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Linking Ecosystem Services with High Nature Value Farmlands

Ana Rita Lopes Amaral

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Linking Ecosystem Services with High Nature Value farmlands

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Todas as correções determinadas pelo júri, e só essas, foram efetuadas.

O Presidente do Júri,

Porto, ______/______/_________

"For too long, our natural capital has been seen as an endless reserve, instead of the limited and fragile resource we now know it to be. Fortunately, it is not too late to stem the tide (…)"

United Nations Secretary-General Ban Ki-moon message on the launch of the United Nations Decade on Biodiversity

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Abstract

Agriculture nowadays constitutes one of the most dominant land cover worldwide, including important areas for biodiversity conservation, as those under low intensity farming practices. Rural landscapes, which are dominantly occupied by extensive agricultural practices, have an important role regarding worldwide biodiversity conservation. Moreover, they contribute to the provision of Ecosystem Services (ES). High Nature Value farmlands (HNVf) concept devise landscapes that are considered to have a high nature value, due underlying low-intensity farming practices, that maintain high levels of biodiversity.

This thesis aims to address if High Nature Value farmlands have the potential to provide relevant Ecosystem Services, rather than only contributing to provisioning. In order to achieve this, two Case Studies were defined: first, we focused on the most important ES mentioned in the literature concerning all farming practices, with special focus on extensive agricultural practices; and secondly, which are the areas of High Nature Value farmlands in the River Vez watershed that are potentially providers of relevant Ecosystem Services.CS1 it was developed as a meta-analysis of ES through distinct farmlands, analysing the literature that focus on them and how their assessment was made. On its turn, CS2 builds on previous research on Ecosystem Services on the River Vez watershed. Briefly, this CS consists on a spatially-explicit analysis of the coincidence between targeted Ecosystem Services and High Nature Value farmlands areas in the watershed.

With this analysis, we intend to understand the relation between agriculture and Ecosystem Services. HNVf areas were highlighted as providers of important Ecosystem Services, having some predominance over other areas with different land uses in the Vez watershed. This underlined the importance of traditional agricultural practices, characterized by low-intensity farming management, to the conservation of biodiversity in Europe, and particularly in Portugal. Our study area has a huge natural and cultural value, has it can be proved by the relevant existence of High Nature Value farmland areas. Due to that, the existence of important Ecosystem Services connected to these areas, shows the greatest need for specific management measures.

Keywords: Biodiversity; High Nature Value farmlands; Low-intensity farming; Ecosystem Services; Extensive Agriculture; Landscape.

Sumário

A agricultura tem-se vindo a afirmar como uma das principais ocupações do solo, a nível mundial, reunindo importantes áreas para a conservação da biodiversidade, nomeadamente as áreas caracterizadas por agricultura menos intensiva. As paisagens rurais que são predominantemente ocupadas por práticas agrícolas extensivas têm um papel importante na conservação da biodiversidade em todo o mundo, e também na provisão de Serviços de Ecossistema (ES). São consideradas Áreas Agrícolas de Elevado Valor Natural (*High Nature Value farmlands* – *HNVf*) paisagens que têm um elevado valor natural, devido à presença de práticas agrícolas pouco intensivas que ajudam a manter elevados níveis de biodiversidade.

O principal objetivo deste estudo é averiguar se as áreas de *High Nature Value farmlands* têm potencial para provisionar importantes Serviços de Ecossistema. Para isto, foram desenvolvidos dois casos de estudo: primeiro, analisar quais os Serviços de Ecossistema predominantemente mencionados na literatura, particularmente a que se foca em práticas agrícolas extensivas; e segundo analisar espacialmente quais as áreas de *HNVf* que se encontram distribuídas na Bacia Hidrográfica do Rio Vez, relacionando-as com a existência de importantes Serviços de Ecossistema existentes nesta área. No Caso de Estudo 1 (CS1), foi desenvolvida uma meta-análise dos Serviços de Ecossistema e da sua relação com os vários tipos de práticas agrícolas, analisando a literatura focada nos serviços e na forma como é feito o seu estudo, com enfoque em todos os tipos de agricultura. Por sua vez, o Caso de Estudo 2 (CS2) procede de um estudo realizado anteriormente em que foi feita uma seleção de Serviços de Ecossistema presentes na Bacia Hidrográfica do Rio Vez. Este CS consiste numa análise da coincidência espacial entre os SE selecionados anteriormente e as áreas de *HNVf* na Bacia.

