ Implement regulatory measures to protect against erosion and soil degradation and which contribute to restoring and improving agricultural and forestry soils, to be applied in preparing the land for agriculture, reforestation and afforestation;
- ✓ Within the framework of climate regulation and carbon sequestration, establish rules that guarantee the conservation and increase of forest areas, preventing their use for other purposes and guaranteeing their management in order to reduce the risk of fires;
- ✓ Limit land use changes that contribute to higher carbon emissions, considering that land is the second largest carbon 'storage' or 'sink' after the oceans;
- ✓ Promote the diversification and adequacy of economic activities, with emphasis on the primary sector;
- ✓ Establish criteria for the ecological value of urban green spaces;
- ✓ Recognize and value natural areas of high cultural value.

- Establish **regulatory mechanisms** in the management of the municipal territory for the creation of a **municipal sustainability fund**, to support the promotion of the sustainability of ecosystems and the provision of environmental services, to which municipal revenues will be allocated referring to: real estate taxes, circulation tax, Municipal fees and the product of fines in administrative proceedings in urban and environmental matters.
- **Create regulatory incentive mechanisms or environmental compensation measures** to be implemented for new territorial developments with a relevant impact, namely new areas for extracting inert materials, in particular to pursue the recovery of degraded ecosystem services and the creation of new areas of natural forest.

D. Implementation and Financing Programs

Establish intervention programs and measures to be developed in the municipal territory, integrated or not in operational management planning units (OMPU), and the implementation and financing program, including the schedule, cost forecast and the contribution of the various entities. The Implementation Program must consider and prioritize the resources, for example, based on the definition of green infrastructure objectives and their hierarchical levels.

Create conditions for active community involvement in protecting the ecosystem services on which they depend. Contemplate, in the strategic dimension, initiatives that mobilize communities and change behavior.

Promote the regeneration of burnt areas considering the replacement of forest formations that are inadequate from the point of view of their adaptation to the season or the functions required in the meantime, by indigenous species that are more resilient and more adapted to the soil and climate conditions of our territory, more resistant to pests and diseases, periods of drought and fires.

Promote the recovery / regeneration of environmental and territorial liabilities, contributing to a reintegration in the value chain of ecosystem services.

Constitution of green infrastructure (with emphasis on urban areas):

- Connection between different areas of urban green, suburban forest, along water courses and sea/beach fronts, creating a network of interconnected, alternative, pedestrian or cycling routes, where possible with trees (*greenways*), with areas of rest/wait, occasionally protected from sun exposure/UVA rays and rain;
- Create urban horticultural spaces and public gardens in which the use of native species or species adapted to edaphoclimatic conditions is privileged, namely in lower areas that enhance infiltration and biodiversity or in public places with adequate capacity for this purpose and with careful landscape integration;
- Increase the degree of coverage of the canopy, namely in streets and other green structures, in particular through the afforestation of distribution lanes and local access routes and areas more exposed to prevailing winds, promoting urban bioclimatic comfort and avoiding areas favorable to exposure excessive sunlight;
- Create new squares/small permeable urban parks in urban centers, in areas of greater density (whenever possible in the vicinity/or integrating buildings/classified heritage), promoting, if necessary, occasional demolitions, also allowing the connection between different urban/suburban green spaces;
- Conversion of artificial lakes into lakes with higher ecological value, rich in biodiversity and where aquatic plants ensure water quality without using chlorine-based chemical compounds for disinfection.
- Invest, from time to time, in the conversion of old unused roads/infrastructures (rail, road, etc.) into pedestrian or cycling routes, alternative crossing of urban/suburban areas and at the same time constituting linear urban gardens;
- Use of natural materials in the construction of buildings (e.g. green roofs and facades) and the renaturalization and recovery of pavement permeability.

Measures for the resilience of ecosystems, species and habitats to the effects of climate change:

- De-artificialization of water courses and restoration of the quality of riverine habitats and ecosystems for the benefit of aquaculture heritage, in harmony with existing and planned uses, in the water domain and with the conservation of nature.
- Identification of potential refuge areas for the conservation of fauna species, considering the added value of the species in terms of ecological value, namely the choice of native species that produce food for the fauna, with a view to guaranteeing the continuity of game species and the maintenance of biological balances.
- Conservation and restoration of habitats in forest areas of high natural value;
- Conservation of temporary pond systems;
- Installation or adaptation of transposition devices in weirs for freshwater fish and vulnerable migrators;
- Installation or adaptation of passages/crossings of fauna on the highway/rail;
- Creation of refuges for vulnerable species of fauna;
- Preserve and enhance the animal, plant and forest genetic heritage, with a view to increasing resilience to climate change (resistance to drought, diseases and pests);

- Recovery/restoration of infrastructure for hydraulic exploitation as a complement to the use by fish fauna;
- Define actions to eradicate invasive species;
- Protection and conservation of wetlands.

Measures to guarantee the provision of fresh water, both in quantity and for its quality:

- Promote the renaturalization of watercourses and the consolidation and recovery of their slopes and banks, using solutions based on nature;
- Eliminate sources of pollution from surface and groundwater, protecting and restoring freshwater ecosystems;
- Promote actions aimed at increasing the resilience of ecosystems that are essential for the provision of fresh water;
- Create rainwater retention basins or increase the capacity of existing ones;
- Within the scope of the wastewater management system, completely eliminate the existence of direct outfalls to watercourses;
- Renovation of wastewater networks on the rise and promotion of the separation of rainwater and wastewater;
- Promote analyzes of the physicochemical and bacteriological quality of surface waters at strategic points.

Conservation measures and soil fertility improvement:

- Promote forest cover in areas with greater aridity, through (re)forestation using appropriate species and installation techniques, in order to contribute to the recovery of degraded soils or those in the process of degradation;
- In forest management, adoption of under-cover management practices that minimize impacts on the soil and increase its carbon content;
- Afforestation with soil improver species – long revolutions;
- Incorporation of manure and compost, rotations with legumes, cover crops and with leftovers of agricultural or forestry origin (from cleaning or deforestation operations);
- Direct sowing or mobilization in the row;
- Crop rotation with different types of root systems;
- Interlining of the lines in permanent crops;
- Installation of under-cover pastures and biodiverse pastures;
- Use of vegetation cover on soils during the wettest period and between the lines, use of livestock effluents, composts and agro-industry by-products as fertilizing materials;
- Creation of infiltration gardens;
- Provide reservoirs / naturalized basins for temporary storage of excess water in order to dissipate water energy and avoid dragging solid material (erosion) to avoid damage downstream;
- Define a strategy for natural infiltration, increasing permeability of surfaces, defining neighborhood green spaces, green infrastructure and water plans.

Measures to increase the resilience of production systems and ensure food safety:

- Maintain and increase agroforestry systems that provide greater agricultural and forestry production and more resilience than monoculture systems. Multispecific systems can include tree species mix, annual crop mix (intercal) or tree and crop mix (agroforestry);

- Install tree and shrub species that are more resistant to drought, allowing the range of options to be expanded with a view to maintaining tree cover and, above all, the capacity of ecosystems to provide goods and services;
- Reconvert populations installed in unsuitable ecological conditions, using better adapted species;
- Install improved permanent pastures;
- Preserve traditional permanent cultures;
- Create proper spaces for urban agriculture;
- Create recovery mechanisms for traditional cultivars and plant biological variety.

Climate regulation measures:

- Promote the adoption of active and passive techniques to increase the energy efficiency of existing public or private buildings, promoting their energy conversion;
- Implement a high degree of canopy coverage, particularly in an urban context in areas most vulnerable to the effects of heat islands;
- Increase the tree crown index;
- Create shading zones (including tree planting actions and installation of external canopies or awnings between buildings);
- Create and maintain ventilation corridors;
- Install or reconvert shading/cooling equipment in urban transport infrastructure and rolling stock (vehicles, stops, stations, parking lots) and public buildings (primarily schools, hospitals and health centers).

Measures to reduce emissions and/or increase carbon sequestration in land use:

- Preserve and increase forested areas;
- Promote pastures/permanent crops in order to minimize soil movement;
- Improve information and monitoring capacity for carbon emissions and sequestration in the land use sector.

4.3. Clues for Financing and Implementation in Municipal Planning for the Valorization and Remuneration of Ecosystem Services

Aware of the need to put into practice the measures of valorization and remuneration of ecosystem services, some clues for implementation and financing are identified, associated with municipal plans for land use planning.

It is therefore essential to understand the current mechanisms that the public administration has at its disposal to intervene, in order to promote sustainability in urban and rural spaces, responding to environmental, social and economic problems.

The current legal framework of urbanism and land use planning already provides mechanisms that can be used for these purposes, however, according to Jorge Carvalho (2018), the most important and necessary change to the practice of urban planning and management is the reinforcement of the dynamizing role of the municipalities, in the places and with the programs that the territory needs, mobilizing for this purpose owners and other investors. For this to happen, there will have to be a change in the municipal urban administration, going from passive (just responding to requests) to active (taking the initiative, entrepreneurial), less dependent on the initiative of each owner, aiming at a more efficient and consequential ordering.

It is important then to understand which financing and execution instruments the municipality has within its reach.

Under the terms of the General Basic Law of Public Policy on Land, Spatial Planning and Urban Planning, all Municipal Plans establish the regime for land use and implementation under the responsibility of the Public Administration, in particular:

- Promoting the execution of the Plans is a “public task”, namely a municipal one, being responsible for their programming and coordination;
- The programming of territorial plans must be included in the activity plans and municipal budgets;
- Private promoters have to materialize and adapt their intentions to the objectives and priorities defined in the territorial plans and in the respective programming instruments;
- The systematic execution of territorial plans is achieved through integrated urban policies, namely, through the acquisition or availability of land, land transformation operations and forms of partnership or contractualization that promote the concertation of the various interests involved, within the scope of implementation units.

In addition to the **implementation instruments** provided for and detailed in the legal framework for territorial management instruments, the Basic Law on Urban Planning and Land Use also introduces a set of **innovations in terms of the economic and financial regime**, providing in its general principles that any municipal decision to create urban infrastructures should be preceded by a demonstration of its economic interest and financial sustainability,

explicitly identifying in the multiannual program of municipal investments the sources of financing for each of the foreseen commitments. In this context, **municipalities must establish a municipal fund for environmental and urban sustainability**, aimed at promoting urban rehabilitation, the sustainability of ecosystems and the provision of environmental services, as well as the creation, maintenance and reinforcement of infrastructure, equipment or areas of use public, **through the allocation of urban revenue and revenue resulting from the distribution of capital gains arising from the buildability established in the territorial plans**. Tax instruments may have different tax rates depending on the cost of the territorial infrastructure provided, their use and incentive or disincentive options justified by environmental and territorial planning objectives.

In short, the **municipal environmental and urban sustainability fund**, given its nature, can be a relevant instrument to support the implementation of measures to enhance ecosystem services. Some examples of the application of Municipal Funds for Environmental and Urban Sustainability or initiatives by Municipalities related to the constitution of Funds are listed below.

Table 7 – Examples of application of Municipal Funds for Environmental and Urban Sustainability or related initiatives

Municipality	Legal instrument	Normative Content
Lisbon	**Lisbon Master Plan - 2012**	**Municipal urbanization fund** 1 - Creation of a Municipal Urbanization Fund aimed at meeting the costs of studying and carrying out projects relating to operations and works of urbanization, construction and reconstruction of housing under the responsibility of the municipality. For this Fund, the proceeds of fees charged by: • creation, maintenance and reinforcement of urban infrastructures; • occupation of the municipal domain; • urban compensation; • alienation of assets; • other revenues allocated to the fund by the City Council and Municipal Assembly, under the terms of the law
Lisbon	**Lisbon Municipal Environmental and Urban Sustainability Fund**	**Revenues** 2 - The following revenues are allocated to the Fund: a) Urban planning revenue from the payment of the fee for the realization, maintenance and reinforcement of urban infrastructure and urban compensation, in cash or in kind, due for the total or partial waiver of the transfer of areas for the implementation of green spaces and for collective use, road infrastructure and equipment; b) Urban planning revenues from payment of the fee for the occupation of the municipal public and private domain resulting from the urban planning operation; c) Urban planning revenues resulting from the payment to the Municipality of the amount corresponding to the construction credits, when the amount paid is intended to be applied in the rehabilitation of municipal properties or in the acquisition of properties for equipment, infrastructure, green spaces for collective use or for other areas of public use; d) Revenue from the sale of municipal property handed over to the City Council to integrate the municipal private domain, under the regime of urban transfers and compensation applicable to allotment operations and operations with a relevant impact and/or similar to allotment and under the mechanisms for compensating equalization of benefits and charges arising from the binding territorial plans of individuals; e) Revenues from the sale of buildings or parcels of municipal land to complement the lot. 3 - The revenue resulting from the redistribution of capital gains arising from the buildability established on a territorial level will also be allocated to the Fund. 4 - Except for the provisions of the preceding paragraph, revenues whose allocation to certain expenses result directly from the law. 5 - The allocation of revenue does not affect that the expenses included in the object of the Fund are financed by other revenue from the Municipality of Lisbon, under the terms defined annually in the budget, or by funds from other entities. **Fund Purposes** The purpose of the Municipal Urbanization Fund is to bear the burden of carrying out actions that promote urban rehabilitation and the sustainability of ecosystems, namely, with: a) The realization, maintenance and reinforcement of urban infrastructures, under the responsibility of the Municipality; b) The acquisition or expropriation of land or buildings intended for equipment for collective use, infrastructure, green spaces for collective use and other areas of public use; c) The carrying out of conservation and rehabilitation works of the

		built-up park and of the degraded or deteriorating urban fabric: d) The construction, maintenance, remodeling and improvement of equipment for collective use, green spaces for collective use and other areas for public use; e) The studies and projects necessary for the activities and achievements provided for in the preceding paragraphs.
Lisbon	**Incentives for Urban Developments with Municipal Relevance**	Allocation of all amounts paid in the sale of construction credits **through the municipal urbanization fund, in the urban rehabilitation** of residential buildings in Bairro Padre Cruz.
Lisbon	**Regulation of the Real Estate Heritage of the Municipality of Lisbon**	Special consignment principle In accordance with special legislation, the budget of the **Municipality of Lisbon must allocate a minimum of 10% of the revenue provided for in the Municipal Fund for Environmental and Urban Sustainability of Lisbon**, for the following purposes: a) Acquisition or expropriation of land or buildings intended for equipment for collective use, infrastructure, green spaces for collective use and other areas of public use; b) Carrying out works for the conservation and rehabilitation of the built-up park and the degraded or deteriorating urban fabric.
Abrantes	**Abrantes Urbanization Plan**	**Municipal Fund for Environmental and Urban Sustainability** A Municipal Environmental and Urban Sustainability Fund is created by the City Council with the following objectives: a) Operationalization of the equalization processes between the various buildings and urban planning operations; b) Provision of land for infrastructure, equipment and public green spaces; c) Safeguarding and valuing the ecological corridors established in the Urbanization Plan. The Fund's income is: a) The transfer of land with buildability and pecuniary compensation for excess buildability; b) Other funds that the City Council may decide to allocate to it, possibly complementary to structural funds to support projects of environmental enhancement. The Fund's charges are: a) Compensate owners who have less than average buildability; b) Compensate owners for uses that give rise to positive environmental externalities; c) Encourage environmental enhancement projects, namely the implementation of pathways destined for gentle modes. Identification and Perpetual Distribution of Land Gains. **Buildability** Average buildability: a) Considering the urban indices established by the Urbanization Plan, it is concluded that the average buildability is 0.4 m^2 of ac/m^2 of land; b) Since any increase in buildability corresponds to the creation of capital gains, the average buildability corresponding to new urban operations is distributed between owners and the Municipal Environmental and Urban Sustainability Fund, with the former being allocated 0.3 m^2 of ac /m^2 land; c) As a stimulus for the participation of owners in programmed strategic operations, within the scope of execution units, the average buildability considered for each of the parcels that integrate the resulting partnerships will be 0.4 m^2 of ac/m^2 of land, with the allocation being eliminated to the Fund provided for in the previous paragraph; **Compensation for the provision of environmental services** Incentives for adequate occupation must be envisaged, as per the PUA regulations, in: a) Riparian galleries; b) Space of dispersed occupation of Samarra;

		c) Protective urban green spaces; d) Agricultural conservation spaces; e) Forest conservation spaces. These incentives must: a) Be framed by specific municipal regulations; b) Take into account the financial resources available at all times in the Municipal Fund for Environmental and Urban Sustainability; c) Translating into protocols, with each owner, guaranteeing effective use in the medium and long term and establishing periodic incentives. **Conservation Rural Spaces** The proper use of these spaces can be periodically promoted by the Municipal Fund for Environmental and Urban Sustainability **Agricultural Spaces for Polyculture and Low Combustibility Forest Spaces** The adequate and innovative use of these spaces can be encouraged by the municipal fund for environmental and urban sustainability.
Sintra	**Sintra Master Plan**	**Municipal Sustainability and Territorial Cohesion Fund** 1. For the execution of the Plan, the Municipal Sustainability and Territorial Cohesion Fund will be created, with the following purposes: a) Promoting the sustainability of ecosystems and the provision of environmental services; b) The promotion of urban rehabilitation; c) The creation, maintenance and reinforcement of infrastructure and equipment or areas for public use. 2. Municipal revenues relating to: a) Municipal Tax on Property Transactions; b) Municipal Property Tax; c) Single Tax on Vehicle Circulation; d) Urban Infrastructure Reinforcement Fee; e) The product of fines in administrative proceedings in urban and environmental matters; a) f) Other fees.
Setúbal	**Setúbal Master Plan**	**Incentives for urban development** 1. Actions that can benefit from incentives within the scope of the Plan's implementation are considered to be projects that contribute to the implementation of the Plan's strategy in the following areas: a) Urban rehabilitation; b) Promotion of environmental efficiency; c) Implementation of the municipal ecological framework; d) Equipment for collective use. 2. The incentive system, to be established in a specific municipal regulation, may cover measures with urban scope and measures of a fiscal nature in the availability of municipal decision, considering that: a) Within the measures with urban scope, the interest of the intervention and its compatibility with the municipal strategy laid down in the Plan can be considered, focusing on urban parameters of buildability defined for the category of space in question, considering the possibility of admitting a increase with an appropriate positive sense, up to 25%, provided that this results in a properly integrated architectural and morphological solution, with effective qualification of the space of the respective surroundings.

EXAMPLES OF INTERNATIONAL PROJECTS AND FINANCING SOLUTIONS FOR ECOSYSTEM SERVICES

Amsterdam Sustainability Fund

According to the C40 *Cities Finance Facility* (2016), in 2015, Amsterdam created the Sustainability Fund (integrated in the City Sustainability Office) with 40 million euros to lend to local sustainability projects that ensure direct GHG reductions, supporting a variety organizations such as owners of buildings, schools, sports clubs, theaters and social housing.

