Stakeholder perspectives on an ecosystem service-based green infrastructure: the ”ROBUST” Lisbon Living Lab approach

Extended Abstract

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Abstract

As the world is becoming increasingly urbanized, the subject of territorial planning and management is becoming a central concern from a political and operational point of view. The management of the territory is thus a key factor towards sustainable economic and social development and for the achievement of the SDG[1].

One of the instruments required for territorial management is the green infrastructure, which seeks for the creation of a continuum naturale, a concept that arises from the need to incorporate and manage the landscape in a continuous way. In Portugal, the Ecological Structure (term used for the GI network in the legislation) is a municipal planning instrument which aims to identify areas in the territory which show a higher potential for the protection and enhancement of natural components. However, it currently lacks criteria regarding mapping, regulation and concrete management actions for its implementation.

Therefore, this study rises from the need of tacking the existing issues regarding GI planning. Subsequently, an innovative approach for mapping ES was developed, which focused on exploring the potential of using local stakeholder-based ecosystem service mapping as a tool to progress towards the integration of GI in the spatial planning process. To gather information regarding this developed methodology and its potential future applications and limitations, interviews were conducted to municipality stakeholders from the LMA.

To finish this study, some final remarks on the prospects for the future applicability of this approach were made.

Keywords: Green Infrastructure; Territorial Planning; Ecosystem Service; Collaborative approach; Lisbon Metropolitan Area

1. Introduction

The EU Green Infrastructure Strategy [2], adopted in May 2013 (European Commission, 2013), is the central European level policy document regarding the development of GI. It constitutes a key instrument of the EU Biodiversity Strategy of 2020, which calls on the Member States to develop a mapping and assessment of ecosystems and of their services (Maes et al., 2013).

More recently, the European Commission has adopted the **EU Biodiversity Strategy for 2030** (European Commission, 2020). This strategy advocates for "the promotion of healthy ecosystems, green infrastructure and nature-based solutions that should be systematically integrated into urban planning, including in public spaces, infrastructure, and the design of buildings and their surroundings" (EU Biodiversity Strategy for 2030, 2020).
Even though GI have been used as a crucial tool in spatial planning for years, there are

[1] SDG- Sustainable Development Goals (available at: https://sdgs.un.org/goals)

[2] Officially named Green Infrastructure (GI) - Enhancing Europe's Natural Capital

still several obstacles that need to be overcome, from both a legal and spatial perspective (*Albert* and von Haaren, *2017*).

In Portugal, the concept of GI was introduced into the legal framework at a national level in 1999 (e.g., Ecological Structure), and since then it has been mandatory to be integrated in both regional and local plans. However, in Portugal, the way the GI managing instrument is framed and mapped currently lacks clear and effective guidelines for its implementation and monitoring.

In this dissertation, the potential of using ES mapping in order to promote the integration of GI in the spatial planning process will be explored. These two concepts - Ecosystem Services (ES) and GI are intertwined. The concept of GI can be broadly defined as "a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings" (European Commission, 2013)[3]. Over the years, this term was preceded by others that conceptually overlapped and generically moved from an ecocentric to a more multifunctional perspective jointly addressing biodiversity and human well-being.

According to the Green Surge guide for practitioners[4], GI planning has four core principles (integration, connectivity, multifunctionality and social inclusion) and it aims to address the following challenges: adapting to climate change, protecting biodiversity, promoting a green economy and increasing social cohesion (Hansen et al., 2007).

In Portugal, the Constitution considers environmental protection in a double perspective: it is a fundamental task of the State as well as a fundamental right of the citizens.[5] In 2015 a revised RJIGT was published[6]. In this new decree the elements that must accompany municipal spatial planning are established, as well the specific criteria for land classification (basic purpose of the land: urban or rural)[7] and reclassification (alteration of the basic purpose of the land, for example, from urban to rural or vice versa) [8], for qualification of the dominant use and related categories to urban and rural land applicable to the national territory.