Com esta análise, foi possível observar a existência de uma estreita relação existente entre agricultura e os Serviços de Ecossistema. Foi feita uma análise da predominância das áreas de *HNVf* como fornecedores de Serviços de Ecossistema comparativamente com áreas com outros usos do solo na Bacia Hidrográfica do Rio Vez, em que a relação entre agricultura e SE foi retratada, através da existência de uma maior potencial contribuição para os serviços, das áreas de HNVf. Isto mostra também a importância de práticas agrícolas tradicionais caracterizadas por agricultura extensiva para garantir a conservação da biodiversidade na Europa, e particularmente em Portugal. A área de estudo selecionada tem um grande valor natural e cultural, como pode ser constatado através da presença de áreas de *HNVf*, existindo por isso Serviços de Ecossistema que delas dependem, mostrando a grande necessidade de medidas de gestão específicas para estas áreas.

Palavras-chave: Biodiversidade; HNVf; Agricultura Extensiva; Serviços de Ecossistema; Paisagem.

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List of abbreviations

ARIES – Artificial Intelligence for Ecosystem Services

CAP – Common Agricultural Policy

CICES – Common International Classification of Ecosystem Services

CMEF - Common Monitoring and Evaluation Framework

CS – Case Study

EEA – European Environmental Agency

EFA – Ecological Focus Areas

ES – Ecosystem Services

ESP – Ecosystem Services Potentials

EU – European Union

EUNIS – European Nature Information System

FADN - Farm Accountancy Data Network

HNVf – High Nature Value farmlands

HRU – Hydrological Response Units

IBAs – Important Bird Areas

LEADER – *"Liaison Entre Actions de Développement de l'Économie Rurale"*

MEA – Millennium Ecosystem Assessment

MS – Member States

PBA – Prime Butterfly Areas

RDPs – Rural Development Programmes

SD – Standard Deviation

SWAT – Soil and Water Assessment Tool

TEEB – The Economics of Business and Economics

UNEP – United Nations Environmental Programme

Chapter 1. Introduction and Research Objectives

1.1. Halting biodiversity loss in a changing world

Over the last century humans have been changing ecosystems more rapidly than in any comparable period in history, resulting in an enormous declining of species and their ecosystems (Plieninger and Bieling, 2013).

Ecosystems worldwide have been transformed and some of them in such a deeply way that they will not recover, and that is why a significant number of species have been extinct or threatened of extinction (Assefa *et al.*, 2007). Biodiversity loss is, therefore, the result of the changes made in ecosystems, contributing also to the decline of the ecosystems functions and the importance of ecosystems in human well-being.

Biodiversity loss involves not only the degradation of ecosystems, but also the loss of genetic diversity and species, through declining of populations, changes in the composition of their communities and ultimately extinction (Proença and Pereira, 2011). Some species are disappearing, while others seem to be copping with change, by developing defence mechanisms and ways to tolerate and resist the environmental changes (Proença and Pereira, 2011). The existence of invasive species, for instance, is also one of the main drivers to increase biodiversity loss, concerning the fact that they are located in an environment that is not theirs, gaining resistance to the human alterations on ecosystems, having no predators, pathogens and competitors, allowing them to endure and frequently eradicating the existent native species (Proença and Pereira, 2011).

In the Convention on Biological Diversity, in 1992, 193 nations compromised to reduce the rate of biodiversity loss at a global, national and regional scale, by 2010 (EP, 2012). Also, other goals were established in this Convention such as: guaranteeing the conservation of biological diversity, the sustainable usage of its constituents and the balanced distribution of the benefits that arise from the equitable utilization of the genetic resources (CBD, 2011). However, the international community has failed in achieving the goals that they proposed (Proença and Pereira, 2011), showing no results in what comes to the distribution to natural resources, as well as poverty reduction, as it was expected (Plieninger and Bieling, 2013)

Biotic communities all over the world are becoming less diverse, and the biodiversity loss rate increasing (Proença and Pereira, 2011). Globally we see that climate change have a huge impact on species, especially on their behaviour and diversity, particularly due to the increasing use of fossil-fuels; at a national level the energy prices are starting to have an impact on decision-making policies; particularly, at a local level, the accessibility to traditional biomass energy is becoming more difficult (Assefa *et al.*, 2007). Consequently, biodiversity loss also has impacts on human well-being, especially on the communities that depend upon environmental resources for their subsistence, like small farmers and the rural populations most affected by poverty (TEEB, 2010).

On May 2011, the European Union came up with the EU Biodiversity Strategy to 2020, in order to halt biodiversity loss in the EU and to protect ecosystems (EC, 2011). This Biodiversity Strategy was meant to improve the conservation status of the species and habitats in Europe, that were targeted in the two nature Directives established at an European level: the Natura 2000 network, the Birds Directive and the Habitats Directive (EC, 2011). Overall, it is estimated that 17% of the habitats and species that are protected under the Habitats Directive have a favourable conservation status; however, the majority of them is under an “unfavourable-inadequate” or “unfavourable-bad state” (EC, 2011). Also, only 52% of the bird species are estimated to be in a favourable condition presently, which is why it is crucial to intervene and make an improvement in their status (EC, 2011).