More than 75% of the loans were used for solar energy projects, but the fund also financed insulation projects and energy-efficient oven projects. Companies seeking project finance may also receive loans, but for regulatory reasons cannot use these funds for “commercial investments” that improve their competitive position.

In addition to energy efficiency and production projects, the fund also finances actions related to the circular economy, in smaller numbers as they are typically projects related to the core business of companies, with the aforementioned stimulus to competition being at stake.

Initially, the Amsterdam Sustainability Fund received a small number of loan applications. Therefore, the fund created a program to provide potential candidates with free energy audits. The council pays independent energy consultants to assess potential projects, estimating a property's energy cost savings potential or its ability to produce renewable energy. Consultants also help homeowners evaluate investment options, vendor technical requirements and loan applications. These energy auditors are, by definition, not linked to the energy equipment installation business to avoid conflicts of interest and build confidence in potential candidates.

This approach was successful in identifying additional projects. The new projects financed as a result of these services include the installation of LED lighting, solar panels and the creation of intelligent systems that make it possible to adjust the stadium's lighting and temperature to the space's use schedules.

All projects financed by the fund must contribute to the objectives of the Agenda for Sustainability, approved by the Municipality of Amsterdam in 2015. Projects worth €200,000 to €500,000 are assessed according to their environmental effect per euro invested or level of co-investment involved, with higher levels getting better rankings. This competitive element helps to encourage the improvement of proposals.

Projects worth less than €200,000 must only demonstrate that they eliminate 1 ton of CO2 per €35 invested. Energy savings and/or revenue from energy sales resulting from the project must be sufficient to pay interest and amortization.

Beneficiaries must repay the Sustainability Fund loans within 15 years.

Results and reasons for success

The Sustainability Fund invested in more than 65 projects in the area of climate, sustainability and air quality, totaling more than €30 million, which translates to around €30,000 per day.

The financing of low-carbon projects encourages banks, which are still reluctant to invest in these projects. Energy efficiency projects are particularly attractive as they provide a reliable return on investment from the savings they generate.

Communication plays a key role. The municipality allocates funds to increase the fund's visibility through a variety of means: a dedicated website, social media, social media, project launches and other events.

The fund creates the capacity of potential candidates to establish a set of projects to be financed. Free energy audits help demonstrate the benefits of renewable energy production or energy efficiency projects to building owners. This service helps stakeholders to decide to invest in sustainability measures relevant to their buildings.

Traditional funds typically do not make investments below €100,000. The Sustainability Fund offers loans starting at €10,000, enabling smaller projects to proceed with affordable financing.

Loan applications are often ill-informed. To help, an easy-to-use Excel template including examples of successful applications is provided on the website.

Potential candidates can contact the fund's team for help and guidance.

5. Final Notes

Within the scope of the ROBUST Project (https://rural-urban.eu/), financed by Horizon 2020, which addresses rural-urban relations, and in which the CCDR-LVT participates with the Instituto Superior Técnico (IST), emerged the challenge of developing an exercise in mapping ecosystem services for the Lisbon and Tagus Valley Region.

The basic work for this Report began in 2019, with contributions from different entities and personalities at different moments of interaction, resulting in this document that is intended to be an innovative contribution at the scale of the Region and inspiring for the development of this theme at other scales of analysis and complemented with other working and research methods.

The initial motto for the preparation of this document was the mapping of ecosystem services in the Lisbon and Tagus Valley Region, and for this purpose we chose to follow the methodology used by Burkhard *et al* (2009), explained in section 3 of this Report . However, this document intended to go further, addressing the concept of ecosystem services, and its relationship with other concepts already integrated into the normative framework and practice of land use planning (Municipal or Regional Ecological Network and National Ecological Reserve) and how these concepts are articulated with the Green Infrastructure (point 4).

This document assumes that as, or more, important than mapping ecosystem services is valuing them through their integration in the practices of land use planning and regular urban management of municipalities, presenting some guidelines to support their integration in the PDM and lanes for its financing and execution (highlighting some examples of municipal and international experiences), and also an approach to the ecosystem services provided by the National Ecological Reserve systems. The main objective of this work is to provide new ways of looking at and exercising territorial planning, valuing the "lens" given by ecosystem services in order to achieve ecologically-based territorial models, with strategic and operational capacity, which allow to value and remunerate forms of occupation and use of land that provide better levels of services provided by ecosystems (provisioning, regulation, cultural or cumulative services).

Approaching the values of the territory and its remuneration should be one of the vectors of the planning work, contributing, on the one hand, to the construction of a more cohesive territory and, on the other, to the mitigation and adaptation to climate change, and so respond to the challenges of the European Ecological Pact.

The application of ecosystem services to planning is still a relatively recent issue. The CCDR-LVT understands that this document can be a contribution to this practice, hoping that it can be assumed as a "*living*" document and come to be complemented with other and more experiences at multiple scales. An example of this is certainly the process of learning, sharing knowledge and the results achieved and to be achieved within the scope of the Working Group "Metropolitan Network of Green Infrastructures", initiated within the scope of the Living Lab of the Lisbon Metropolitan Area, created within the Robust project (Coordinated by the Municipality of Setúbal, with the participation of the Academy (IST, FCT-UNL), CCDR-LVT, Lisbon Metropolitan Area and 17 municipalities). This Working Group has evolved towards the co-creation of knowledge (taking advantage of the practical and scientific component

participation), creating a common language, exploring cartographic approaches to ecosystem services on a metropolitan scale to support and enhance the metropolitan green infrastructure and its integration into the Land Planning. The continuation of work is also foreseen, aiming at proposing a model for the operationalization of the metropolitan green infrastructure, taking into account its management and financing, taking into account ecosystem services, and providing guidelines for a more focused investigation in this field.

This type of demonstration projects and the creation of new methodologies are of fundamental importance for the dissemination, valorization and use of the concept of ecosystem services, and one of the central aspects for a true integration in the mainstream of territorial planning is the form of accounting services provided, and how their economic and financial dimension can be incorporated into the plans.

In this particular aspect of remuneration/accounting for ecosystem services, reference should be made to the European Union's *Glint Research Venter*, which has developed a set of studies for four services: pollination, wood, climate regulation, and flood control - Knowledge Innovation Project on an Integrated system of natural capital and ecosystem services accounting[12].

This work is a starting point and will constitute a platform for the aggregation of knowledge on ecosystem services in the Lisbon and Tagus Valley Region, open to contributions from other stakeholders, in the hope that it can benefit and contribute to territorial planning, and also that it can interact with other projects that mobilize knowledge around ecosystem services.

[12] https://ec.europa.eu/environment/nature/capital_accounting/index_en.htm/

6. BIBLIOGRAPHY

Parque dos Moinhos de Santana Lisboa
Source: CCDR-LVT

AEA. (2011) - Green infrastructure and territorial cohesion. Luxemburgo: Publications Office of the European Union.

BENEDICT, M. A., McMahon, E. T., & Fund, M. A. T. C. (2012) - Green Infrastructure: Linking Landscapes and Communities. Island Press.

BURKHARD, B et al, (2012) - Mapping Ecosystem Service Supply, Demand and Budgets. *Ecol. Indicators* 21, 17–29. doi:10.1016/j.ecolind.2011.06.019~[consultado em setembro 2019]. Disponível em: https://www.sciencedirect.com/science/article/abs/pii/S1470160X11001907

BURKHARD et al, (2009 - Landscapes' Capacities to Provide Ecosystem Services - A Concept for Land-Cover Based Assessments. *Lo* 15, 1–22. doi:10.3097/LO.200915. [consultado em setembro 2019]. Disponível em: https://www.landscape-online.org/index.php/lo/article/view/LO.200915

CAMPAGNE C, Roche P (2018) - May the matrix be with you! Guidelines for the application of expert-based matrix approach for ecosystem services assessment and mapping. One Ecosystem 3: e24134. [consultado em setembro 2021]. Disponível em: https://doi.org/10.3897/oneeco.3.e24134

CANCELA, Jorge (2016) - Serviços de Ecossistemas, apresentação no âmbito do Seminário organizado pela CCDR-LVT e pela DGT no contexto da revisão do PNPOT, sob o tema "Território e Economia Circular", 24 de outubro de 2016, CCDR-LVT, Lisboa. [consultado em setembro 2020]. Disponível em: file:///C:/Users/UTILIZADOR/Downloads/JorgeCancela-sem-27out2016.pdf

CANGUEIRO, José (2004) – A Estrutura Ecológica e os Instrumentos de Gestão do Território. CCDR Norte

C40 Cities Finance Facility (2016) - C40 Cities Good Practice Guide – City Climate Funds, Sustainable Infrastructure Finance Network; [consultado em maio de 2019]. Disponível em: https://cff-prod.s3.amazonaws.com/storage/files/iGNW4ywKRix6hPj9BvUQSnhbNncrmy982Ki4hGpV.pdf

CCDR-LVT – Comissão de Coordenação e Desenvolvimento Regional de Lisboa e Vale do Tejo (2019) – O Ordenamento do Território na Resposta às Alterações Climáticas: Contributo para os PDM, ISBN: 978-972-8872-38-0, Lisboa. Disponível em: http://www.ccdr-lvt.pt/files/e85da0b52d3e72c3a6aa739bf8b8fc997d87f83c.pdf

COMISSÃO EUROPEIA (2013a) – Infraestrutura Verde – Valorizar o Capital Natural da Europa, Bruxelas. [consultado em outubro de 2020]. Disponível em: https://eur-lex.europa.eu/resource.html?uri=cellar:d41348f2-01d5-4abe-b817-4c73e6f1b2df.0009.03/DOC_1&format=PDF

COMISSÃO EUROPEIA (2013b) – Building a Green infrastructure for Europe. Lexemburgo: Serviço das Publicações da União Europeia. Doi. 10.2779/54125. [consultado em outubro de 2020]. Disponível em: https://ec.europa.eu/environment/nature/ecosystems/docs/green_infrastructure_broc.pdf

COMISSÃO EUROPEIA – (2019) - EU guidance on integrating ecosystems and their services into decision-making. Commission Staff Working Document. Bruxelas. Disponível em https://ec.europa.eu/environment/nature/ecosystems/pdf/SWD_2019_305_F1_STAFF_WORKING_PAPER_EN_V2_P1_1042629.PDF ;

https://ec.europa.eu/environment/nature/ecosystems/pdf/SWD_2019_305_F1_STAFF_WORKING_PAPER_EN_V2_P2_1042629.PDF ; https://ec.europa.eu/environment/nature/ecosystems/pdf/SWD_2019_305_F1_STAFF_WORKING_PAPER_EN_V2_P3_1042629.PDF

CICES (2019a). Structure of CICES. [consultado em junho 2019]. Disponível em: https://cices.eu/cices-structure/

CICES (2019b). Supporting Services & Functions. [consultado em junho 2019]. Disponível em: https://cices.eu/supporting-functions/

CORREIA, Inês Pereira (2012) - Das Estruturas Ecológicas Municipais às Infraestruturas Verdes Visões, discursos e prática municipal, Dissertação apresentada para obtenção do grau de Mestre em Engenharia do Ambiente, Instituto Superior Técnico, Universidade de Lisboa. [consultado em abril 2020]. Disponível em: https://fenix.tecnico.ulisboa.pt/cursos/meambi/dissertacao/2353642425856

COSTANZA, R., d'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'neill, R. V., and Paruelo, J. (1997) - The value of the world's ecosystem services and natural capital. Nature 387, 253-260. [consultado em junho 2019]. Disponível em: https://www.nature.com/articles/387253a0

DGT - Direção-Geral do Território - (2018) - Especificações técnicas da Carta de uso e ocupação do solo de Portugal Continental para 1995, 2007, 2010 e 2015. Relatório Técnico. Direção-Geral do Território. [consultado em julho 2019]. Disponível em: http://mapas.dgterritorio.pt/atom-dgt/pdf-cous/COS2015/ET-COS-1995-2007-2010-2015.pdf

DGT - Direção-Geral do Território - (2019) - Especificações técnicas da Carta de Uso e Ocupação do Solo (COS) de Portugal Continental para 2018. Relatório Técnico. Direção-Geral do Território. [consultado em dezembro 2019]. Disponível em: https://www.dgterritorio.gov.pt/cartografia/cartografia-topografica/normas-especificacoes-tecnicas

DUARTE, Isabel Cristina Jesus (2019) – Quantificação e valoração de serviços de ecossistema das árvores monumentais da cidade do Porto, Dissertação apresentada para obtenção do grau de Mestre em Engenharia Agronómica, Faculdade de Ciências da Universidade do Porto. [consultado em abril 2020]. Disponível em: https://sigarra.up.pt/fcup/pt/pub_geral.pub_view?pi_pub_base_id=378426

FERREIRA, J. C., Monteiro, R., Silva, V. R., Marques, A., Moreno, P. (2020) - Estrutura Ecológica Municipal de Setúbal - Uma Infraestrutura Verde para um ordenamento do território de base ecológica. Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa. Caparica. 80 pp. ISBN: 978-972-8893-73-6. [consultado em outubro 2020]. Disponível em: https://www.mun-setubal.pt/wp-content/uploads/2020/03/RPDM_A_ECTM_Estrutura_Ecologica_Municipal.pdf

FISHER B. & Turner R.K. (2008) - Ecosystem services: Classification for valuation. Biological Conservation 141 (5): 1167-1169.

FISHER B., Turner R.K. & Morling P. (2009) - Defining and classifying ecosystem services for decision making. Ecological Economics 68: 643-653. [consultado em junho 2019]. Disponível em: https://www.sciencedirect.com/science/article/abs/pii/S0921800908004424

GRÊT-REGAMEY, Adrienne & Weibel, Bettina & Rabe, Sven-Erik & Burkhard, Benjamin. (2017) - A tiered approach for ecosystem services mapping. In Mapping Ecosystem Services, editado por: Burkhard, Benjamin & Maes, Joachim, pp. 213-217, Sofia: [consultado em setembro 2021]. Disponível em:. https://doi.org/10.3897/ab.e12837

HAINES-YOUNG, R., Potschin, M., & Fish, R. (2012) - Classifying Ecosystem Services. Ecosystems Knowledge Network Briefing Paper Nº1. [consultado em junho 2019]. Disponível em: https://ecosystemsknowledge.net/sites/default/files/wp-content/uploads/2012/10/EKN_Classification_briefing1_R1.pdf

HAINES-YOUNG, R., & Potschin, M. B. (2018) - Common international classification of ecosystem services (CICES) V5. 1 and guidance on the application of the revised structure. European Environment Agency (EEA). [consultado em junho 2019]. Disponível em: https://cices.eu/content/uploads/sites/8/2018/01/Guidance-V51-01012018.pdf

LANDSCAPE INSTITUTE (2008) – Landscape archuitecture and the challenge of climate change, Position Statlement, The Landscape Institute, London. [consultado em setembro 2020]. Disponível em: https://www.landscapeinstitute.org/publication/landscape-architecture-and-the-challenge-of-climate-change-2008/

LANDSCAPE INSTITUTE (2013) - Green Infrastructure An integrated Approach to Land Use, Position Statement, he Landscape Institute, London. [consultado em setembro 2020]. Disponível em: https://landscapewpstorage01.blob.core.windows.net/www-landscapeinstitute-org/2016/03/GreenInfrastructureLIPositionStatement2013.pdf

MA – Milennium Ecossystem Assessement (2005) - Ecosystems and Human Well-being: Biodiversity Synthesis. Washington, DC: World Resources Institute.

MAES J., Teller A., Erhard M. et al. (2013) - Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020. Publications Office of the European Union, Luxembourg. [consultado em junho 2019]. Disponível em: https://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf

MARTA-PEDROSO C., Laporta L., Proença V., Azevedo J.C. & Domingos T. (2014) - Changes in the ecosystem services provided by forests and their economic valuation: a review (Chapter 5). In: Azevedo J.C. et al. (eds.), Forest Landscapes and Global Change – Challenges for Research and Management. Springer Science Business Media, New York, 107-137. [consultado em julho 2019]. Disponível em: https://www.researchgate.net/publication/265727088_Changes_in_the_ecosystem_services_provided_by_forests_and_their_economic_valuation_a_review

MELL, Henneberry et al, (2013) – Promoting Urban Greening: Valuing the development of green infrastructure investments in the urban core of Manchester, UK, pp 1 – 11.

MENDES, Rúben Tiago da Silva (2016) - Análise à integração dos serviços de ecossistemas em PDM na envolvente à Ria de Aveiro, Dissertação apresentada para obtenção do grau de Mestre em Ecologia Aplicada, Universidade de Aveiro. [consultado em março 2020]. Disponível em: https://ria.ua.pt/handle/10773/17349

OJEA E., Martin-Ortega J. & Chiabai A. (2012) - Defining and classifying ecosystem services for economic valuation: the case of forest water services. Environmental Science & Policy 19-20: 1-15.

PADRÃO, Ana Rita Martinho (2016) – Como Financiar a Implementação da Estratégia Europeia da Infraestrutura Verde à Escala Local? Análise do Poder de Aplicação dos Fundos Europeus, Dissertação apresentada para obtenção do grau de Mestre em Engenharia do Ambiente, Instituto Superior Técnico.