The regulatory decree of 2009[9] establishes the technical concepts in the field of spatial planning and urbanism to be used by the territorial management instruments. In these documents, in "Ficha nº 29", is included the definition of GI as well as elements that it integrates in rural and urban soil, respectively. This regulatory decree was revoked in 2019 in order to ensure the update of the concepts related to indicators, parameters, symbology and graphic systematization to be used by the territorial management instruments and following the evolution of the juridical regime. **In the new version, the concept of ecosystem services is integrated in "Ficha nº29"[10].**

The concept of ecosystem services has been gaining influence in the development of environmental research and policies, contributing to a redesign of the relations between humans and the environment (Chaudhary et al., 2015). With the

[3] European Commission- Building a Green Infrastructure for Europe , 2013

[4] Green Surge: Urban Green Infrastructure Planning. A guide for practitioners available at: https://www.e-pages.dk/ku/1340/html5/

[5] Constituição da República Portuguesa, VIII Revisão Constitucional (2005) Artigo nº.9, alínea e) e Artigo nº.66

[6] Decreto-Lei nº 80/2015, de 14 de Maio - Regime Jurídico dos Instrumentos de Gestão Territorial

[7] Artigo nº 71, Decreto-Lei nº. 80/2015, 14 de Maio

[8] Artigos nº 72 e 73, Decreto-Lei nº. 80/2015, 14 de Maio

[9] Decreto Regulamentar nº9/2009, 29 de Maio

[10] Ver notas complementares da "Ficha nº29"do Decreto Regulamentar n.º 5/2019

Millennium Ecosystem Assessment the concept of ecosystem services makes its way into the policy agenda (Braat and de Groot, 2012). According to the Millennium Ecosystem Assessment **ecosystem services are defined** as "**the benefits ecosystems provide to human wellbeing**" (MA, 2005).

Currently, the definitions and applications of this concept are evolving fast as researchers, policy makers and managers explore the benefits that ecosystems provide to people (Haines-Young and Potschin, 2009).

The mapping of ES is a crucial tool to operationalize the concept of ES, since ecosystems and their capacity to provide ecosystem services have a spatial expression. The assessment of ES and their mapping has a broad range of applications, such as: raising awareness about areas of ES supply and demand, environmental education on the importance of functioning ecosystems for human wellbeing, decision making and priority setting instrument (e.g., green infrastructure planning), environmental resource management, land use optimization, portraying trade-offs and synergies for ES, identifying spatial congruence or mismatches between supply, flow and demand of different ES (Burkhard and Maes, 2017; Baró 2016; Maes et al., 2014).

In this dissertation, the potential of using ES mapping in order to promote the integration of GI in the spatial planning process will be explored. **The case-study will focus on the Lisbon Metropolitan Area. It was developed within the context WG[11] 2.1. of the Lisbon Living Lab, which in turn was set up in the framework of the ROBUST project[12].** The main goal was to find (and apply) a methodology for the mapping of ecosystem services at metropolitan scale **by using a collaborative co-creation process** gathering local knowledge (using a "bottom up" approach).

2. Objectives and methodology

To achieve this main purpose, specific objectives were outlined, namely:

1st Objective - Analyzing and synthesizing the mapping criteria of GI included in the masterplans; through the synthesis of the current mapping criteria and the study of the legal framework of the GI at a national level, leading to conclusions regarding the coherence of the current mapping criteria;

2nd Objective - Explaining the conceptual model and the iterative methodology followed in the scope of Working Group 2.1. of the Lisbon Living Lab;

3rd Objective - Understanding the potential associated to the use of a collaborative, bottom-up approach[13], that builds on local stakeholder knowledge;

4th Objective- Collecting stakeholder's perspectives on the potential and future possible applicability of the developed approach: **discuss how to progress towards the integration of the ecosystem service mapping approach in GI planning, at both a local and metropolitan scale** by **conducting interviews** with several participants of the Lisbon Living Lab Working Group 2.1.

5th Objective- Explaining and analyzing the integration approaches used for the statistical treatment of the results; developing an exploratory confidence analysis approach using the answers given in the interviews as a basis;

The methodology outlined to respond to these objectives is illustrated in the figure below (see fig.1.):

[11] Working Group

[12] https://rural-urban.eu/

[13] In the bottom–up approach, the information requirements are defined at the local level and accumulated upwards. (Lund, H.G, 2004)