Also, land-use change has been highlighted as a major driver of biodiversity loss. The linkage between land use and biodiversity is the key to comprehend the connection of people with the physical environmental and the way they shape it in the territory, beside the fact that the human intervention is not always managed the right way (Haines-Young and Potschin, 2009) concerning, for instance, the intensification of agricultural practices, since it leads to the declining of biodiversity (EEA, 2004). The relationship between the maintenance of certain farming practices and high levels of biodiversity has also been acknowledged as important for preserving and enhancing the nature value of farmlands in the EU countryside (Lomba *et al.*, 2014). In fact, such farmlands are often areas of conservation concern, due to the number of species that, totally or partially, dependent on their maintenance (Lomba *et al.*, 2014). Further, about 15% to 25% of the extensive agricultural areas that once were High Nature Value farmlands are now only 7%, which has a huge negative impact on species that depend upon extensive agricultural systems, concerning that only 3% of the species that are under the protection of Habitats Directive have a “favourable conservation status” (EC, 2011). Farming practices have, therefore, been changing over the years, becoming much more highly mechanised and intensively management or abandoned, having devastating consequences for the maintenance of biodiversity (EC, 2011).

Biodiversity loss is one of the main environmental changes that the world faces, and does, in fact, carry very high costs for society, causing serious consequences in the main sectors that depend upon Ecosystem Services (EC, 2011). Very important species of plants and animals have a vital role in agriculture, for example through the control of pests, through predation and competition or through the provision of essential services as pollination (EC, 2011). The loss of biodiversity affects directly the provision of Ecosystem Services, as shown in Figure 1 (adapted from Braat and ten Brink (2008).

The Millennium Ecosystem Assessment (MEA) refers that the «loss of habitat, pollution, overexploitation, climate change and invasive species» are the main reasons for the occurrence of changes in the ecosystems, having as consequence the loss of biodiversity and in some cases leading to the deterioration of important Ecosystem Services. Species are becoming more vulnerable to the changes that have been occurring in ecosystems due to the loss of the genetic diversity, with special focus on the biodiversity from agricultural areas that is declining (Proença and Pereira, 2011).

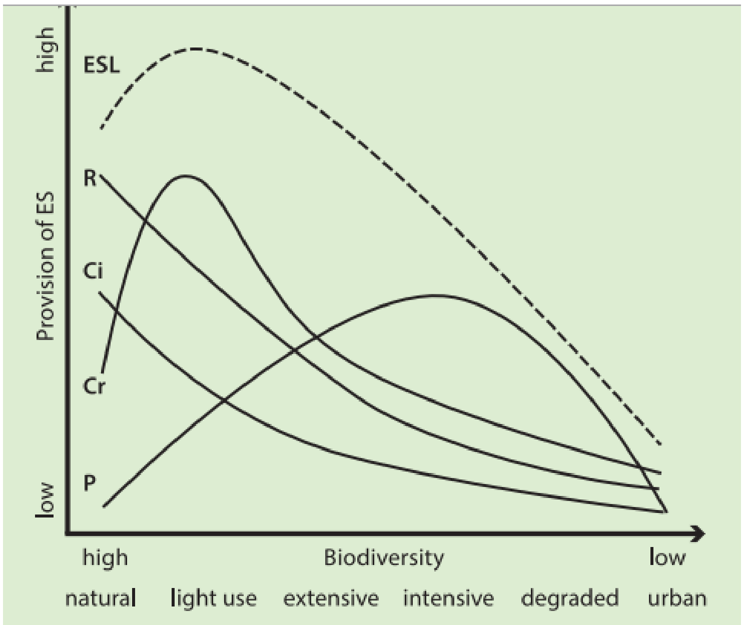

Figure 1 - Relationship between Biodiversity and the Provision of ES (Braat and ten Brink, 2008). The P is the sum of provisioning services; Cr the sum of cultural-recreation value; Ci is the sum of the cultural-information value; and ESL the sum of all the Ecosystem Services. Here it is clear the connection between biodiversity and Ecosystem Services, as we see that the higher the levels of biodiversity, the higher provision of Ecosystem Services we have.