PEREIRA, H. M., Domingos, T., Vicente, L., e Proença, V. (2009) - Ecossistemas e bem-estar humano: avaliação para Portugal do Millennium Ecosystem Assessment, Fundação da Faculdade de Ciências da U. L. e Escolar Editora

RODRIGUES, Ana Paula da Palma (2015) - Quantificação, valoração e mapeamento de serviços de ecossistema na bacia superior do Rio Sabor (concelho de Bragança), Dissertação apresentada para obtenção do grau de Mestre em Gestão de Recursos Florestais, Escola Superior Agrária de Bragança, Instituto Politécnico de Bragança. [consultado em outubro 2019]. Disponível em: https://bibliotecadigital.ipb.pt/handle/10198/12770

ANNEXES

Salvaterra de Magos
Fonte: CCDR-LVT

Annex 1 - Notes on application of the Common International Classification of Ecosystem Services (CICES) V5.1

Source: Haines-Young, R. & M.B. Potschin (2018) - in gray the Services worked within the scope of this Report

Supply	Code	Description	Service Example	Example of Goods and Benefits
Crops for food purposes (including fungi, algae)	1.1.1.1	Any crops and fruits grown by humans for food; food crops	Wheat ready to be harvested before harvest (Proxy for: ecosystem contribution to harvestable wheat growth)	Harvest; Grain in the farmer's shop; flour, bread
Fibers and other material from crops, fungi, algae and bacteria for direct use or processing (excluding genetic materials)	1.1.1.2	Material from plants, fungi, algae or bacteria that we can use	Crop surplus	Processed wood (Volume of harvested wood)
Crops (including fungi, algae) as an energy source	1.1.1.3	Plant materials used as an energy source	Grass crop at harvest time	Energy production
Aquatic crops for food, products or energy	1.1.2.1	Edible plants grown in fresh or salt water	Usable surplus of *in situ* algae biomass	Vitamin supplement
	1.1.2.2	Plants that are grown in fresh or salt water that we can use as material	Usable surplus of *in situ* algae biomass	Seaweed as insulating material
	1.1.2.3	Plants that are grown in fresh or salt water that we can use as an energy source	Usable surplus of *in situ* algae biomass	Algae as an energy source
Animal husbandry for food, products or energy	1.1.3.1	Livestock raised indoors and / or grazing outdoors	Increase in weight or number of heads of cattle per year [previously the pasture for feeding these animals was considered the final service]	Meat produced at abattoir, eggs, milk sold on farm or in shops
	1.1.3.2	Animal material we can use	Number and quality of animal skins in the herd	Hidden products
	1.1.3.3	Animal materials used as an energy source or for traction	Manure volume or number of animals used for traction	Cooking or transport fuel
Breeding aquaculture animals for food, products or energy	1.1.4.1	Animals we eat that are raised in fresh or salt water	Bivalve stock that can be harvested	Seafood (eg mussels)
	1.1.4.2	Animals that are raised in fresh or salt water that we can use as material	Pearls produced by oyster banks	Pearls used for adornment
	1.1.4.3	Animals that are grown in fresh or salt water that we can use as an energy source	Aquaculture Waste Biogas	Production of energy
Wild plants, algae and their products	1.1.5.1	Wild plant foods	Potential volume of wild berries or wild mushrooms, or benthic macroalgae (eg Dulse, Laminaria (Kelp)) and macrophytes (eg Salicornia and other sea salt plants) harvested in the sublittoral and/or shallow coastal zone	Berries as food or for the production of candy
	1.1.5.2	Wild plant materials	Potential volume of reeds, or macroalgae used for thickeners, agar and superconducting electrodes	Covering material
	1.1.5.3	Wild plant materials, fungi and algae used for energy	Volume of harvested wood	Fuel wood
Wild animals and their products	1.1.6.1	Wild animal food	Exploitable surplus of the cod population or the deer population	Cod liver oil, venison joint
	1.1.6.2	Wild animal materials	Reindeer skins, or zooplankton - jellyfish used to produce collagen for various purposes	Hidden products
	1.1.6.3	Wild animal material that can be used as an energy source	Whale fat used by traditional cultures in lamps, or Herring (historic) or cetaceans	Fuel source
Genetic material from all biotypes (including seeds, spores or gametes)	1.2.1.1	Seed collection	Seeds or spores that we can harvest	Wild plant seed for commercial sale
	1.2.1.2	Plants, fungi or algae that we can use for reproduction	Population of plant algae or fungal species used in breeding programs	Species of plants, algae or fungi with new characteristics that increase yield or reduce costs, resisting diseases or pests
	1.2.1.3	Genetic material from wild plants, fungi or algae that we can use	Portion of population that can be harvested from plant species used to extract genes	Creation of artificial gene products

	1.2.2.1	Animals used to replenish *stock*	Eggs for fish and seafood creations	Reduced production costs
	1.2.2.2	Wild animals that we can use for breeding	Animal population used in breeding programs	Animals with new traits that increase yields or reduce costs by resisting diseases or pests
	1.2.2.3	The genetic information that is stored in wild animals that we can use	Portion of population that can be harvested from a particular species used to extract genes	Creation of a new microorganism for the production of a pharmaceutical product
Surface water for drinking, for products	4.2.1.1	Drinking water from ground surface sources	Volume and characteristics of water from natural springs	Água potável no sistema de abastecimento público
	4.2.1.2	Surface water for uses other than drinking	Temperature and volume of water that can be used for cooling or irrigation	Reduced energy costs; greenhouse cultivation
Surface water for products or energy	4.2.1.3	Energy from water sources	Hydraulic potential	Hydro-electric energy
	4.2.1.4	Wave or tidal energy	Tidal speed	Tidal energy
Deep water for drinking, for products or energy	4.2.2.1	Underground drinking water	Aquifer volume and characteristics	Drinking water in the public supply system; mineral water
	4.2.2.2	Underground water for uses other than drinking	Characteristics and volume of water that can be used for washing purposes	Reduced material costs
	4.2.2.3	Underground water that we can use as an energy source	Hot water and steam outlets	Reduces energy costs
Mineral substances for food, materials or energy	4.3.1.1	Minerals in our food	Salt	Dietary value
	4.3.1.2	Natural inorganic materials that we can use	Pigments	Decor
	4.3.1.3	Natural inorganic materials that we can use as an energy source	Uranium	Energy production
Non-mineral substances or properties of ecosystems used for food, materials or energy	4.3.2.1	The ways the physical environment contributes to our nutritional health	Sun light	D vitamin
	4.3.2.2	Inorganic natural gaseous, fluid or non-mineral materials that we can use (excludes water vapour)	Ozone; or mineraloids (eg Opal)	Health benefit; precious stones
	4.3.2.3	Wind energy	Wind energy	Renewable energy source
	4.3.2.4	Solar energy	Solar energy	Renewable energy source
	4.3.2.5	Using underground heat	Hot Springs	Renewable energy source
Regulation	**Code**	**Description**	**Service Example**	**Example of Goods and Benefits**
Transformation of biochemical or physical inputs to ecosystems	2.1.1.1	Waste decomposition	Bio-remediation of industrial waste by deposition on agricultural land, or Bacteria like Marionobacter that can transform oil into simple monomers	Sustainable waste disposal
	2.1.1.2	Waste filtration	Dust filtering by urban trees, or Macrophytes, for example, marsh grasses can trap particles in the roots, trapping residues / toxics in the sediment (Govers et al. 2014)	Reduction of respiratory diseases
	2.1.2.1	Odor reduction	Protection belts that filter the particles that carry the odors, or birds, epifauna, infauna and bacterial communities contribute to this service by removing materials such as rotten algae mats, in the coastal zone or at sea, which can be reached by the tide at the margin and produce olfactory and visual impacts	Reduction in the annoying effect of smells
	2.1.2.2	Noise reduction	Protection belts along highways	Low noise environment
	2.1.2.3	Screening Visually Unpleasant Elements	Visual protection belts around industrial structures	Visual amenity
Control of erosion rates	2.2.1.1	Control or prevent soil loss	The ability of vegetation to prevent or reduce the incidence of soil erosion, or macroalgae, microphytobenthos, macrophytes and biogenic reef structures (epifauna and infauna) all contribute through sediment stabilization	Reduction of damage (and associated costs) of sediment entry into watercourses
Buffering and attenuation of mass streams	2.2.1.2	Prevent landslides and avalanches harmful to people	The ability of forest cover to prevent or mitigate the extent and strength of snow avalanche	Reduced cost to human lives and physical damage to infrastructure

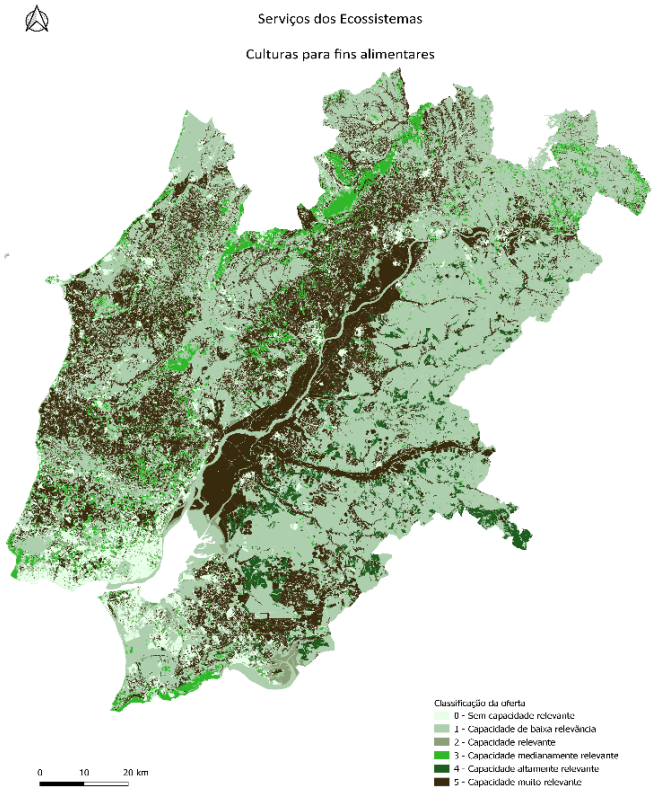
Regulation of the hydrological cycle and water flow (including flood control and coastal protection)	2.2.1.3	Regulation of water flows in the environment	The ability of vegetation to retain water and release it slowly, or the ability of mangroves to mitigate the effects of tsunamis, or localized coastal influences in the hydrological cycle by phytoplankton through the production of Dimethylsulfide (DMS) and localized flow changes due to structures of algae and higher plants. Macroalgal beds such as algae forest, macrophytes and biogenic reefs (epifauna and infauna) contribute to wave energy attenuation and flood prevention	Damage mitigation as a result of reduction in magnitude and frequency of flood/storm events
Wind storm protection	2.2.1.4	Protection of people against winds	Windbreaks	Reduction of scale or frequency of crop damage
Forest fire protection	2.2.1.5	Protection of people from forest fires	The ability of ecosystems to reduce the frequency, extent or magnitude of fires (eg, floodplain area between forests or fire curtain in forest containing low-combustible species)	Reduction in fire costs
Maintenance of life cycle, habitats and protection of the genetic stock	2.2.2.1	Pollination of fruit trees and other plants	Providing a habitat for native pollinators, or in the context of society's efforts to restore, for example, seaweed beds, may be considered final since seed dispersal can occur through this service rather than artificially.	Contribution to fruit crop income
	2.2.2.2	Spreading wild plant seeds	Acorn Scattering by Eurasian Jays	Tree regeneration in parks
	2.2.2.3	Providing habitats for wild plants and animals that may be important to us	Important nursery habitats include estuaries, seagrass, algal forests, wetlands, soft sediments, hard bottom, bark bottom and water column habitats. Clusters of floating algae (macroalgae) form rafts under which groups of juvenile fish gather (eg in the North Sea in pelagic habitats)	Sustainable populations of important or iconic species that contribute to a service in another ecosystem
Pest and disease control	2.2.3.1	Control of pests and invasive species	Creating a habitat for native pest control agents	Reduction of damage to crops by pests
	2.2.3.2	Disease control	Presence of native disease control agents such as microbial antagonists for post-harvest disease control	Reduction of damage caused by fruit or vegetable harvesting
Soil quality regulation	2.2.4.1	Ensure the formation and development of soils	Release of inorganic nutrients in cultivated fields	Maintenance of soil quality and therefore soil capacity for human use
	2.2.4.2	Ensure that organic matter in soils is maintained	Decomposition of vegetable residues; Nitrogen fixation by legumes	Maintenance of soil quality; legumes used to increase / maintain nitrogen levels in the soil
Quality water	2.2.5.1	Control the chemical quality of fresh water	Use of buffer strips along watercourses to remove nutrients in runoff	Reduction of damage costs caused by the flow of nutrients from the agroecosystem
	2.2.5.2	Control the chemical quality of salt water	Fish communities that regulate the resilience and resistance of coral reefs to eutrophication	Coral reef health and its benefits to people in terms of wave action, etc
Composition and atmospheric conditions	2.2.6.1	Global climate regulation	Carbon sequestration in tropical peat bogs	Climate regulation that results in avoided costs or mitigation of impacts from ocean acidification
	2.2.6.2	Regulation of physical air quality for people	Evaporative cooling provided by trees in urban areas	Increased thermal comfort in cities
Mediation of waste, toxics and other nuisances by non-living processes	5.1.1.1	Diluting waste	Use of fresh/marine water systems as pollution sinks	Reduced disposal costs, waste disposal
	5.1.1.2	Diluting waste	Use of the atmosphere as a pollution sink	Reduced disposal costs, waste disposal
	5.1.1.3	Natural waste processing	Dissolved silica in the flow	Biogeochemical effects of the reduction of dissolved silica in estuaries causing changes in the composition of phytoplankton species
Mediation of anthropogenic annoyances	5.1.2.1	Natural protection	Topography tracking effect	Visual quality
Regulation of reference flows and extreme events	5.2.1.1	Physical barriers to landslides	Sand cord for coastal protection	Reduction in damage costs
	5.2.1.2	Physical barrier to flows	Natural dikes for flood protection	Reduction in damage costs

	5.2.1.3	Physical barriers to air movement	Topographic control of wind speed	Reduction in damage costs
Maintenance of physical, chemical and abiotic conditions	5.2.2.1	Regulation of living conditions by the physical environment	Sea / land breeze	Human comfort
Cultural	**Code**	**Description**	**Service Example**	**Example of Goods and Benefits**
Direct, in situ and external interactions with living systems that depend on presence in the environment	3.1.1.1	Using the environment for sports and recreation; using nature to help get fit	Ecological qualities of forest that make it attractive to hikers; private gardens or opportunities for diving, swimming	Recreation, fitness; de-stress or mental health; nature based playground
	3.1.1.2	Observation of plants and animals in the environment; using nature to de-stress	Species mix in a forest of interest to bird watchers, or whales, birds, seals and reptiles can be enjoyed by wildlife watchers	Recreation, fitness; de-stress or mental health; ecotourism
	3.1.2.1	Investigating nature	Site of special scientific interest, Natura 2000 site	Knowledge about the environment and nature
	3.1.2.2	Study nature	Site used for voluntary conservation activities	Skills or knowledge about environmental management
	3.1.2.3	The things in Nature that help people to identify with the history or culture of where they live or come	Sherwood Forest	Tourism, local identity
	3.1.2.4	The beauty of nature	Area of Outstanding Natural Beauty; panoramic site	Artistic inspiration
	6.1.1.1	Things in the physical environment that we can experience actively or passively	Caves	Ecotourism
	6.1.2.1	Things in the physical environment that we can study or think about	Rock walls for climbing	Recreation
Indirect, remote, often internal interactions with live systems that do not require presence in the environment	3.2.1.1	Using Nature equally as a national or local symbol	Bald eagle	Social cohesion, cultural icon
	3.2.1.2	The things in nature that are of spiritual importance to people	Totemic species such as the turtle	Mental well-being
	3.2.1.3	The things in nature used to make movies or write books	Archive records or collections	Nature movies
	3.2.2.1	The things in nature that must be preserved	Areas designated as wild	Moral/mental well-being
	3.2.2.2	The things in nature that we want future generations to enjoy or use	Endangered species or habitats	Moral/mental well-being
	6.2.1.1	Things in the physical environment that are important as symbols	Emblematic Mountain Peaks	Identity
	6.2.2.1	Things in the physical environment that are important to others and to future generations	Geological formation of distinctive feature or geomorphological feature	Cultural meaning

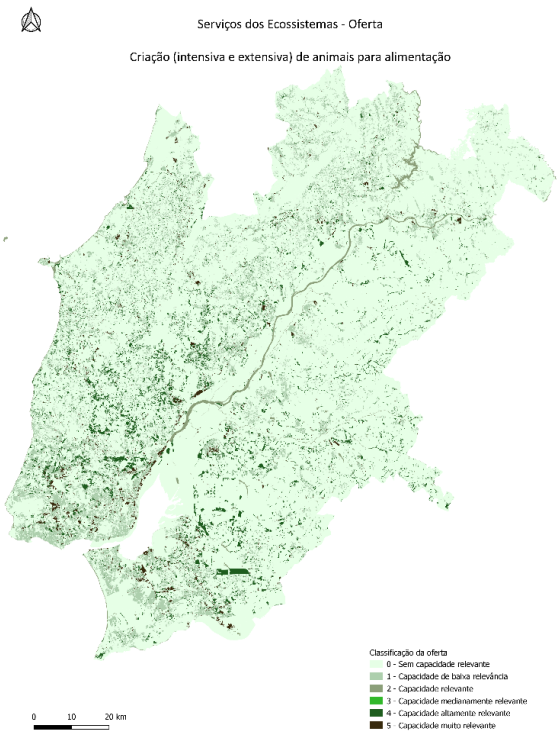
Annex 2: Ecosystem Services Maps on LTVR

Mapping of Ecosystem Services Offer at LTVR – 1st and 2nd stage

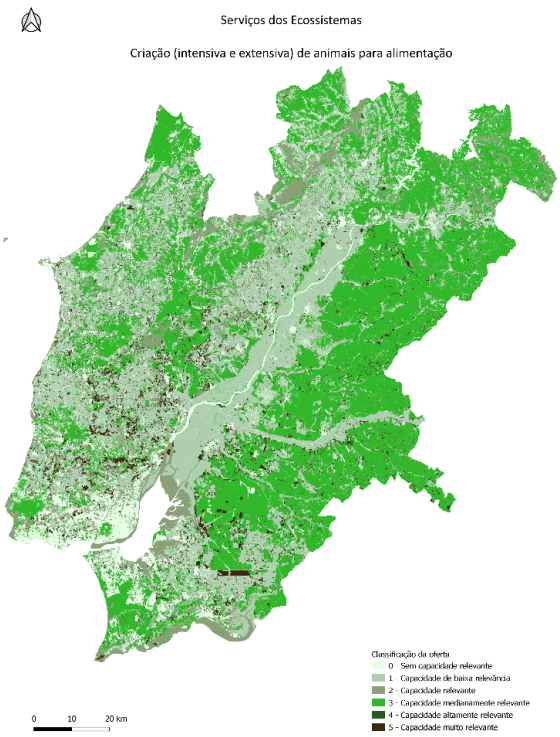
Picture 14 - Supply - Crops for food purposes (1st stage)



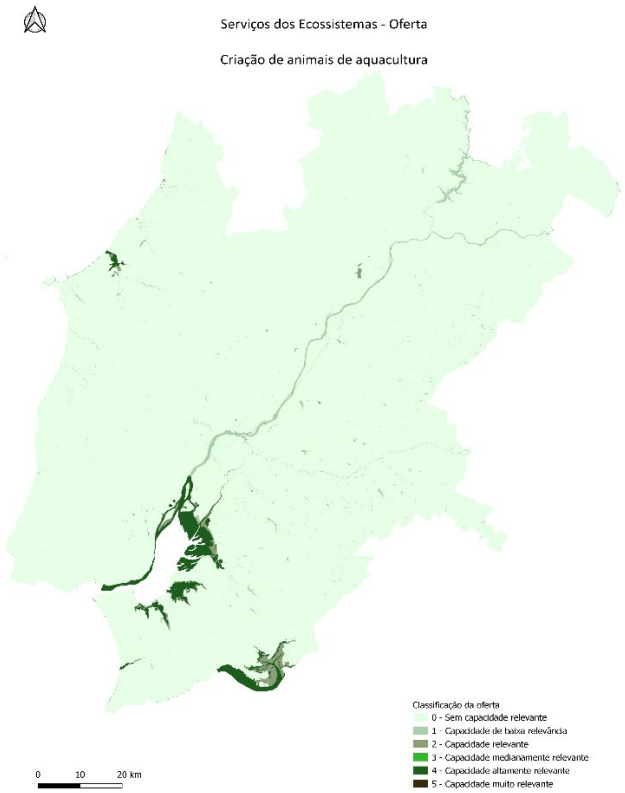
Picture 15 - Supply - Crops for food purposes (2nd stage)