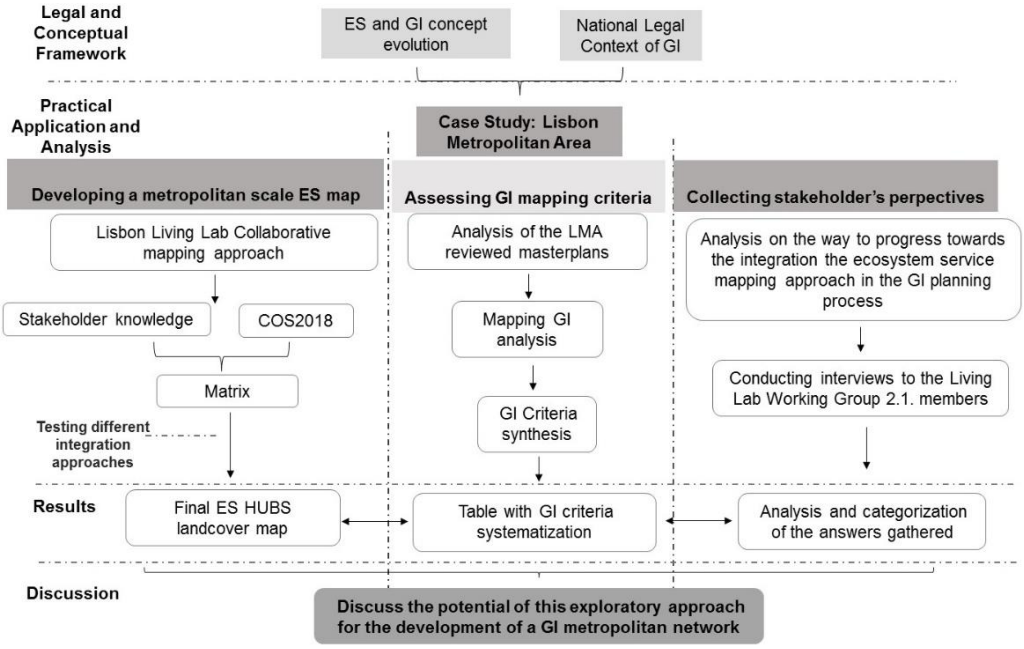

Fig. 1 – Methodological approach.

3. Case Study: Lisbon Metropolitan Area. Framework assessment

At a first stage, to understand the GI mapping criteria used at a local level**,** an analysis of the masterplans from the municipalities of the LMA was done, following the methodology used by Vaz (2018) for the Alentejo Region. The collected information was subsequently synthesized for the 10 municipalities of the LMA with revised masterplans: Cascais, Lisboa, Loures, Mafra, Moita, Odivelas, Oeiras, Seixal, Sintra, Vila Franca de Xira. The information retrieved from the masterplans and reports was then submitted to a categorization process and organized in two tables. The first summarizes the following information: the name of the municipality, the year of publication of the masterplan (e.g. notice and date of publication), the definition of Municipal Ecological Structure as defined in regulation of each municipality's masterplan, the (explicit) inclusion or exclusion of the concept of ecosystem services within the masterplans and/or the reports, and the way their GI is organized (structure used). The second table summarizes the main criteria used for the delimitation of GI in each municipality.

The analysis of the masterplans highlighted the fact that distinct planning approaches have been used when it comes to the development and implementation of GI. This can be justified by the lack of clear planning guidelines in the Portugal law regarding GI planning. It's also relevant to mention that the majority of the municipalities still don't include the concept of ES within their legal documents. **The diversity of GI criteria used by the different municipalities emphasized the need for a new methodological approach for the mapping of GI.**

The following stage comprehends the practical part of the case-study which was **developed within the context of the ROBUST project Lisbon Living Lab WG 2.1. "From the Regional Ecological Network to a Metropolitan Green Infrastructure".** The main objective of WG 2.1. was to map **ES at the metropolitan scale in order to explore the potential that this mapping could eventually have for the development of a GI metropolitan network.** The methodology used in order to

elaborate these maps was based on the matrix developed by Burkhard et al. (2009)[14].

The conceptual model and the iterative methodology followed in the scope of WG 2.1. focused on creating a safe space where participants could share knowledge and clarify doubts. The group of stakeholders who engaged in this WG included several municipalities from the LMA, central government entities and decentralized entities of centralized administration. Several participatory workshops were held virtually (due to the COVID-19 pandemic) with these stakeholders. From the 18 municipalities invited, 16 answered and engaged in multiple meetings. Science partners (IST, FCT-NOVA) had a supporting role, assisting leading local stakeholder in suggesting methodologies, organization of sessions on demand, and participating in discussions.