Biodiversity and human well-being are, indubitably, intimately connected (Proença and Pereira, 2011). Over the last years, there has been given special attention to the synergies between agriculture and ecosystem functions in rural areas, giving particular importance to the local communities' ability to fight the pressures that affect the livelihoods in these areas, contributing to landscape planning (Marsden and Sonnino, 2008; Renting *et al.*, 2009; O'Farrell and ML, 2010; Martinez-Harms *et al.*, 2015). Farmed habitats have extreme importance in the conservation of Europe's species, particularly the ones located in areas of low intensity farming, which have gain a very important role in the conservation of biodiversity outside protected areas (Beaufoy *et al.*, 1994). Sustainable strategies to fight the loss of biodiversity and the declining of ecosystems and habitats, such as those related to agriculture, are of extreme importance, and make the need for new measures to halt biodiversity loss, unquestionable (Proença and Pereira, 2011).

1.2. Farmlands and the maintenance of biodiversity in the EU countryside

The increase of human population and the progressively rising pressure on the natural resources, makes protection of ecosystem and biodiversity essential (MEA, 2005). Farmers and their practices are responsible for the maintenance of most of the terrestrial habitats in Europe, having a very important role towards biodiversity conservation (Lomba *et al.*, 2014). Farming is known to play a relevant role in the conservation of farmland biodiversity, and more in areas under low intensity agricultural practices (Bignal and McCracken, 1996).

Particularly, the term “farmland” is used to describe all kinds of agricultural activities (Lomba *et al.*, 2014), concerning that two different types of farming, intensive and extensive, depend upon resources in a different way (Assefa *et al.*, 2007). The intensification of agricultural practices means to have more effective breeds and crops based on the use of agrochemicals with greater use of energy and water; on the other hand, we have extensive agricultural practices, that involve a much greater area of cultivation, and therefore implies the addition of land to the one that already existed (Assefa *et al.*, 2007).

Due to different and diverse farming practices occurring over the centuries, the agricultural landscapes in Europe are, nowadays, the result of those changes and are, for certain, one of the main drivers of EU biodiversity (EC, 2011). The importance of agricultural land to biodiversity has been recently acknowledged in Europe due to policy convergence with environmental and conservation related commitments (Halada *et al.*, 2011). The third target of the EU Biodiversity Strategy to 2020, for instance, aims to improve the integration of biodiversity into policies concerning agriculture and forest, by supporting farmers through incentives (EC, 2011). These two sectors are very important in Europe, seeing that they cover almost 72% of the European territory and play a tremendously important role in the conservation of biodiversity (EC, 2011). Also, within the Common Agricultural Policy (CAP) some efforts have been done to integrate biodiversity conservation, particularly with Pillar II, that has as one of the main targets the restoration, preservation and enhancement of ecosystems that are related to agriculture and forestry (Tropea, 2015). The Pillar II of the CAP established as main objective the "sustainable management of natural resources and climate action" which has been divided in six different approaches, being one of them "the restoration, preservation and enhancement of biodiversity, gathering Natura 2000 network areas, areas with natural limitations, High Nature Value Farmland areas and the state of landscapes in Europe" (MAES, 2014). This shows the important role of the CAP in contributing to the maintenance of biodiversity and rural landscape, combating biodiversity loss through the "green measures" for agriculture (MAES, 2014). Besides the CAP, the Financial Framework for 2014-2020 offers important opportunities to improve the conservation of biodiversity in the countryside and farming systems, and also on forest areas (EC, 2011), promoting the sustainable development of rural areas (Tropea, 2015).

During the second half of the 20th century, agriculture in Europe suffered some very important changes that still have impacts nowadays (Halada *et al.*, 2011). From the beginning of 1950s to the 1970s, the process of intensification of agriculture was improved in different parts of Europe, together with changes in land use, making the rural landscape in Europe more homogenous and fragmented, having direct consequences in the habitats that depend upon them (Halada *et al.*, 2011). Side by side with agricultural intensification was the abandonment of the less productive and remote areas, that, just like intensification of agriculture, potentiated several negative impacts on biodiversity of agroecosystems (Halada *et al.*, 2011). Numerous Ecosystem Services that are very important to maintain the function of agriculture, like the case of pollination and soil nutrient cycle, are at risk due to the deficient management and destruction of agricultural biodiversity (Assefa *et al.*, 2007). The changes that have been occurring in agricultural practices are, therefore, one of the key drivers for the changes occurring in the landscape, contributing to the loss of biodiversity (Lomba *et al.*, 2014). At the present time, intensification and abandonment of agricultural lands continue to have damaging consequences on biodiversity in agricultural areas, contributing, most of the times, to the loss of nature value in agro-ecosystems (Bignal and McCracken, 1996).