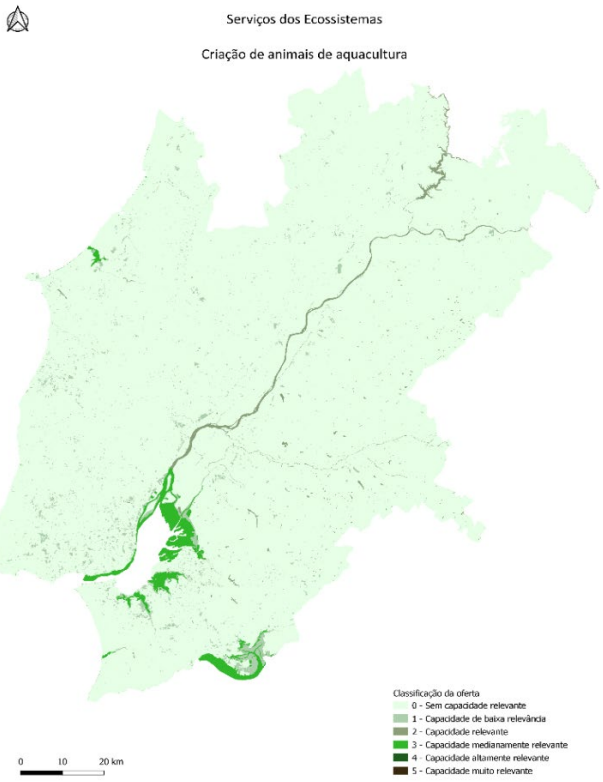
Picture 16 - Supply - breeding animals for food (1st stage)



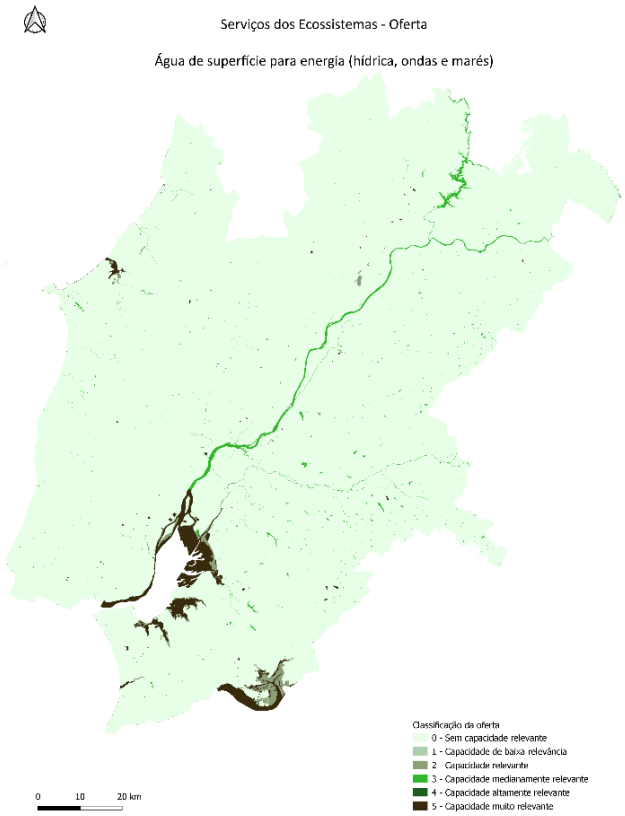
Picture 17 - Supply - breeding animals for food (2nd stage)



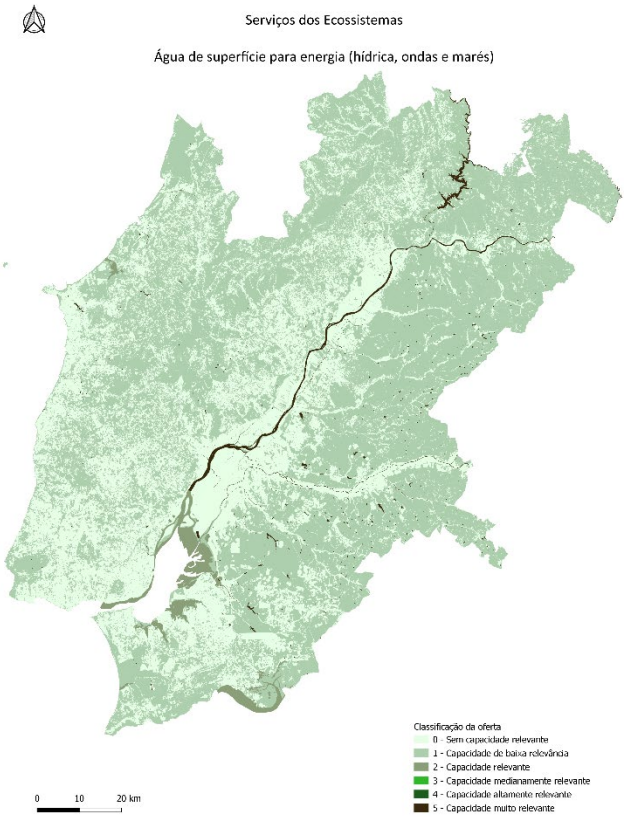
Picture 18 - Supply - breeding of aquaculture animals (1st stage)



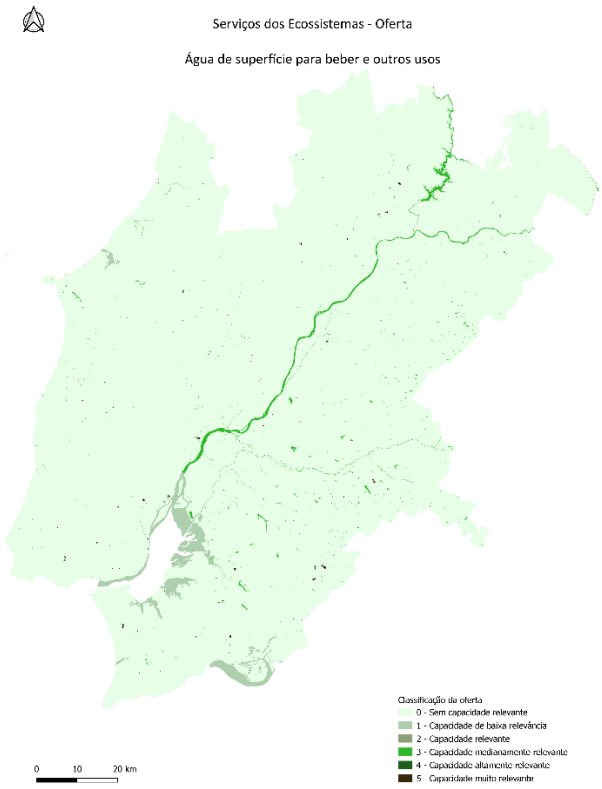
Picture 19 - Supply - breeding of aquaculture animals (2nd stage)



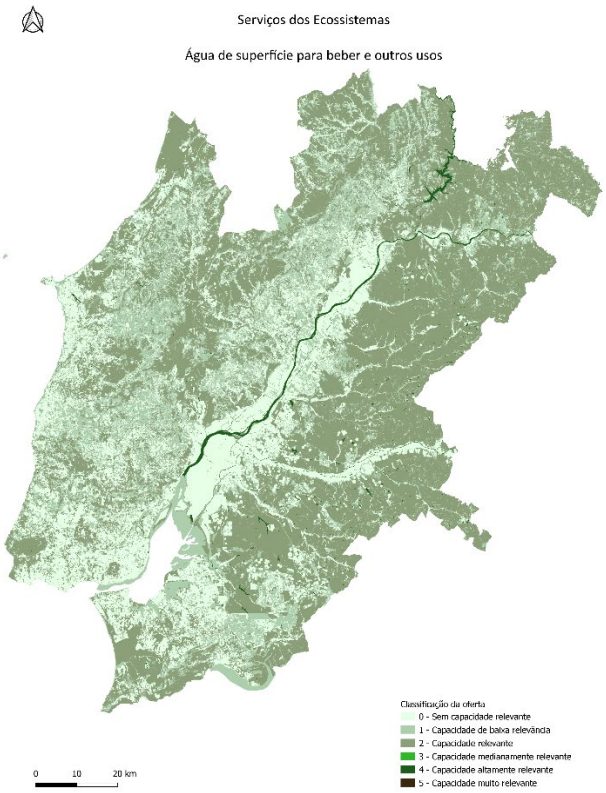
Picture 20 - Supply - Surface Water for Energy (1st stage)



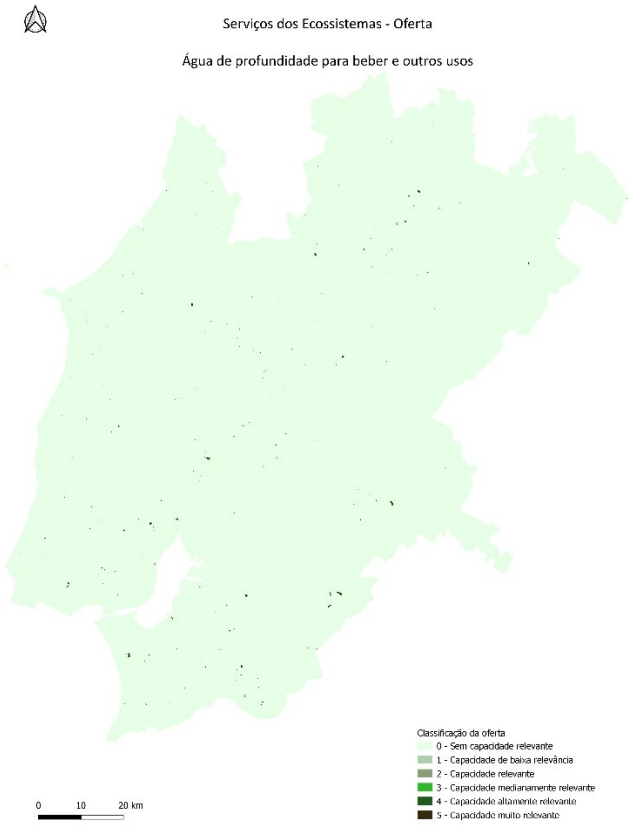
Picture 21 - Supply - Surface Water for Energy (2nd stage)



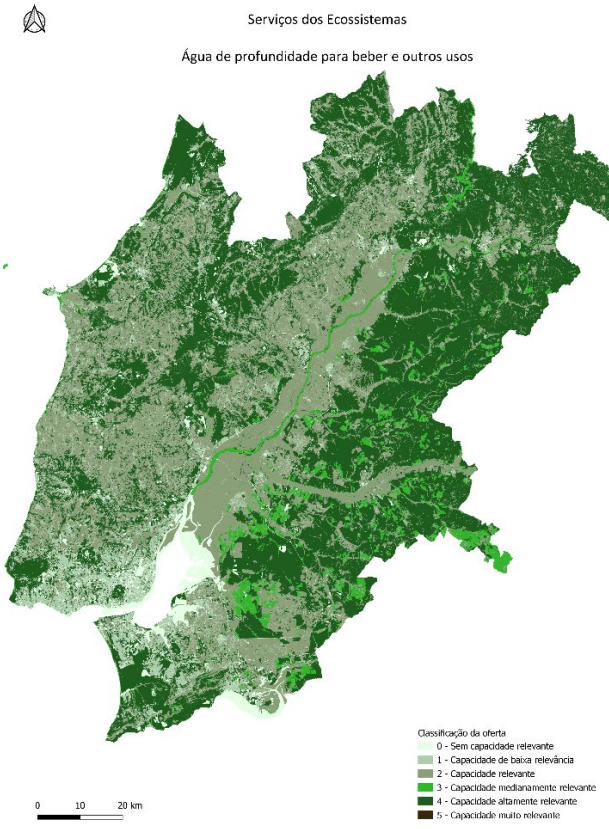
Picture 22 - Supply - Surface Water for Drinking and Other Uses (1st stage)



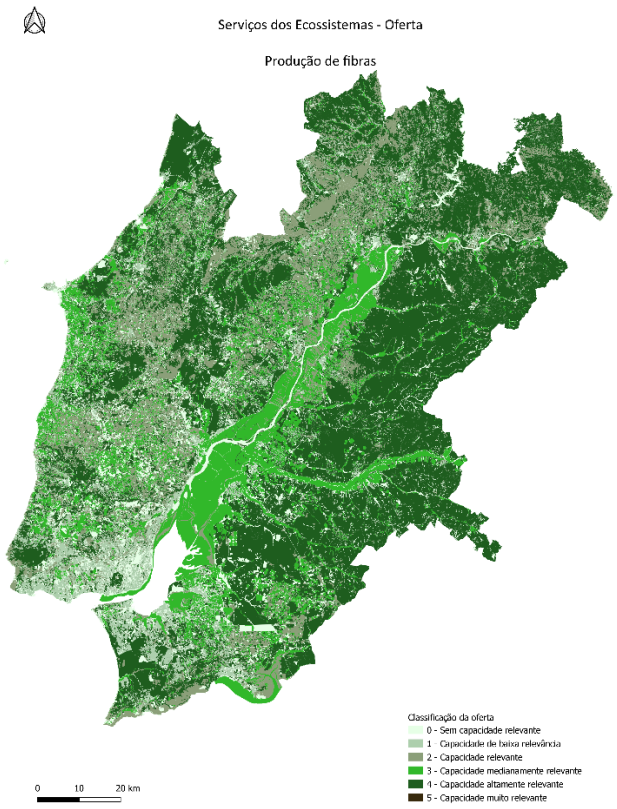
Picture 23 - Supply - Surface Water for Drinking and Other Uses (2nd stage)



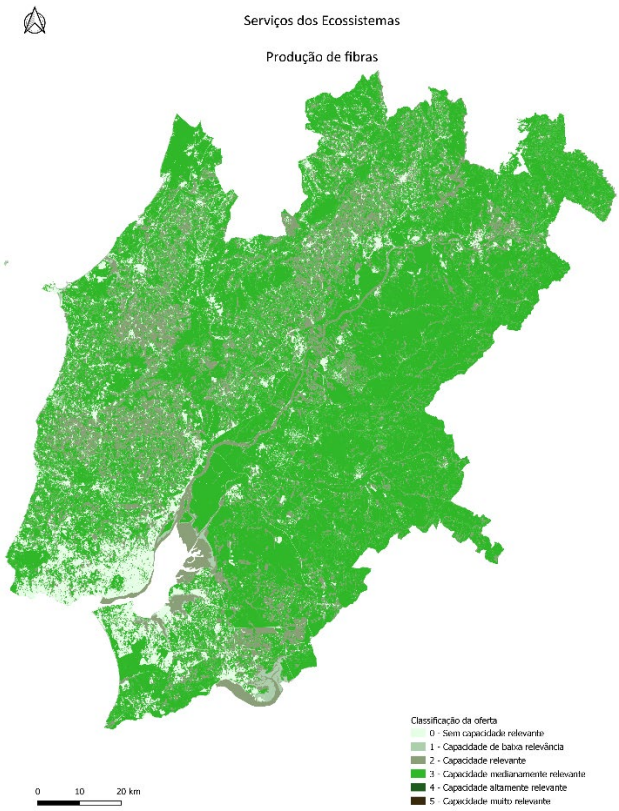
Picture 24 - Supply - Deep Water for Drinking and other Uses (1st stage)



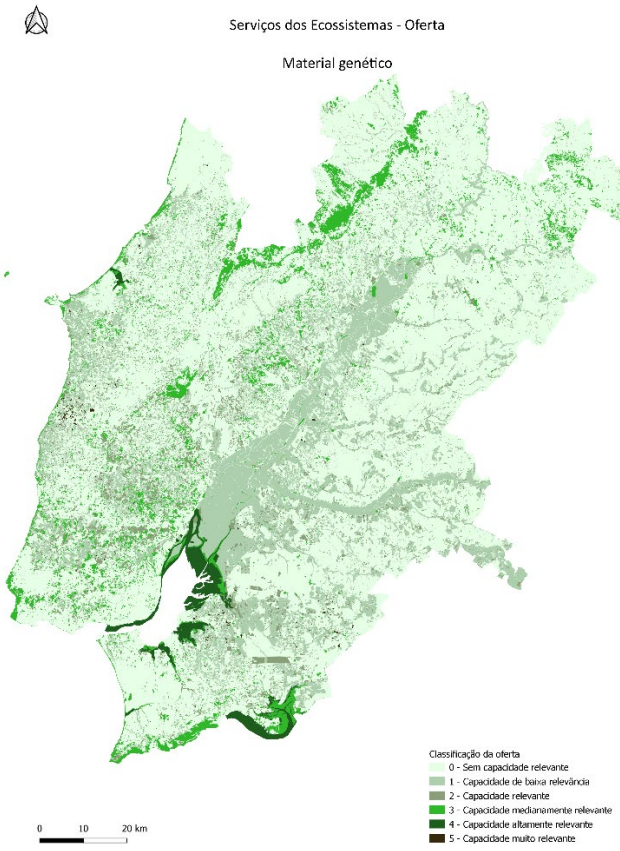
Picture 25 - Supply - Deep Water for Drinking and other Uses (1st stage)



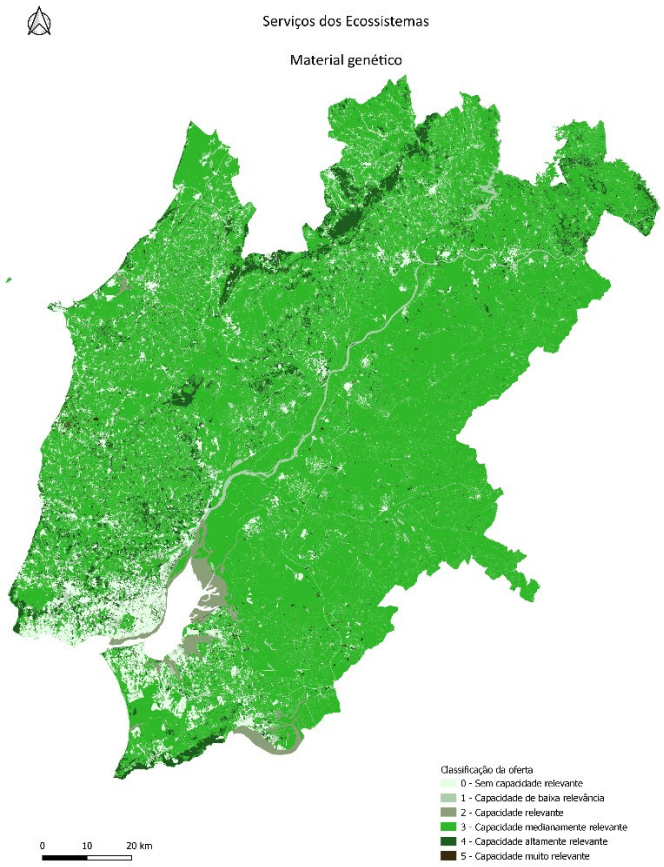
Picture 26 - Supply - Fiber Production (1st Stage)