The iterative methodological process followed throughout these sessions, aimed for the collaborative development of a new methodology in which all the participating stakeholders contributed actively. As doubts were raised in the workshops, different approaches were tested, and alternative paths were explored. The main goal is to showcase the process of developing a metropolitan GI network using a bottom-up approach within a transdisciplinary research context.

3.1. ES mapping: the ROBUST approach

During the workshops of WG 2.1., **an exercise was proposed to all the municipalities and entities present: to fill in an empty Burkard inspired matrix** (Burkhard 2009) **prototype,** in which a vertical column displayed all the land cover type classes, and a horizontal column displayed the different types of ecosystem services. The stakeholders from the different municipalities and the entities (e.g., CCDR-LVT) present were asked to fill this matrix, classifying each landcover class, from the perspective of ecosystem service provision.

Regarding the ecosystem services (horizontal axis of the matrix), a total of 23 ecosystem services were considered for this assessment, which were retrieved from the literature and follow the Millennium Ecosystem Assessment classification: provision, regulation, supporting, and cultural.

In relation to the landcover type classes, the classes of **sublevel 4 of COS 2018 were used.** A total of 80 landcover classes were considered (vertical axis of the matrix).

Regarding the process of filling in the matrix, the stakeholders engaging in the WG were designated the task of filling the matrix, classifying each landcover class, from the perspective of ecosystem service provision. The classification used was the same as the one used by Burkhard (2009): 0= no relevant capacity; 1=low relevant capacity ;2= relevant capacity; 3=medium relevant capacity; 4=high relevant capacity; 5= very high relevant capacity.

During the held online workshops, guidance was given steering the stakeholders from each municipality in the direction of attributing the classifications according to the "**effective provision of services**" verified in their territories rather than considering the "**potential provision**" of a given services. This was done so that the results obtained translated the reality of each of municipality's territory as much as possible.

The proposal to perform this exercise was done to all the participants of the project. From the municipalities engaging in the workshops, the following presented results: **Alcochete, Barreiro, Lisboa, Loures, Mafra, Odivelas, Palmela, Seixal, Setúbal, Vila Franca de Xira and CCDR-LVT**[15].

[14] Burkhard et al; 2009 - Landscapes' Capacities to Provide Ecosystem Services

[15] CCDR-LVT- Comissão de Coordenação e Desenvolvimento Regional de Lisboa e Vale do Tejo

At a first stage, for operational reasons, 5 ES were chosen as more relevant to map (due to the fact that the matrix had a total of 23 ES, and the mapping of each of them would be a nearly impossible task). To elect the 5 ES that the participants considered more relevant the interactive presentation software of "Mentimeter" was used, during one of the initial workshops. **The results of this voting elected the following 5 ES as the most relevant to map: Food Supply; Water supply; Climate regulation; Water flow regulation; Recreation and tourism.** The mapping of these 5 ES was performed by NOVA University using software of ArcGIS**.** A total of 10 maps were produced, 2 maps for each of the 5 ES which were voted as more relevant: One map that resulted in mapping the aggregated scores of all the matrixes delivered by the municipalities; Another map that resulted from mapping the scores of the matrix delivered by CCDR-LVT. This approach was useful by allowing for a visual comparation of possible different perspectives from the municipalities and CCDR-LVT regarding ES provision in the territory of the Metropolitan Area of Lisbon.

3.2. First Results: Analysis and Discussion

During the workshop that occurred on the 10th of May, the maps produced were analyzed with the aim of **highlighting the main geographical discontinuities found** as well as **interpretating the causes that could be behind them.** The **2 generated maps for the ecosystem service of "food provision"** can be seen below (fig.2).

It's also relevant to highlight the fact that the maps produced are non-uniformized maps.

A patchwork has been done, in a deliberate way, in order to understand how to progress to a proper integration methodology for creating continuity (the subsequent integration of the results is addressed in 5.). During the workshop in which these maps were presented, **both the municipalities and the entity of CCDR-LVT were inquired on the rationale used while filling in the matrix.**

Looking at figure 2, it's possible to observe that the map represented on the left presents more discontinuities and is, from an overall perspective, less homogeneous than the map represented on the right (which illustrates the generated map for the matrix delivered by the entity of CCDR-LVT). Looking at the boundaries between the municipalities in the map represented on the left (fig.2), it is possible to highlight three main discontinuities: between the municipalities of Alcochete and Palmela; between the municipalities of Vila Franca de Xira and Loures; between the municipalities of Mafra and Loures. Regarding the main discontinuities found, the municipalities of Loures, Mafra, Palmela and Vila Franca de Xira were asked to confront and compare their results with the aim of understanding why these visible gaps between their boundaries were showing in the map. After this workshop, some of the municipalities rectified their matrix classifications, in order to try to smooth the transitions between the borders of the different territories and obtain a more uniformized map.