Considering the negative impacts of intensification and abandonment of agriculture, it is well established that low intensity farming practices are considered crucial for agro-biodiversity from a conservational point of view (Lomba *et al.*, 2014). About 50% of the highly valued biotopes in Europe occur in low intensity farmlands, and the more restricted ones occur normally in areas of crofting agriculture since their survival and floristic richness is dependent of the traditional agricultural practices (Bignal and McCracken, 1996). Associated with low intensity livestock systems are mosaics of «cropped and stubble» fields, as well as cattle and sheep cropped grass pastures and moorland (Bignal and McCracken, 1996). Habitats such as semi-natural grasslands, *dehesas* and *montados*, steppe grasslands, permanent crops, and arable crops in dryland areas (such as olive groves, fruit and nut orchards), are also characteristic of low intensity farmlands, specifically of areas of traditional agricultural landscapes (Lomba *et al.*, 2014). Likewise, high nature value conservation grasslands gather the ideal characteristics to halt a huge variety of wildlife, being also associated to low intensity farming systems and high levels of biodiversity (Bignal and McCracken, 1996). Most of the habitats they provide are of particular nature conservation concern, being represented in the European Union (EU) Species and Habitats Directives (Lomba *et al.*, 2014).

The annual farming cycles characteristic of low intensity farming potentiate complex interactions with several species, and even, in some cases, there are species that depend upon the daily farm management practices in agricultural areas (Bignal and McCracken, 1996). Low intensity farming systems are characterised by their natural and environmental value, and for underlying social-economical systems s(Beaufoy *et al.*, 1994). So, farmers also depend upon biodiversity to guarantee their subsistence and the success of their harvests, for example, in the case of pollination that is estimated to have an economic value of 15 billion euros per year, in Europe (EC, 2011).

Low intensity farming practices are crucial to guarantee the maintenance of regional and cultural landscapes, however just a small number of these farmlands has a special designation of protection, such as National Parks, Reserves, etc. (Beaufoy *et al.*, 1994). Beside the fact that nature conservation on low intensive farmlands is becoming a more present theme in policy making, there still exist some issues in planning the right measures with a true ecological value, having consequences like the decrease of the areas predominantly occupied by low intensity farmlands, with special focus on the south of Europe (Bignal and McCracken, 1996).

Europe aims to reduce the pressures made on nature and specifically on Ecosystem Services through legislation, by including specific measures into sectorial policies (EC, 2011). Whilst some efforts have been done to enhance the maintenance of biodiversity in the EU countryside (e.g. through agri-environmental programmes) (Bignal and

McCracken, 1996; Halada *et al.*, 2011), there's still a pressing need in evaluating how such measures are contributing to the established goals (Halada *et al.*, 2011).

1.3. Objectives of the thesis

The overarching goal of this thesis is to analyse the relation between Ecosystem Services and High Nature Value farmlands, to contribute to a more effective management and protection of such farmlands, specifically of their natural and cultural value. To do that at the landscape level, a spatially-explicit approach was implemented aiming to analyse the coincidence between Ecosystem Services and High Nature Value farmlands.

More specifically, two case-studies were *a priori* defined:

- **The first (CS1)** consists on a meta-analysis and literary review of ES targeting farmlands, analysing which and how they have been assessed in the literature, considering all kinds of farming systems practices, but emphasizing extensively managed farmlands;

- **The second (CS2)** departs from a selection of Ecosystem Services from a previous selected study, and constitutes a preliminary spatially-explicit assessment of the coincidence between ES and HNVf areas, aiming to understand the potential of High Nature Value farmlands multiple ES providers. The selected study area is the River Vez watershed in the NUT III region Minho-Lima, located in the Northwest of Portugal.

1.4. Thesis Structure

This thesis is organized in 5 chapters:

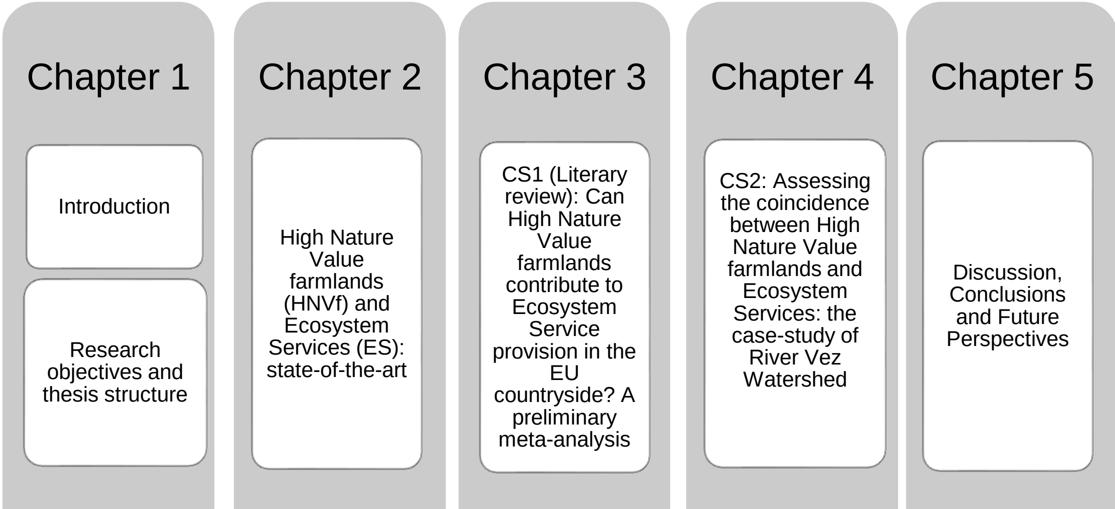

Figure 2 - Thesis workflow.

- **Chapter 1** departs from an overview of concepts on biodiversity, and the current challenge of halting biodiversity loss, making a general approach and introduction to the main issues. Also here, the general and specific goals of the thesis are defined and schematized.

- **Chapter 2** refers to the acknowledged role that farmlands, specifically High Nature Value farmlands (HNVf), can play to reach such ambitious worldwide goal. Also, it focuses on the most relevant concepts on Ecosystem Services and summarizes the main differences across existent classifications, to feed a comprehensive meta-analysis on services, spatially-explicit approaches and indicators more commonly assessed in extensively managed farmlands.

  Chapter 3 corresponds to CS1 and it constitutes a literary review, where a meta-analysis of 40 references concerning farming practices, but focusing mostly on extensive agricultural practices and Ecosystem Services assessment was made, analysing how Ecosystem Services have been assessed in the literature concerning this theme;

- **Chapter 4** concerns the CS 2 in which a spatially-explicit approach was implemented to assess the coincidence between Ecosystem Services and High Nature Value farmlands in the River Vez watershed. Here, the selected Ecosystem Services for the analysis were based on a previous elaborated study, and an assessment of the areas of HNVf that may coincide with the areas from the selected Ecosystem Services predominate was carried out.

- **Chapter 5,** on its turn, will consist in discuss the main achievements of the Case-Studies from Chapters 4 and 5, in the context of previous and ongoing research, highlighting how the socio-ecological systems underlying HNVf can be maintained in the future and how can future research support them.

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Chapter 2. High Nature Value farmlands (HNVf) and Ecosystem Services (ES): State-of-the-art

2.1. The concept of High Nature Value farmlands

The natural and rural landscapes of Europe are representative of its cultural heritage and natural richness (EEA, 2004). Due to the diversity of farming practices in all regions of Europe, different agricultural habitats emerged and so, they host a big number of different species and habitats all over Europe (EEA, 2004).

The idea of farmlands being consider of "high nature value" is something that calls into question the interaction between farming and environment, something that was not very common until the concept of High Nature Value Farmland appeared (Andersen *et al.*, 2003). In the 1990s it began to be documented that in some cases farming was not just less damaging to the environment, but, on the other hand, it was a good contribution to the conservation of biodiversity in Europe, and some of the farmlands were, in fact, essential to the maintenance of the current conservation value (Andersen *et al.*, 2003). According toBeaufoy *et al.* (1994) , «*High Nature Value farmland comprises those areas in Europe where the agriculture is a major (usually the dominant) land use and where that agriculture supports or is associated with either a high species and habitat diversity or the presence of species of European conservation concern or both*». The term "value" in High Nature Value farmlands concerns the conservation value that these areas gather (Andersen *et al.*, 2003), so that the CAP recognizes the important role of HNVf in conservation and the habitats that they created for a big amount of species, particularly the ones with a special conservation concern (EEA, 2004). Therefore, High Nature Value farmlands include hotspots of biodiversity located in agricultural areas, that exist because of the extensive farming practices that occur in those lands (Figure 3) (EEA, 2004).

Figure 3 - Species that exist in HNVf areas with a special conservation concern (EEA, 2004). High Nature Value farmlands include hotspots of biodiversity located in agricultural areas characterised by extensive farming practices.

High Nature Value farmlands owe their nature value to their intrinsic characteristics, since they: i) allow the maintenance of a several important vegetation structures and niches on farmlands that are essential to specific species and biotas; ii) their farming practices, such as grazing, contribute to the existence of many vegetation communities that are highly valued; iii) the farming practices they hold are more constrained by location, climate and topographic factors that allow a bigger connection between natural features and natural processes; iv) the large scale farming is a benefit to guarantee the sustainability of plant and animal populations that depend upon them (Andersen *et al.*, 2003).