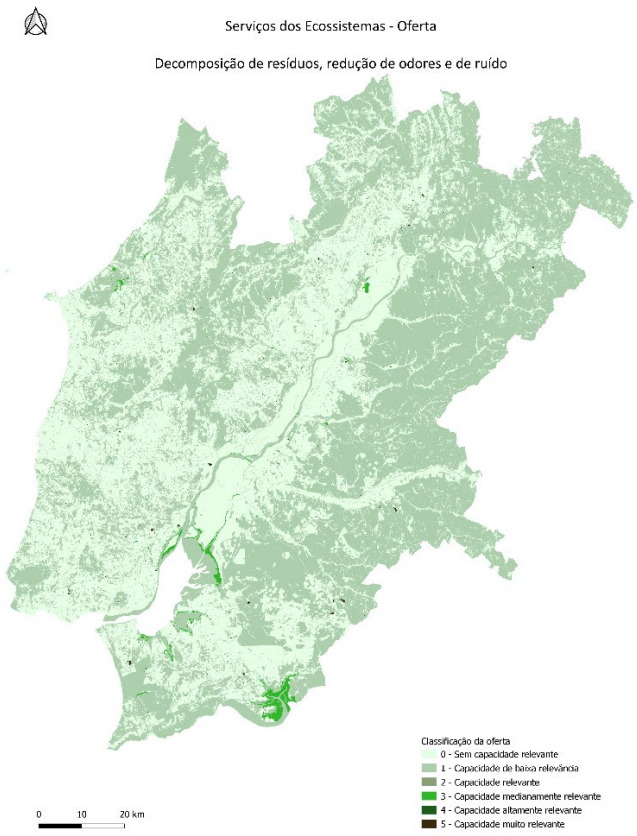
Picture 27 - Supply - Fiber Production (2nd Stage)



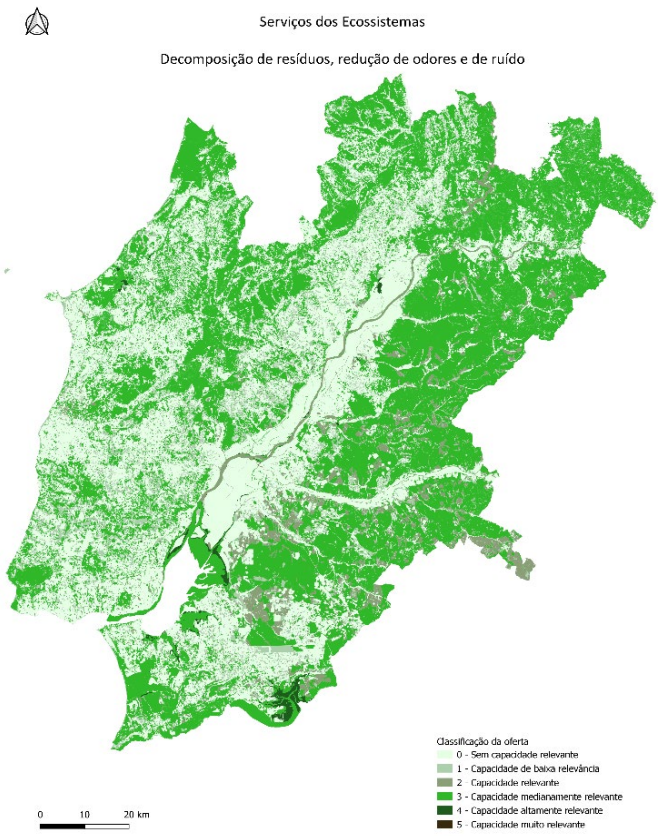
Picture 28 - Supply - Genetic Material (1st Stage)



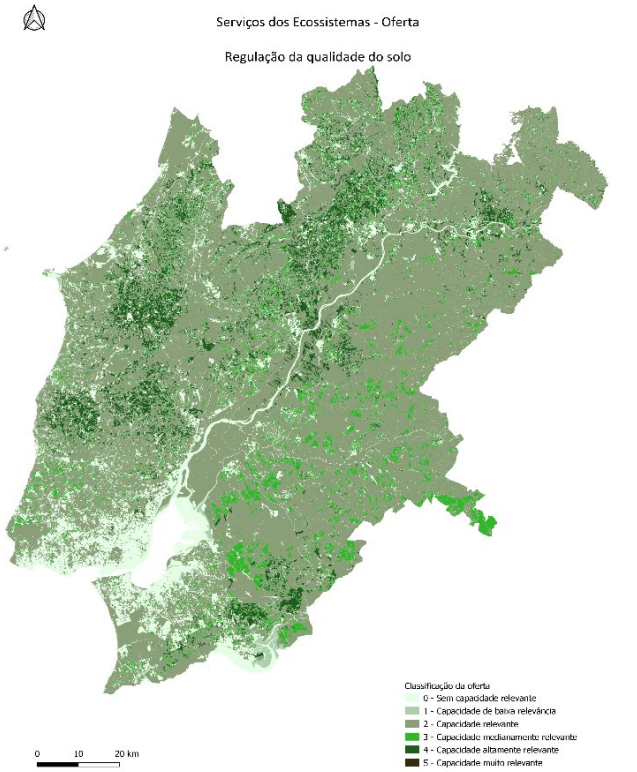
Picture 29 - Supply - Genetic Material (2nd Stage)



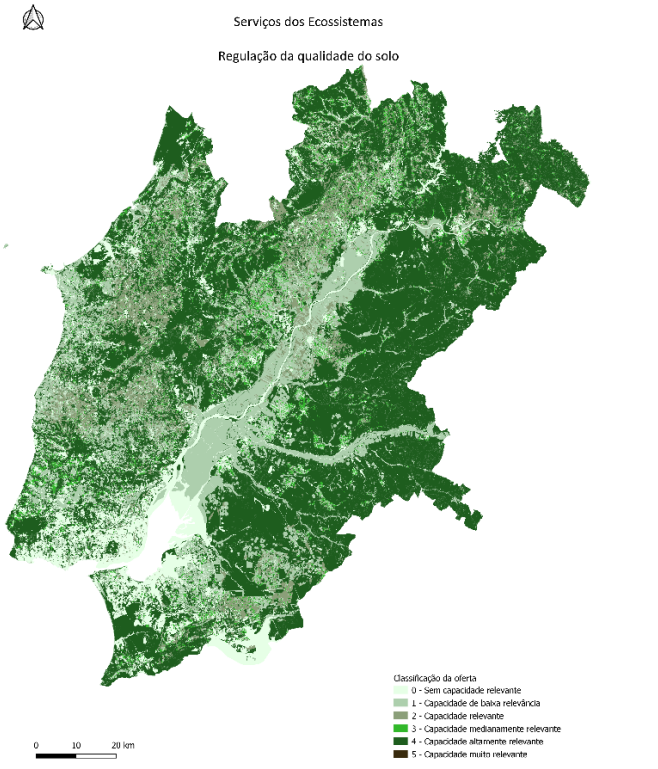
Picture 30 - Regulation - Waste decomposition, odor and noise reduction (1st Stage)



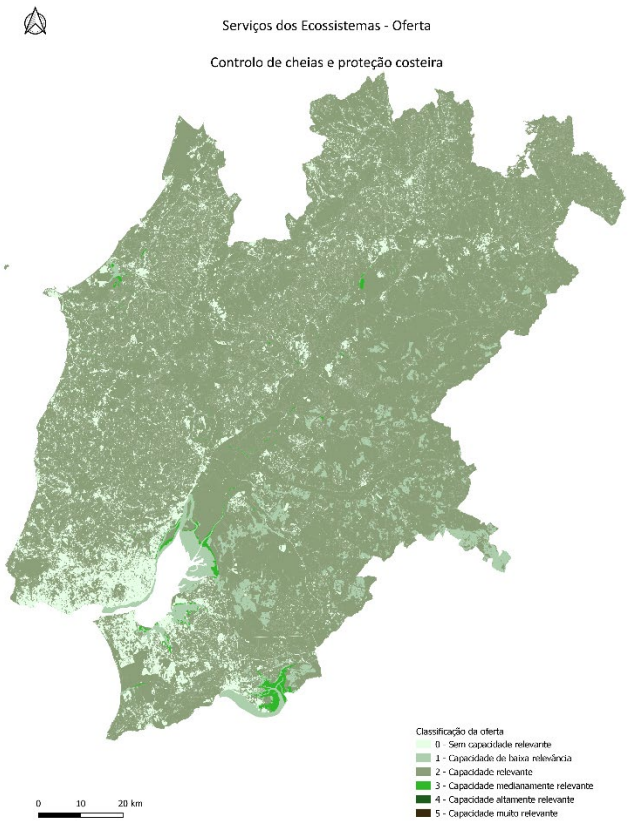
Picture 31 - Regulation - Waste decomposition, odor and noise reduction (2nd Stage)



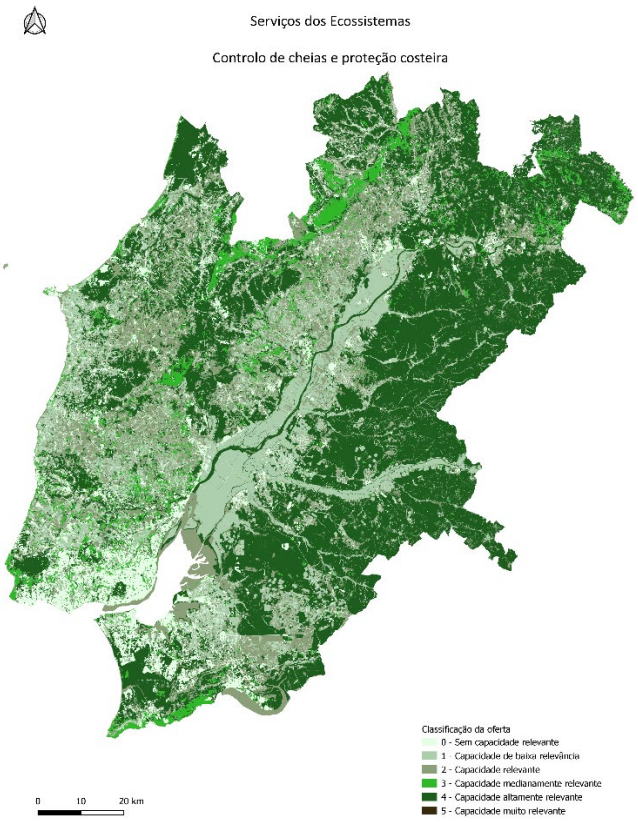
Picture 32 - Regulation - Control or prevention of soil loss (1st Stage)



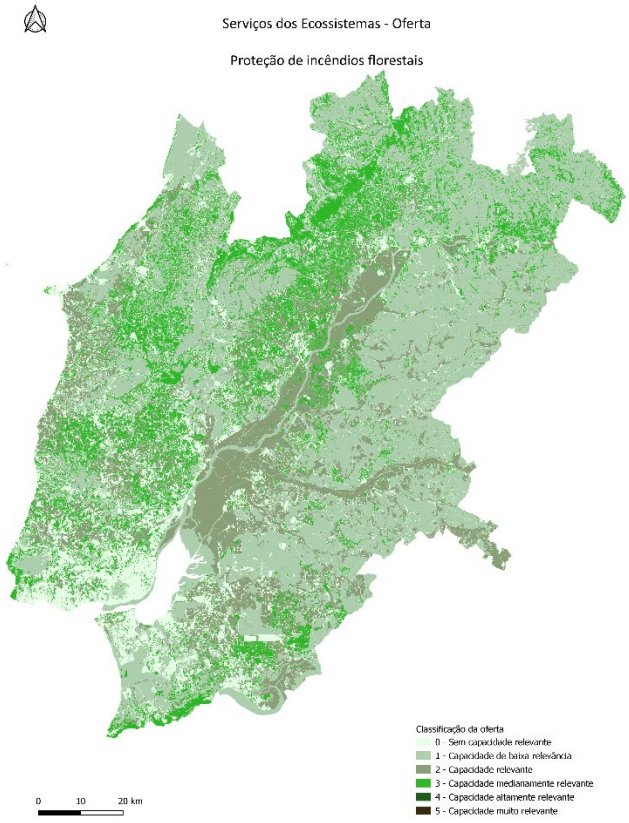
Picture 33 - Regulation - Control or prevention of soil loss (2nd Stage)



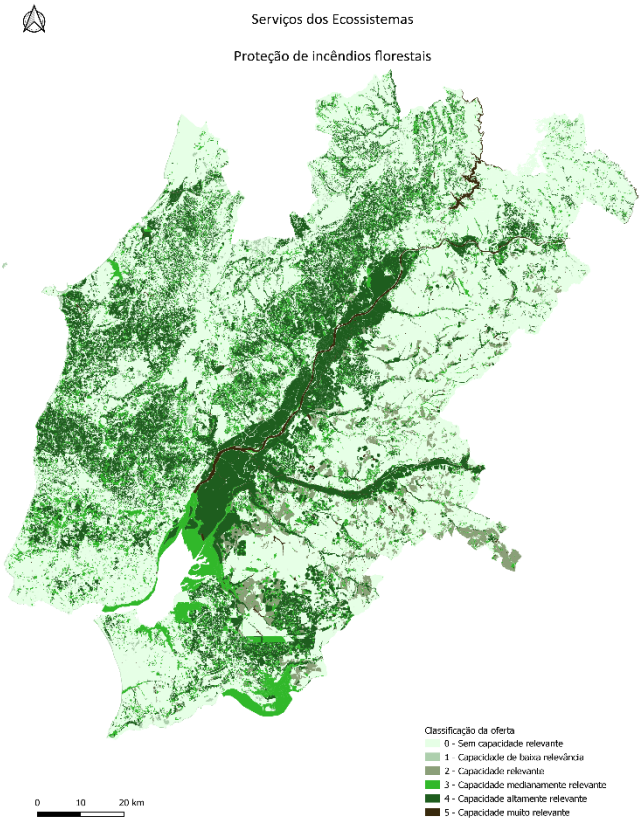
Picture 34 - Regulation - Flood Control and Coastal Protection (1st Stage)



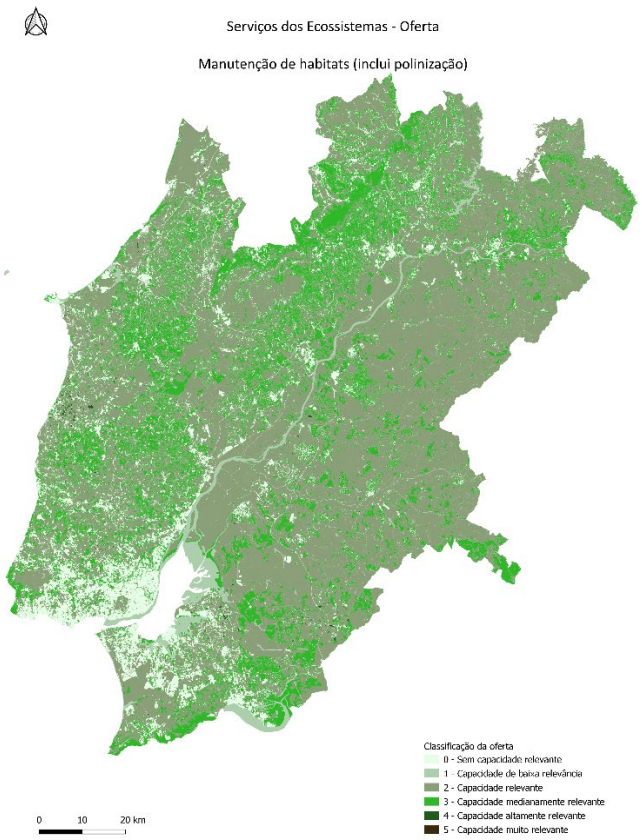
Picture 35 - Regulation - Flood Control and Coastal Protection (2nd Stage)



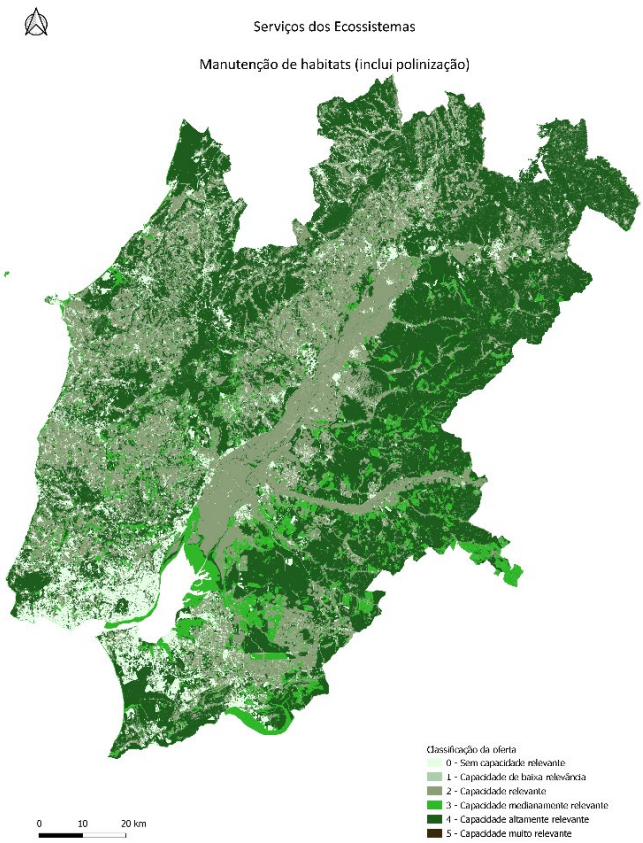
Picture 36 - Regulation - Protection of forest fires (1st Stage)