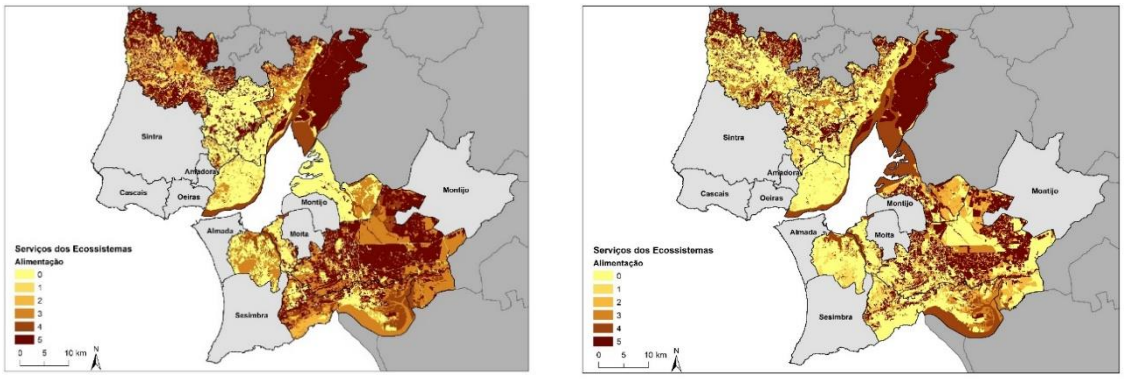

Fig. 2 - Maps generated for the ecosystem service of "food provision" that resulted from the mapping of the aggregated results from the municipalities (on the left) and from the mapping of the matrix delivered by CCDR-LVT (on the right).

4. Collecting Stakeholder's perspectives

In parallel to the work developed within the WG 2.1., several interviews were conducted by me to some of the stakeholders engaging in this WG, with the aim of gathering information on how to progress towards the integration of this ES mapping approach in the planning of GI at both a local and metropolitan scale, as well as on their perceptions about the potential of using this tool in GI territorial planning. To organize and categorize the gathered information from the answers given, the analysis was divided into the following four subjects: I - Motivation to adhere to WG 2.1.; II- Exploration of the rationale behind the attribution of classifications in the matrix; III - How to integrate this methodology in territory planning; IV - Governance measures required to put the initiative developed in this WG into practice.

A questionnaire with the same structure and content was formulated and used as a guideline for the interviews conducted to the municipalities. However, the questions formulated worked only as a guide during the interviews and total freedom was given to the respondents to share their views on the multiple topics addressed, as well as to add any information they considered relevant. From the stakeholders engaging in the WG the following were interviewed **: Cascais, Mafra, Odivelas, Seixal, Setúbal, Palmela and Vila Franca de Xira.**

4.1. Results

I – Motivation to adhere to WG 2.1.

The first question addressed in the interviews regarded the **motivation of the municipalities to join the ROBUST project Living Lab Group 2.1. workshops** and why they maintained their interest throughout the several working sessions. This question was done with the aim of deepening the understanding of the reasons that drove the municipalities to participate in this project as well as to highlight the different perspective of the stakeholders regarding the importance of the theme addressed in this group work: **the development of a metropolitan green infrastructure network, using ecosystem services** as a key tool. The following reasons were stated as a reason to adhere to the WG: Invitation to participate; Interest in the group's thematic; masterplan's revision in process (and the ES mapping approach developed within WG 2.1. could be a helpful tool to solve the current issues related to the definition of the Municipal Ecological Structure).

The following question addressed to the representatives of the municipalities regarded their perspective on **what was the potential/interest of developing a metropolitan GI network**. The diagram highlights the main answers given (fig.3).