Being "low-intensity farming systems" is the main characteristic of HNVf (Figure 4), as well as the traditional practices, which are main drivers to sustain the European habitats and species that depend upon this systems, seeing that the increase of intensity reduces the levels of biodiversity in this areas (Plieninger and Bieling, 2013).The presence of semi-natural vegetation, such as unaltered pastures is one of the main characteristics of these systems, but also the diversity of the land cover, that is dominated by crops, unplanted land, pasture and other components that are common in this landscapes (Plieninger and Bieling, 2013)

HNVf areas are, therefore, compound by small dimension mosaics with cultivated land, traditional plantations and low-intensity olive orchards (Plieninger and Bieling, 2013).The existence of patches of natural vegetation, such as woodland, are tremendously important to create habitats and connectivity for animal groups, and therefore, are one of the key characteristic of High Nature Value farmlands areas (Plieninger and Bieling, 2013). The areas in Europe that have the High Nature Value designation are not just the low-intensity farming ones (High Nature Value farmlands), but also other farming areas where species exist alongside them despite the type of farming (Plieninger and Bieling, 2013). HNVf areas have different characteristics in different countries in Europe, being commonly characterized by areas of grazed uplands, meadows and pasture typical from the alpine regions, steppes that are emblematic of eastern and southern regions, and *dehesas* and *montados* that are typical form Portugal and Spain, as well as some areas in western Europe that are important for migratory flow of some species (Plieninger and Bieling, 2013)

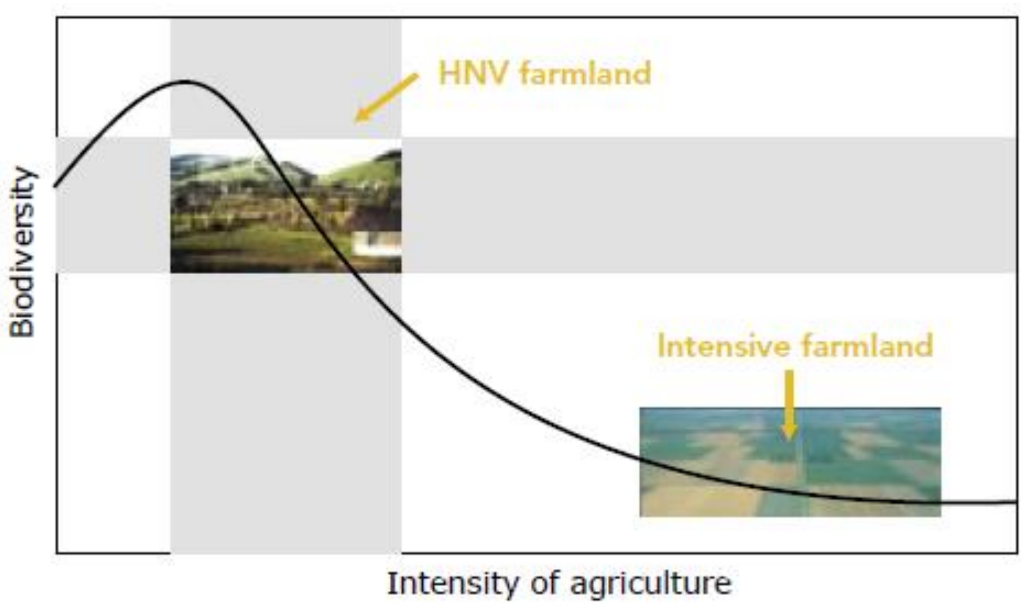

Figure 4 - Relation between biodiversity and agriculture intensity. High Nature Value farmlands are vital to the maintenance of biodiversity, having in account that they gather areas where extensive agricultural practices predominate.

A typology was developed intending to separate the different levels of farming (Lomba *et al.*, 2014). The High Nature Value farmland concept was divided in three types, which gather several indicators that are representative of the extensive character of agriculture sustaining the typology of HNVf (Figure 5) (Lomba *et al.*, 2014). Type 1 focus on farmlands characterized by an extensive management, having a significant proportion of semi-natural vegetation; Type 2 concerns the farmlands where the low intensive agriculture inputs are connected with mosaics of semi-natural vegetation and cultivated land, combined with different landscape geographies, such as harvest diversity; Type 3, is about the farmlands that gathered a high number of species with an important conservation concern, at an European and world level, even if the farming system is a bit more intensive (Andersen *et al.*, 2003; Lomba *et al.*, 2014).