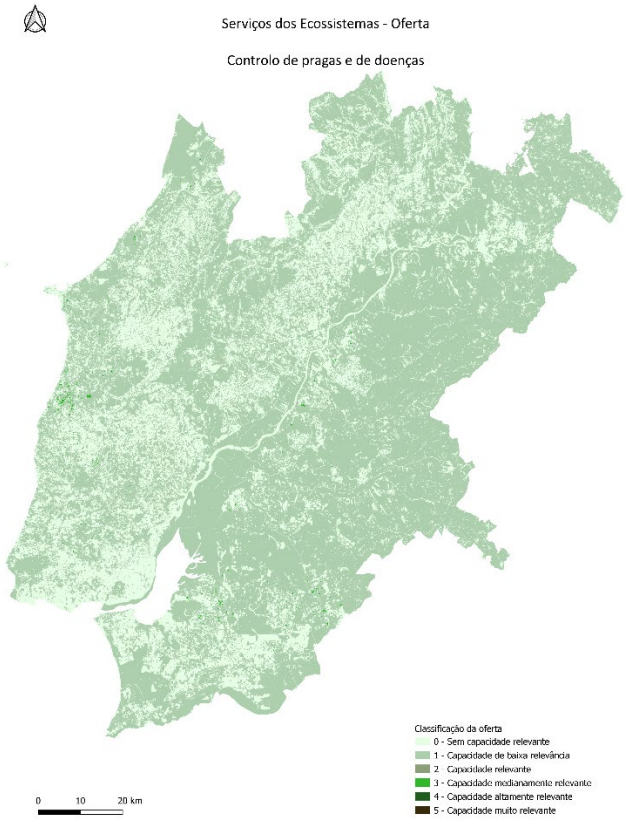
Picture 37 - Regulation - Protection of forest fires (2nd Stage)



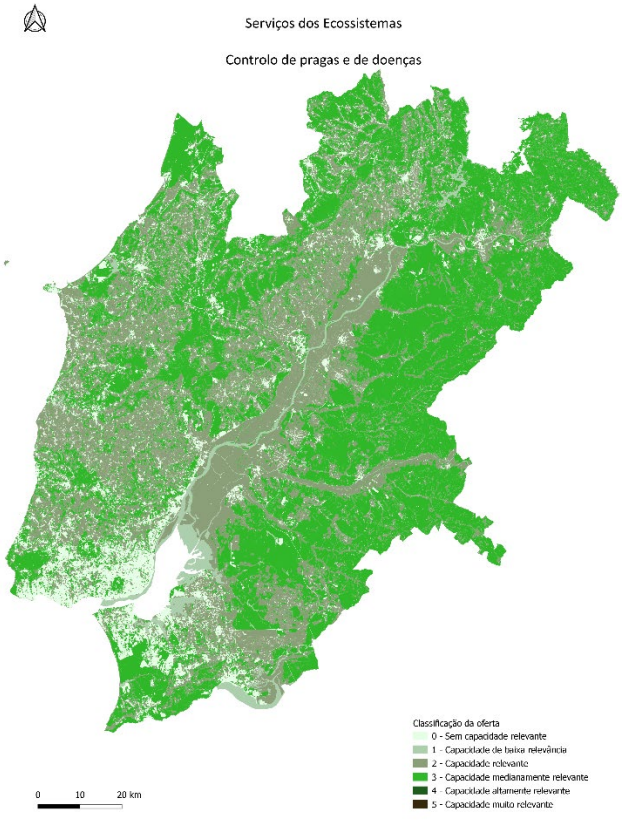
Picture 38 - Regulation - Maintenance of habitats (includes pollination) (1st Stage)



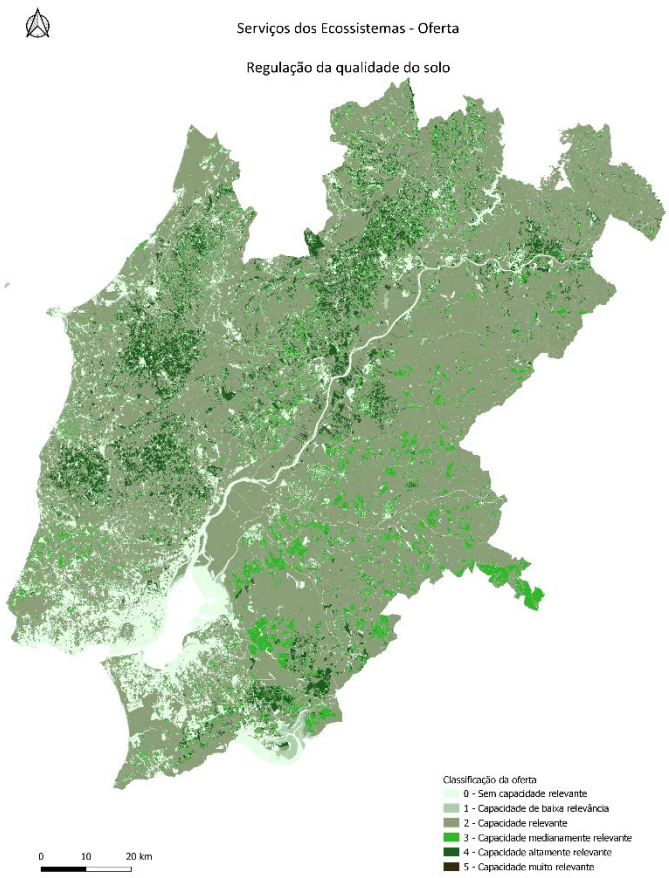
Picture 39 - Regulation - Maintenance of habitats (includes pollination) (2nd Stage)



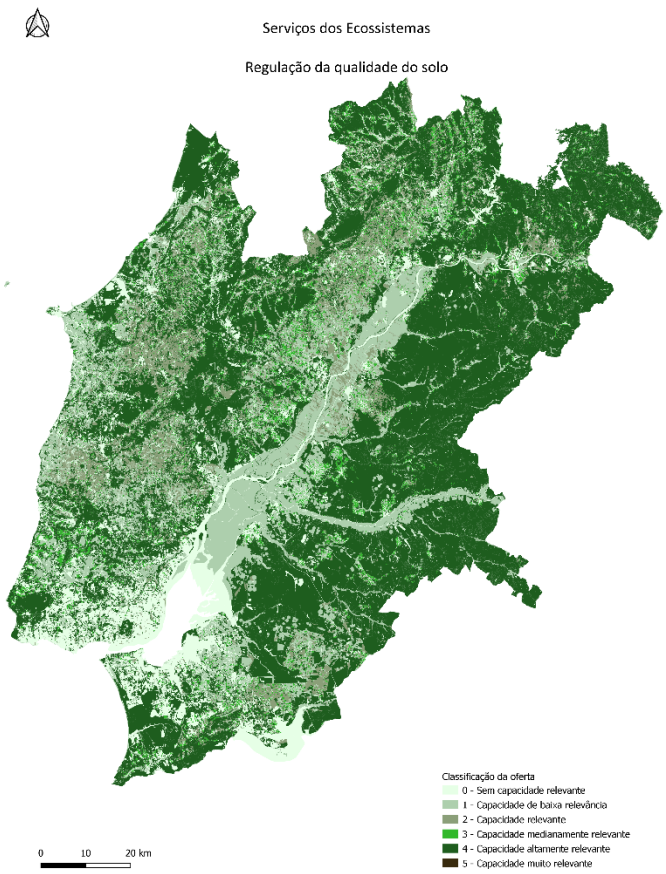
Picture 40 - Regulation - Control of pests and diseases (1st Stage)



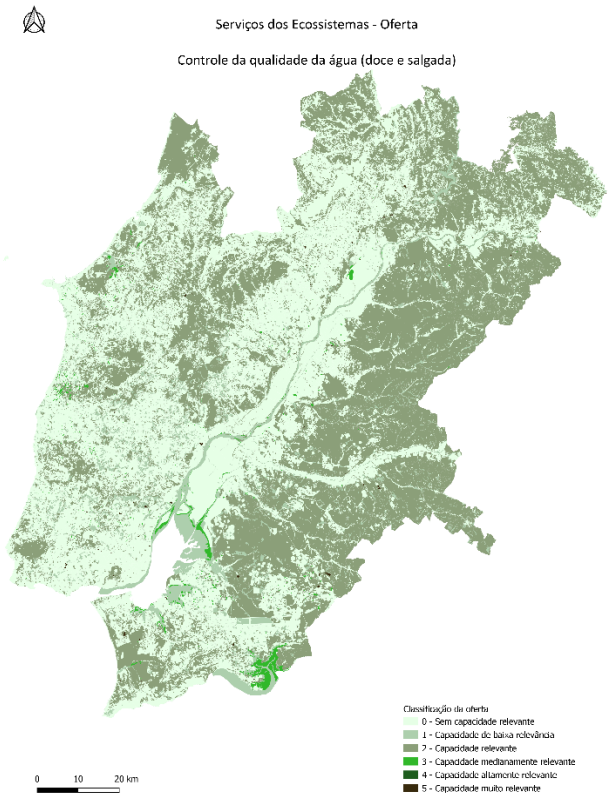
Picture 41 - Regulation - Control of pests and diseases (2nd Stage)



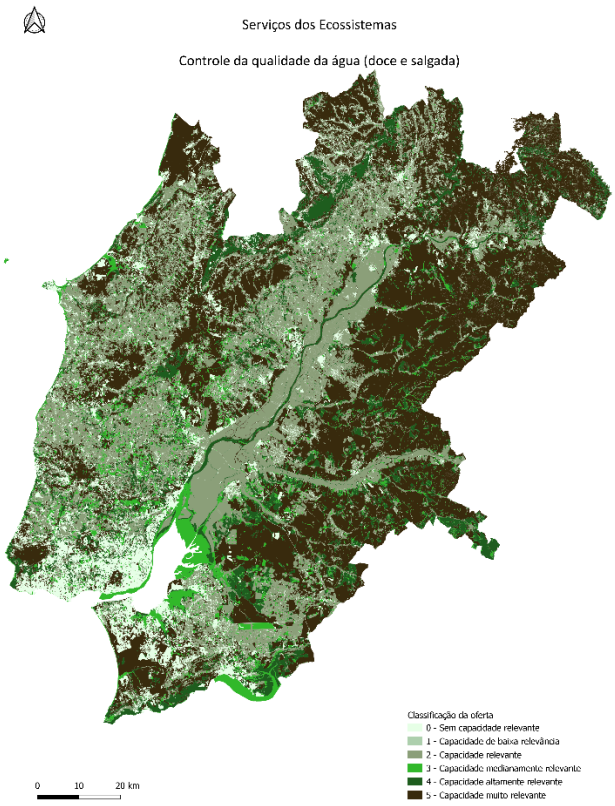
Picture 42 - Regulation of soil quality (1st Stage)



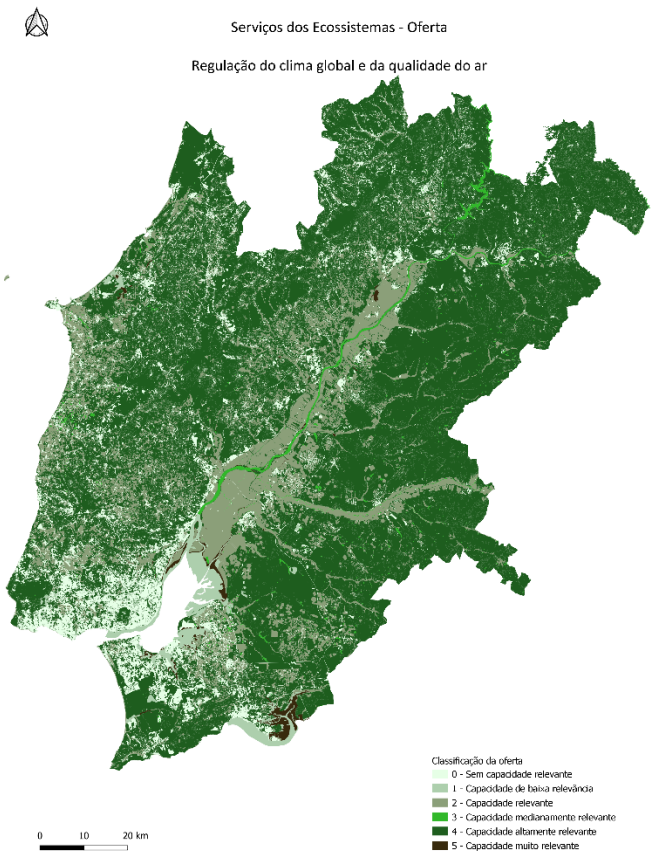
Picture 43 - Regulation of soil quality (2nd Stage)



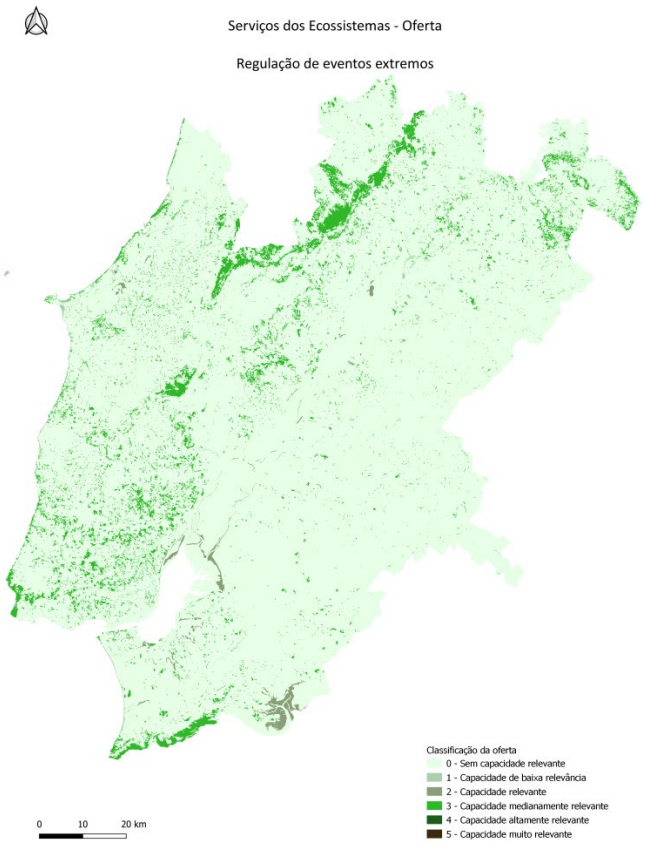
Picture 44 - Water quality control (fresh and salt) (1st Stage)



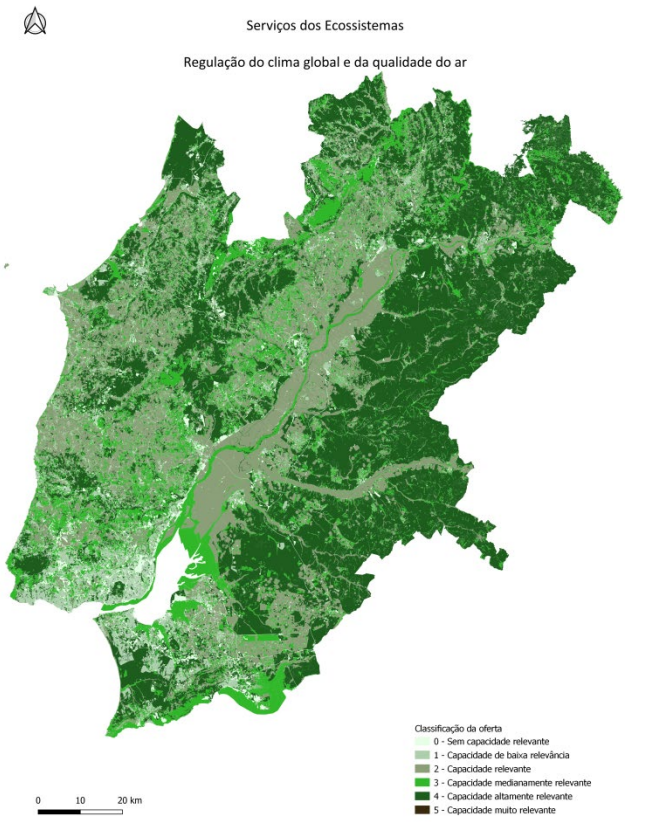
Picture 45 - Water quality control (fresh and salt) (2nd Stage)



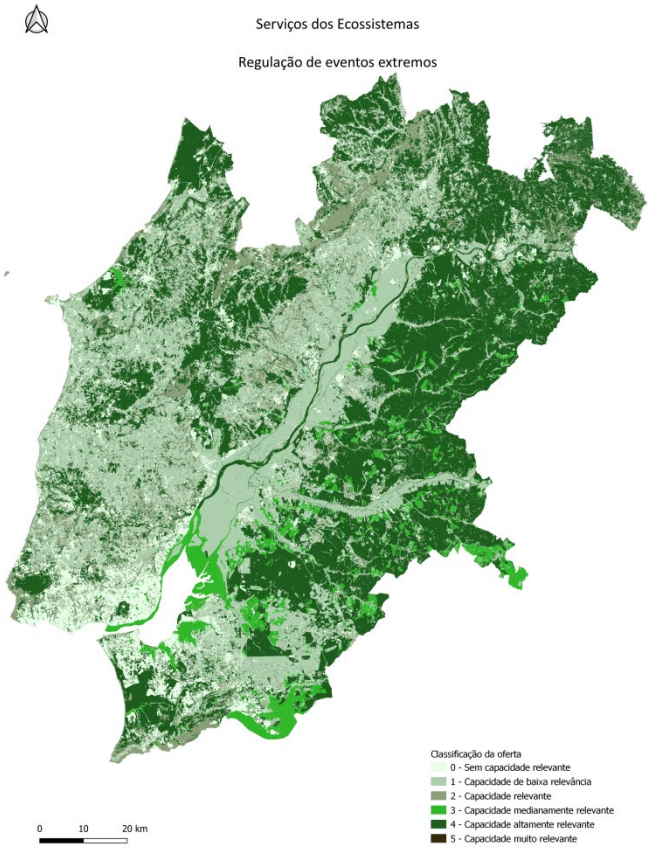
Picture 46 - Global climate and air quality regulation (1st Stage)



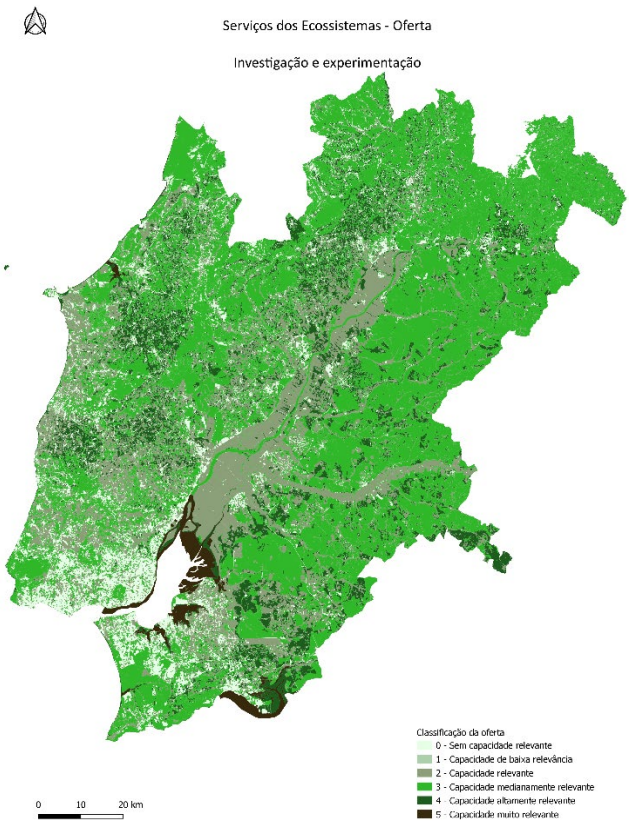
Picture 47 - Regulation of extreme events (1st Stage)