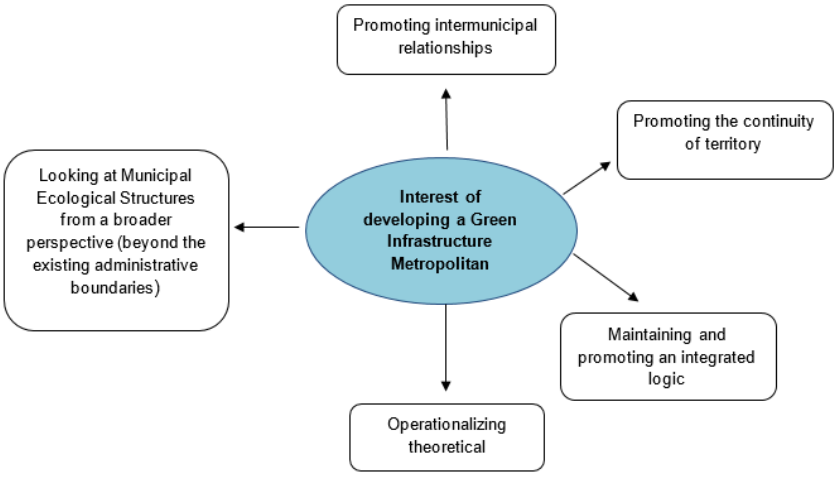

Fig. 3 - Diagram displaying the answers given by the municipalities when inquired about the importance of developing a GI metropolitan network.

II- Exploration of the rationale behind the attribution of classifications in the matrix

This part of the interview was conducted in an effort to understand the reasoning behind the classifications made and also in order to understand what were the main challenges/difficulties found in the use of this methodology.

Regarding the process of filling in the matrix, all the interviewed municipalities manifested the need to communicate with different sectors in order to be able to do the scoring of the ecosystem services with a higher confidence level. In this section of the interviews, an effort was also made to understand what perspective they used for attributing the classifications in the matrix: if they had considered the **effective production of services** (according to the reality of their territory) **or** if instead they considered **the potential** that those given classes had to provide the ES.

The results showed that from the totality of 7 municipalities interviewed, 5 of them considered the effective production (Cascais, Odivelas, Palmela and Setúbal and Vila Franca de Xira) and 2 considered the potential (Mafra and Seixal).

The stakeholders were also asked to specify in which classifications they had felt a lower/higher level of confidence.

Subsequently, with the responses collected a confidence matrix was elaborated, in order to illustrate which classifications were easier or harder to perform.

III- Integration in territory planning

The diagram below displays the advantages/potential of using an ES mapping approach as a tool in territory planning, according to the responses given during the interviews (fig.4).

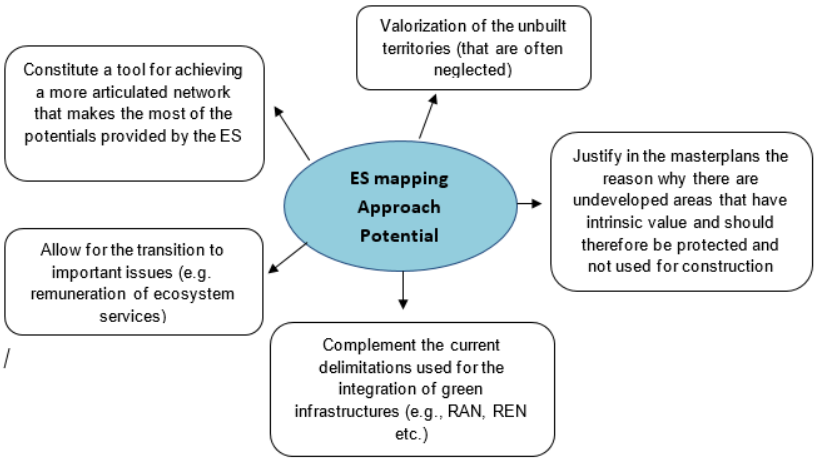

Fig. 4 - Diagram displaying the potential of using an ES mapping approach according to the answers given by the interviewed stakeholders.

IV- Governance

The final theme addressed in the interviews regarded the organizational tools and the hierarchical political figures that would be required to implement this initiative. Analyzing the responses given by the stakeholders, it was possible to see that there was an overall consensus in the fact that the management of this green infrastructure network should be attributed to a regional entity (CCDR-LVT and AML were the entities referred in the answers) and that this organization task should work more in the form of guiding and collaborating with the municipalities, rather than imposing terms.