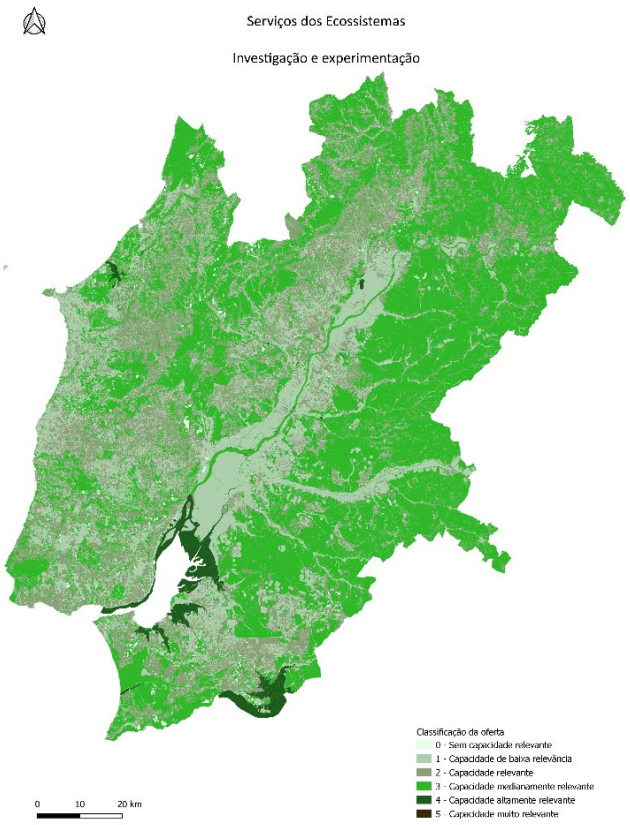
Picture 48 - Global climate and air quality regulation (2nd Stage)



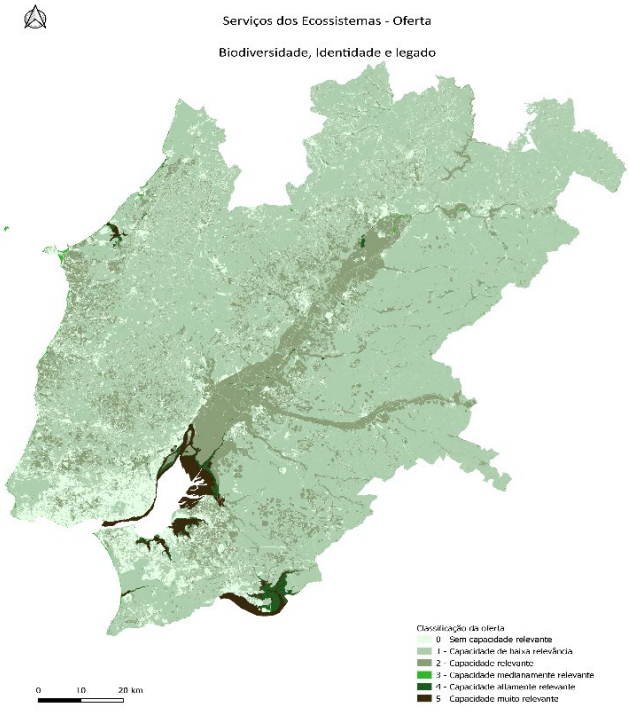
Picture 49 - Regulation of extreme events (2nd Stage)



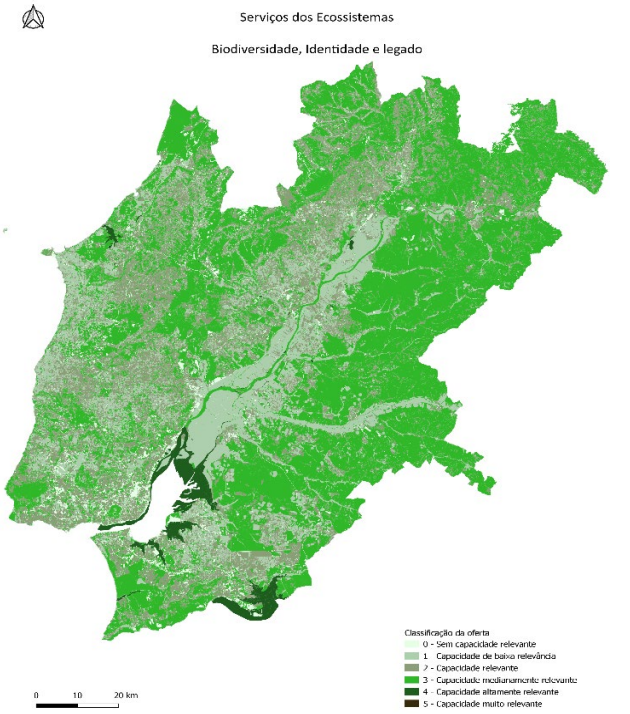
Picture 50 - Supply - Cultural - Research and experimentation (1st Stage)



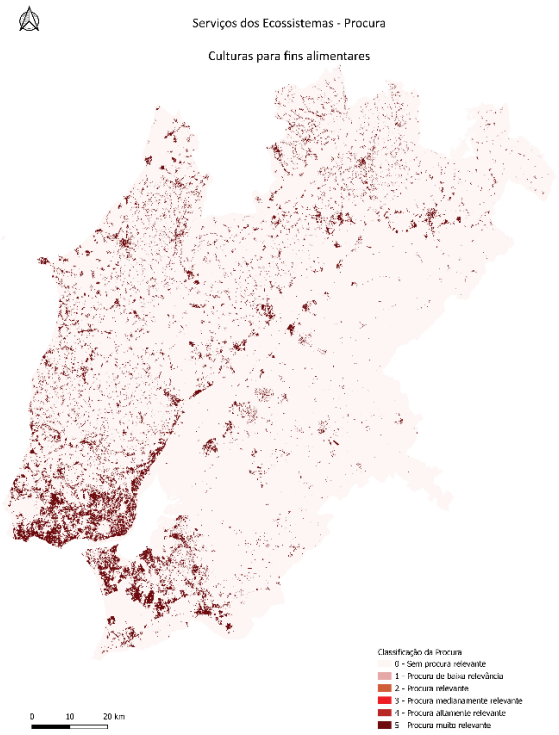
Picture 51 - Supply - Cultural - Research and experimentation (1st Stage)



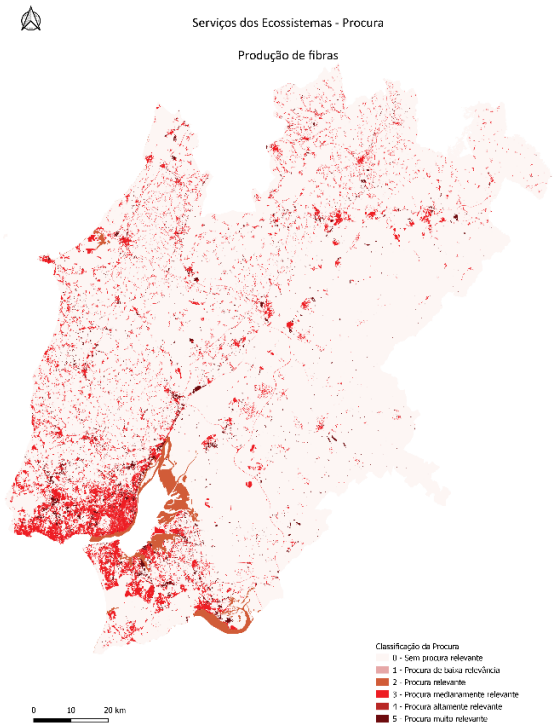
Picture 52 - Supply - Cultural - Biodiversity, Identity and Legacy (1st Stage)



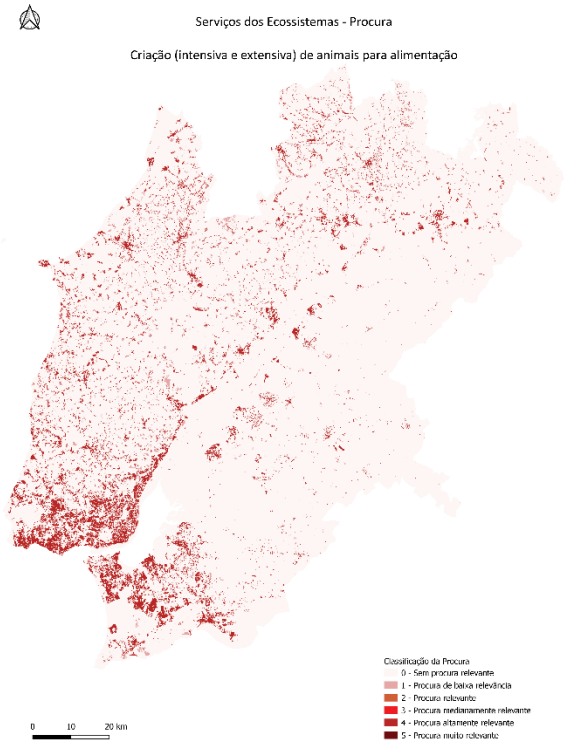
Picture 53 - Supply - Cultural - Biodiversity, Identity and Legacy (2nd Stage)



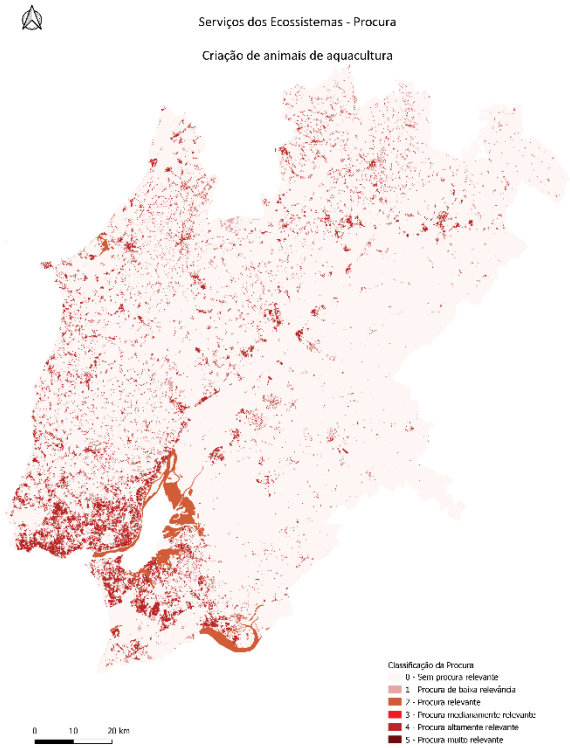
Picture 54 - Demand - Supply - Crops for food purposes



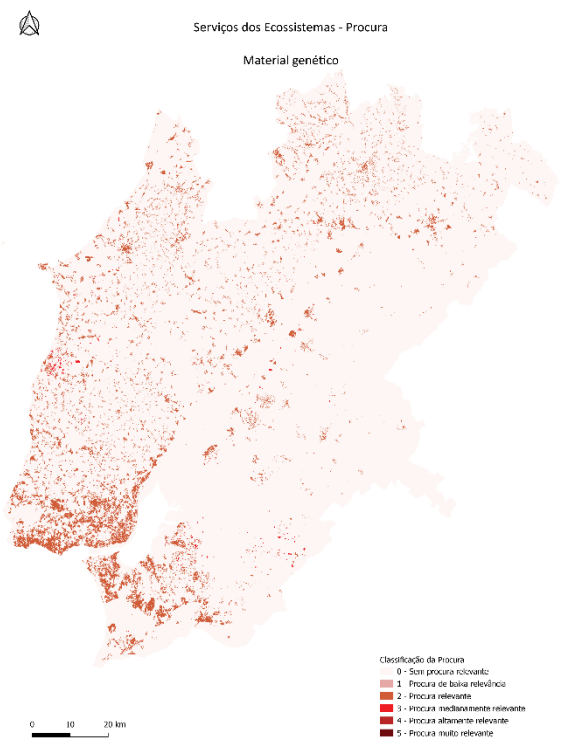
Picture 55 - Demand - Supply - Fiber production



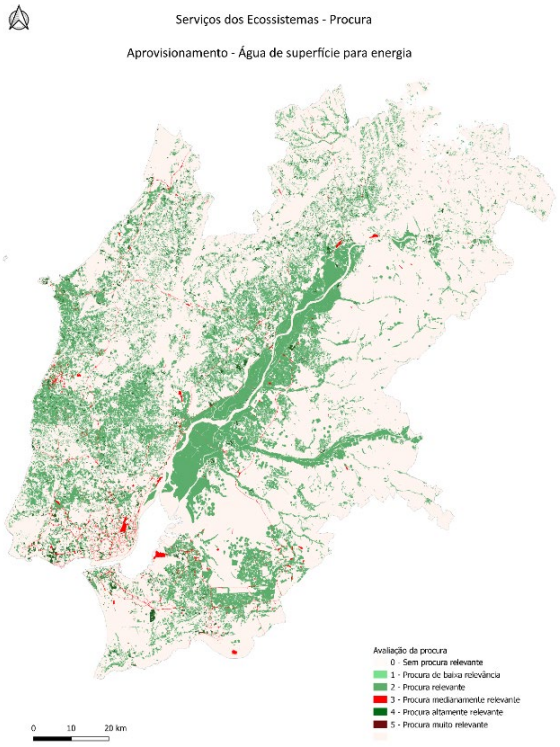
Picture 56 - Demand - Supply - Breeding (intensive and extensive) of animals for food



Picture 57 - Demand - Supply - Raising aquaculture animals



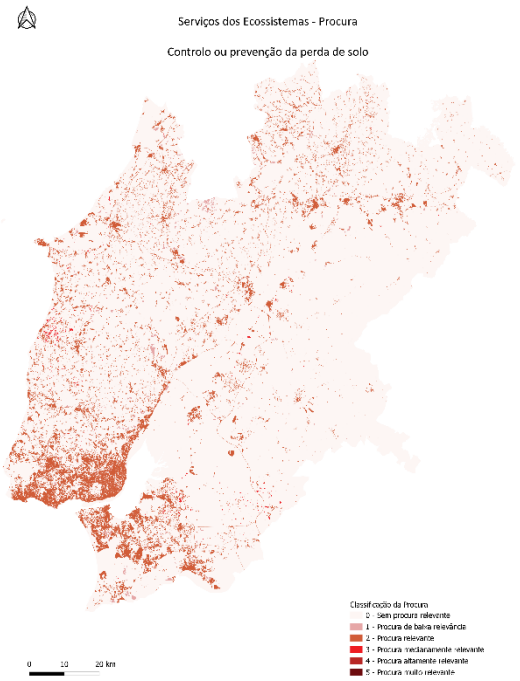
Picture 58 - Demand - Supply - Genetic material



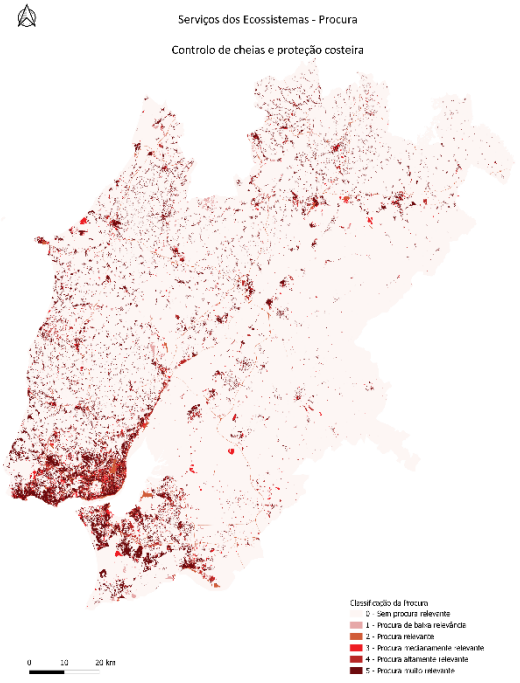
Picture 59 - Demand - Supply of surface water for energy

Picture 60 - Demand - Supply of surface water for Drinking and Other Uses

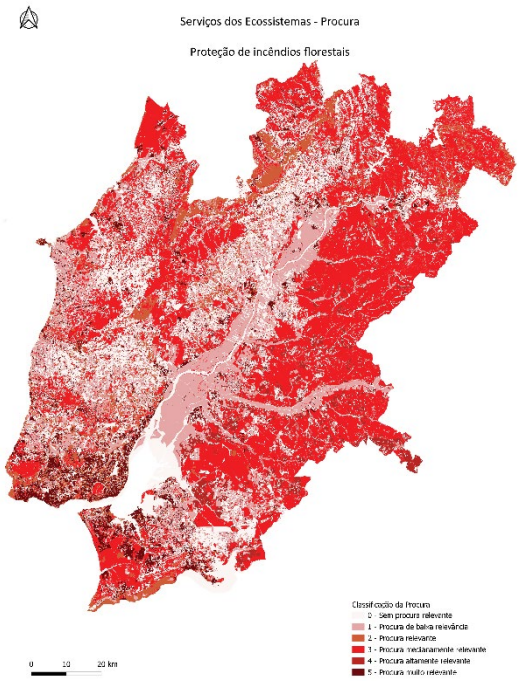
Picture 61 - Demand - Deep Water Supply for Drinking and Other Uses



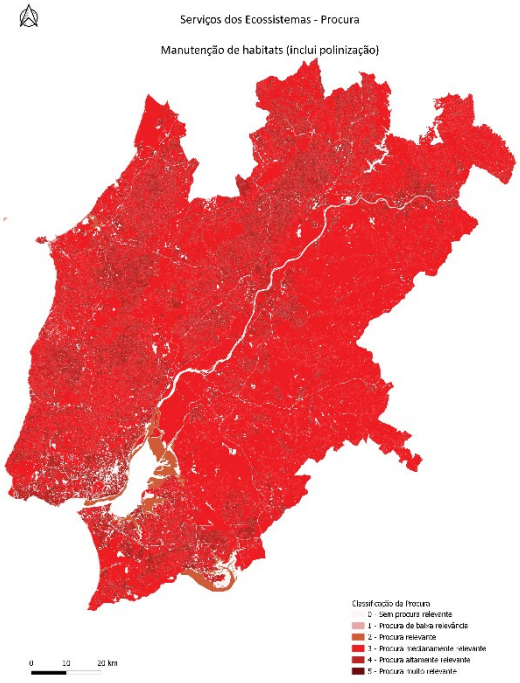
Picture 62 - Demand - Regulation - Control or prevention of soil loss



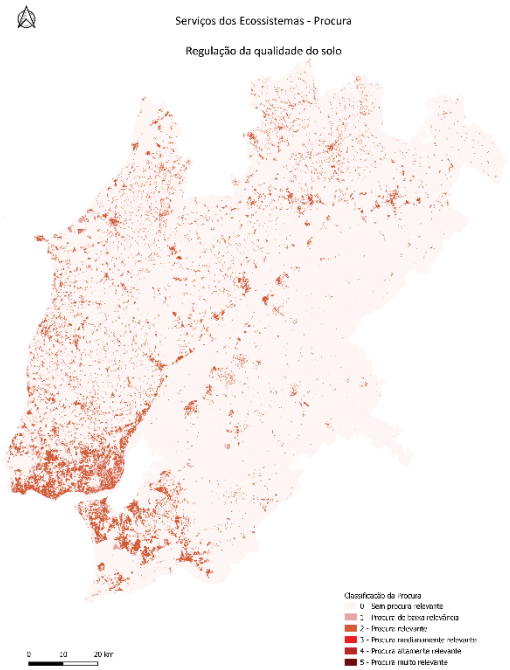
Picture 63 - Demand - Regulation - Flood control and coastal protection



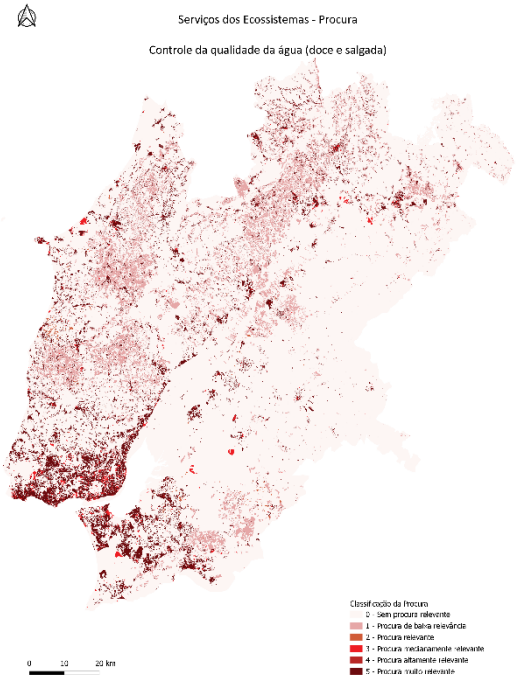
Picture 64 - Demand - Regulation - Protection of forest fires



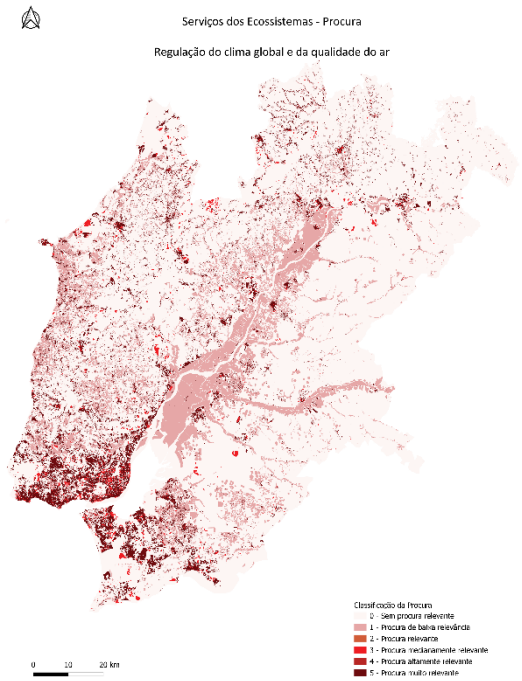
Picture 65 - Demand - Regulation - Habitat maintenance (includes pollination)



Picture 66 - Demand - Soil quality regulation



Picture 67 - Demand - Regulation - Water quality control (fresh and salty)



Picture 68 - Demand - Global climate and air quality regulation

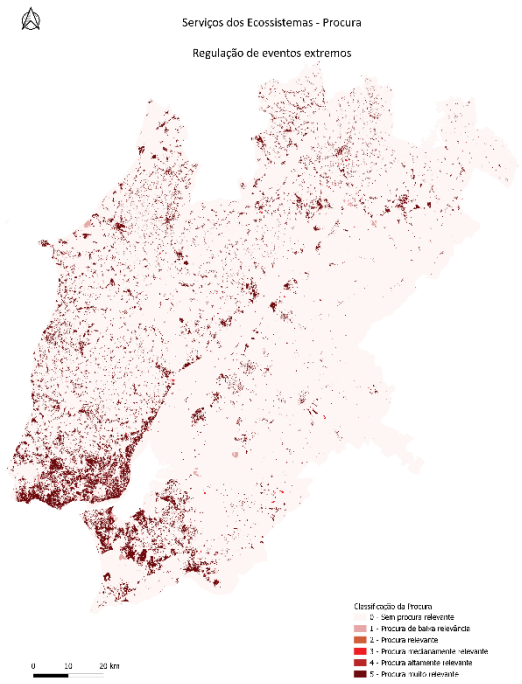
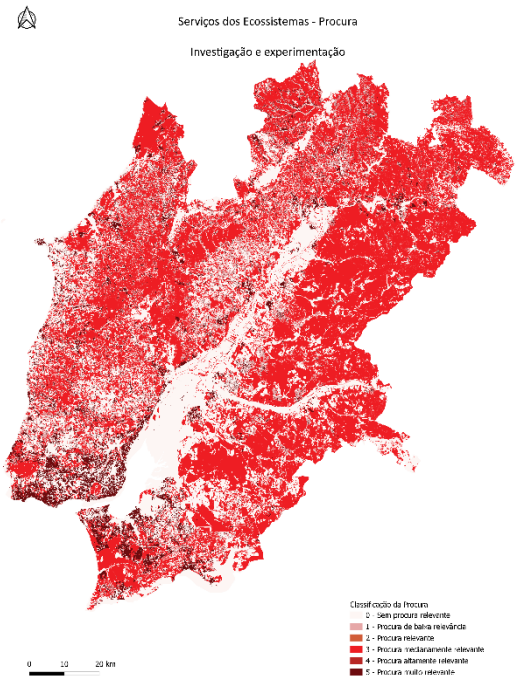
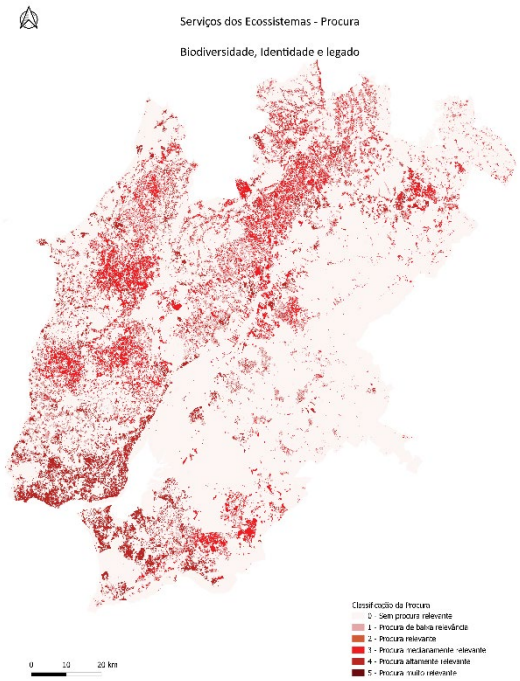


Figura 69 - Demand - Extreme Events Regulation



Picture 70 - Demand - Cultural - Research and experimentation



Picture 71 -Demand - Cultural - Biodiversity, identity and legacy

Annex 3: Valuation matrices of ecosystem services vis-à-vis LOC

Matrix for Valuing Ecosystem Services against COS (1st Stage), following the Burkhard *et al*, 2009 methodology – Supply Component

LOC 2018 2 levels	Supply CICES v 5.1 class	Crops for food purposes (including fungi, algae)	Fibers and other material from crops, fungi, algae and bacteria for direct use or processing (excluding genetic materials)	Animal husbandry for food, products or energy	Breeding aquaculture animals for food, products or energy	Genetic material from all biotypes (including seeds, spores or gametes)	Surface water for drinking, for products	Surface water for power	Deep water for drinking, for products or energy	Regulation CICES v 5.1 class	Transformation of biochemical or physical inputs to ecosystems	Control of erosion rates	Regulation of the water cycle and water flow (including flood control and coastal protection)	Forest fire protection	Maintenance of life cycle, habitats and protection of the genetic stock	Pest and disease control	Soil quality regulation	Quality water	Composition and atmospheric conditions	Regulation of extreme events and reference flows	Cultural CICES v 5.1 class	Direct, in situ and external interactions with living systems that depend on presence in the environment	Indirect, remote, often internal interactions with living systems that do not require a presence in the environment
1.1 Fabric built up		1	1	1	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0
1.2 Industry, commerce and agricultural facilities		1	1	5	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0
1.3 Infrastructure		0	0	0	0	0	5	5	5		5	0	0	2	0	0	0	5	0	0		0	0
1.4 Transports		0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0
1.5 Aggregate extraction areas, waste disposal areas and construction sites		0	0	0	0	0	0	0	0		1	0	0	0	0	0	0	0	0	0		0	0
1.6 Equipments		0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	1	0		2	0

1.7 Parks & Gardens		0	0	0	0	0	0	0	0		0	0	1	0	1	0	0	0	4	1		3	1
2.1 Temporary crops		5	3	0	0	1	0	0	0		0	0	2	2	2	1	2	0	2	0		2	2
2.2 Permanent crops		5	2	0	0	0	0	0	0		0	2	2	3	3	0	4	0	4	0		4	1
2.3 Heterogeneous agricultural areas		4	4	1	0	0	0	0	0		0	3	2	3	3	0	3	0	4	0		3	1
2.4 Protected Farming and Nurseries		5	1	0	0	5	0	0	0		0	2	2	2	4	3	3	3	3	3		0	0
3.1 Grasslands		0	0	4	0	2	0	0	0		0	3	2	0	2	0	2	1	4	0		2	1
4.1 Agroforest lands		0	4	0	0	1	0	0	0		1	5	1	2	3	1	3	2	4	0		4	1
5.1 Florests		0	4	0	0	0	0	0	0		1	3	2	1	2	1	2	2	4	0		3	1
6.1 Bushes		0	2	0	0	3	0	0	0		1	5	2	3	3	1	2	0	4	3		3	1
7.1 Bare spaces or spaces with little vegetation		0	0	2	0	3	0	0	0		0	0	2	0	1	0	1	0	2	1		4	3
8.1 Wetlands		0	2	0	2	4	0	2	0		3	1	3	2	3	1	1	3	5	2		4	4
9.1 Inland water bodies		0	0	2	1	1	3	3	0		1	0	2	1	1	0	0	1	3	0		3	2
9.2 Aquaculture		0	1	0	5	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0
9.3 Estuary and coastal waters		0	3	0	4	4	1	5	0		1	0	1	1	1	1	0	1	1	0		5	5

No relevant capacity - 0

Low relevance capacity - 1

Relevant capacity - 2

Medium relevant capacity - 3

Highly relevant capacity - 4

Very relevant capacity - 5

Matrix for Valuing Ecosystem Services against COS (1st Stage), following the Burkhard et al, 2009 methodology – Demand Component

LOC 2018 2 levels	Supply	Crops for food purposes (including fungi, algae)	Fibers and other material from crops, fungi, algae and bacteria for direct use or processing (excluding genetic materials)	Animal husbandry for food, products or energy	Breeding aquaculture animals for food, products or energy	Genetic material from all biotypes (including seeds, spores or gametes)	Surface water for drinking, for products	Surface water for power	Deep water for drinking, for products or energy	Regulation	Transformation of biochemical or physical inputs to ecosystems	Control of erosion rates	Regulation of the water cycle and water flow (including flood control and coastal protection)	Forest fire protection	Maintenance of life cycle, habitats and protection of the genetic stock	Pest and disease control	Soil quality regulation	Quality water	Composition and atmospheric conditions	Regulation of extreme events and reference flows	Cultural	Direct, in situ and external interactions with living systems that depend on presence in the environment	Indirect, remote, often internal interactions with living systems that do not require a presence in the environment
1.1 Fabric built up		5	3	4	4	2	4	4	5		4	2	5	5	4	5	2	5	5	5		5	4
1.2 Industry, commerce and agricultural facilities		5	5	4	4	0	5	5	5		5	2	4	5	4	5	2	5	5	5		5	4
1.3 Infrastructure		0	5	0	0	0	5	3	5		0	0	3	0	0	0	0	0	0	3		0	0
1.4 Transports		0	3	0	0	0	0	3	0		0	2	2	0	0	0	0	0	0	0		0	0
1.5 Aggregate extraction areas, waste disposal areas and construction sites		0	0	1	1	0	0	3	3		2	1	1	1	0	0	0	0	3	0		0	0
1.6 Equipments		1	1	1	0	1	4	2	3		0	0	1	2	2	0	1	0	3	0		0	0
1.7 Parks & Gardens		0	3	0	0	0	2	2	3		2	2	3	2	0	3	1	3	3	1		0	0
2.1 Temporary crops		0	0	0	0	0	2	0	2		0	0	0	1	3	0	0	0	1	0		0	0
2.2 Permanent crops		0	0	0	0	0	5	0	5		0	0	0	0	4	0	0	1	0	0		3	3

2.3 Heterogeneous agricultural areas		**0**	**0**	**0**	**0**	**0**	**3**	**0**	**3**		**0**	**0**	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**0**		**1**	**1**
2.4 Protected Farming and Nurseries		**0**	**0**	**0**	**0**	**3**	**5**	**3**	**5**		**3**	**3**	**4**	**2**	**1**	**3**	**2**	**2**	**0**	**5**		**3**	**0**
3.1 Grasslands		**0**	**0**	**0**	**0**	**0**	**2**	**0**	**2**		**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**		**3**	**0**
4.1 Agroforest lands		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		**0**	**0**	**0**	**4**	**3**	**0**	**0**	**0**	**0**	**0**		**0**	**0**
5.1 Florests		**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**		**0**	**0**	**0**	**3**	**3**	**0**	**0**	**0**	**0**	**0**		**3**	**0**
6.1 Bushes		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		**0**	**0**	**0**	**2**	**3**	**0**	**0**	**0**	**0**	**0**		**0**	**0**
7.1 Bare spaces or spaces with little vegetation		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**		**0**	**0**
8.1 Wetlands		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		**0**	**0**
9.1 Inland water bodies		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		**0**	**0**
9.2 Aquaculture		**0**	**2**	**2**	**2**	**0**	**0**	**0**	**0**		**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**		**0**	**0**
9.3 Estuary and coastal waters		**0**	**2**	**0**	**2**	**0**	**0**	**0**	**0**		**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**		**0**	**0**

No relevant capacity - 0

Low relevance capacity - 1

Relevant capacity - 2

Medium relevant capacity - 3

Highly relevant capacity - 4

Very relevant capacity - 5

Matrix for Valuing Ecosystem Services against COS (2nd Stage), following the Burkhard et al, 2009 methodology – Supply Component

LOC 2018 2 levels	Supply	Crops for food purposes	Fiber production	Breeding (intensive and extensive) of animals for food	Aquaculture animal husbandry	Genetic material	Surface water for drinking and other uses	Surface water for energy (water, waves and tides)	Deep water for drinking and other uses	Regulation	Waste decomposition, odor and noise reduction	Control or prevention of soil loss	Flood control and coastal protection	Forest fire protection	Maintenance of life cycle, habitats and protection of the genetic stock	Pest and disease control	Soil quality regulation	Water quality control (fresh and salty)	Global climate and air quality regulation	Extreme events regulation	Cultural	Research and experimentation	Biodiversity, Identity and Legacy
1.1 Fabric built up		0	0	0	0	0	0	0	1		0	0	0	0	0	0	0	0	1	0		2	2
1.2 Industry, commerce and agricultural facilities		2	0	2	1	1	0	0	1		0	0	0	0	0	0	0	0	0	0		1	0
1.3 Infrastructure		0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	1	0		0	0
1.4 Transports		0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0		1	0
1.5 Aggregate extraction areas, waste disposal areas and construction sites		0	0	0	0	0	0	0	0		0	0	0	1	0	0	0	0	0	0		0	0
1.6 Equipments		0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	1	0		1	1
1.7 Parks & Gardens		0	0	0	1	2	1	0	2		2	3	3	3	2	2	2	3	4	3		3	3
2.1 Temporary crops		5	3	1	0	3	0	0	2		0	1	1	4	2	2	1	2	2	1		1	1
2.2 Permanent crops		5	2	1	0	3	1	1	2		0	3	2	4	2	2	2	2	2	1		2	2
2.3 Heterogeneous agricultural areas		5	3	1	0	3	1	0	2		1	3	2	3	2	2	3	2	3	2		2	2
2.4 Protected Farming and Nurseries		5	1	1	1	5	1	0	2		2	0	1	3	1	1	2	2	2	1		1	1
3.1 Grasslands		1	2	5	0	3	1	0	2		1	3	2	3	3	2	4	3	3	1		2	2
4.1 Agroforest lands		4	3	3	0	3	2	1	3		2	4	4	2	3	3	4	4	4	3		3	3

5.1 Florests		1	3	2	0	3	2	1	4		3	5	4	0	4	3	4	5	4	4		3	3
6.1 Bushes		3	3	2	0	4	2	1	4		3	4	3	0	4	3	4	4	3	2		3	3
7.1 Bare spaces or spaces with little vegetation		1	1	2	0	3	1	1	3		1	2	2	1	2	2	1	3	2	2		1	1
8.1 Wetlands		2	1	1	1	3	2	1	2		4	1	4	3	4	2	0	4	3	3		4	4
9.1 Inland water bodies		1	2	0	2	1	4	4	3		2	1	4	5	2	1	0	4	3	4		3	3
9.2 Aquaculture		3	2	2	5	2	0	0	0		0	0	0	2	0	0	0	1	2	0		0	0
9.3 Estuary and coastal waters		1	2	2	3	2	1	2	0		3	0	2	3	3	1	0	3	3	3		4	4

No relevant capacity - 0

Low relevance capacity - 1

Relevant capacity - 2

Medium relevant capacity - 3

Highly relevant capacity - 4

Very relevant capacity - 5