5. Statistical and cartographic treatment of the results

The following step was to define a set of exploratory approaches for the statistical treatment of the results in order to obtain a "uniform" cartography for the whole metropolitan area. With this aim three exploratory approaches were developed: an area-weighted average, the median and a confidence matrix. The first two were performed by the FCT- NOVA : the methodology followed, and the results obtained are displayed in the dissertation.

The third - the confidence matrix - is an exploratory approach developed by me using the information retrieved from the interviews, with the aim of assessing the level of uncertainty associated to the classifications of the ES VS. landcover classes matrix. Looking at the final confidence matrix produced, it stood out that category of “cultural services” was the one associated to a higher level of uncertainty, which is most likely associated to the subjectivity inherent to the classification of cultural services.

After testing the maps that resulted from these 3 integration approaches, the median was considered by the steering board to be the most appropriate measure of statistical integration and was the one used for integrating the final results.

6. Final Results

For the final workshop a final map that identifies ES HUBS – the areas where various services overlap was produced. This final map was then overlayed with the Metropolitan Ecological network (REM), to see the adherence between these two maps (fig.5).

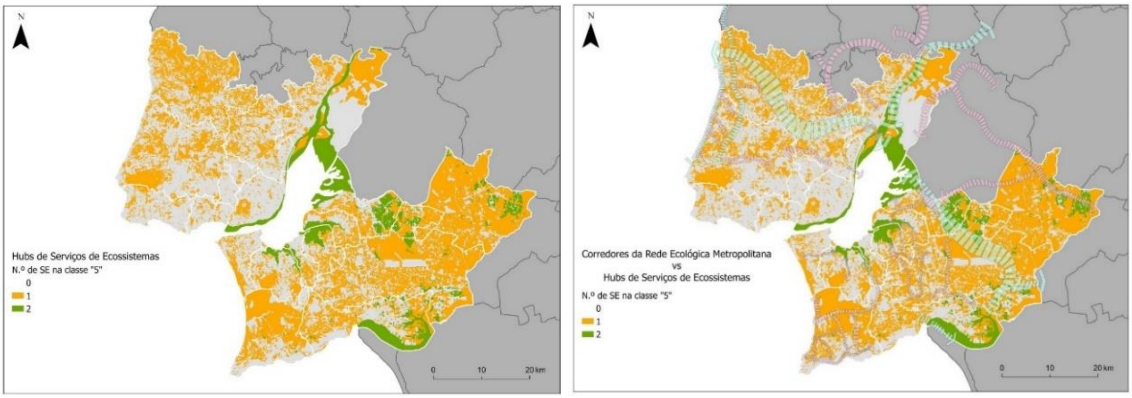

Fig. 5 - Final ES HUBS map (on the left) and overlay of the ES HUBS map with the REM (on the right).

This final ES HUBS map shows scores varying from 0 to 2, which are relative to the number of ES categories (provision, regulation, cultural and support) which have a score of “5”. Analyzing the HUBS map it's possible to see that the estuary zones stand out as having the greatest importance from the point of view of the provision of ES.

There is in fact some coherence between the corridors from the REM and the corridors from the ES HUBS map. However, the final aim of the approach developed in this dissertation would be to reach a multifunctional green infrastructure network, associated with the diversity of the existing ES, which the current model of the REM does not address.

7. Final Conclusions and future applicability

On the basis of the obtained results of this dissertation, it’s possible to see the potential that a GI metropolitan network could have to cope with multiple challenges, at different spatial scales. The final map produced – ES HUBS map – identified the areas where more ES overlap. These areas could therefore be seen as possible “nodes” of a future GI network.

In the context of the revision of their masterplans, several municipalities engaging in this WG noted that often, in the process of transposing the PROT-AML guidelines to their Ecological Structure, they experienced several difficulties. They felt the transition was often too rigid and the approach developed within the WG 2.1. could be advantageous in order to promote a more flexible and dynamic process. The bottom-up approach developed within WG 2.1. shows great promise for the future development of an innovative governance model for the GI network. The study developed aims therefore to plant a seed towards the co-creation of a real GI network, based on the diversity of territorial actors and in the leadership of the municipalities in the design, implementation and management of a metropolitan GI network.

The planning and management of this GI network requires a holistic approach, that considers the whole range of ES potentially provided by the different types of landcover. In order to reach this multifunctional GI network there is a need for a transdisciplinary coordination between all the authorities dealing with urban and environmental policy.

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