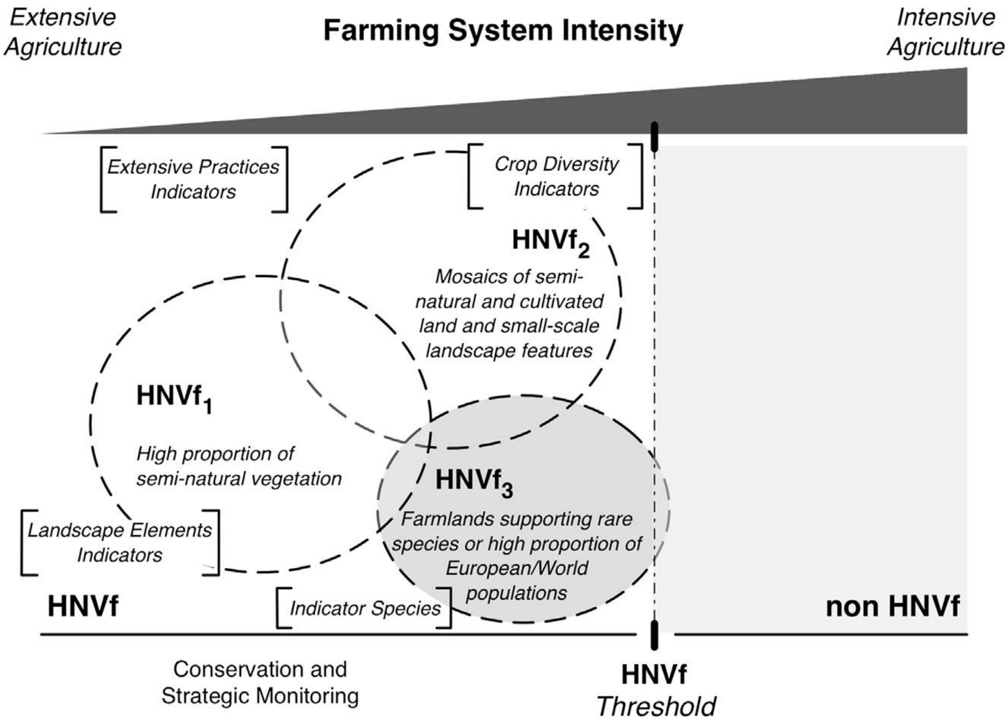

Figure 5 - High Nature Value farmland conceptual framework relating the intensity of farming systems with HNVf types according to Lomba *et al.* (2014).Lomba *et al.* (2014) considered that HNVf type 1 are connected with extensive practices and landscape elements indicators, HNVF type 2 are related with indicators focused on the diversity of crops, and HNVF type 3, for their role in the conservation of particular species, are associated with species indicators. In this approach, the authors stand that the systems that contribute to the maintenance of farmland biodiversity should be considered as HNVf, while the ones that are characterised by an intensively managed agriculture should not be considered.

The areas that belong to type 1 are very rich in species and involve extensive agricultural practices for their maintenance, having a high conservation value, being characterised by low-intensity practices for livestock raising and for semi-natural vegetation, like the case of grasslands, scrubs or woodlands or even a combination of different types (Paracchini *et al.*, 2008; Beaufoy, 2014). This type of HNVf gathers high nature values, providing a range of habitats that are used by wildlife species, such as invertebrates, birds, mammals and reptiles (Beaufoy, 2014).

In turn, HNVf type 2 is defined by a small scale variation of land use and vegetation, being straightly connected with low agricultural inputs and high species richness (Paracchini *et al.*, 2008). This type of farmland has habitats that are not necessarily classified as semi-natural, but the management of this areas must be extensive in order to allow the existence of an “ecological infrastructure” in the landscape, since its deterioration is especially critical for wildlife and can lead to a rapid decline in nature values (Paracchini *et al.*, 2008; Beaufoy, 2014). Marginal semi-natural features, as hedges or other field-margins and trees can be found in this type (Beaufoy, 2014). On the other hand, their total surface area is smaller than the productive areas, making the difference between what is HNVf and what is not (Beaufoy, 2014).

The last type is type 3, and it is defined by intensive farming systems, that are considered has being at the "margin" of the HNVf spectrum, because of their controversial nature, since their land cover and management practices do not correspond to the HNV farming criteria (Paracchini *et al.*, 2008; Beaufoy, 2014). However, they support high concentrations of species with a special conservation concern, at a local level, particularly bird populations (Paracchini *et al.*, 2008; Beaufoy, 2014).

The three types of HNVf are not precise categories, isolated between them, but instead they must be seen has a continuum process, that varies from the ones with a higher proportion of semi-natural vegetation and low intensity land use (type 1) to a more intensive managed but with the ability of supporting important species (type 3) (Figure 6) (Beaufoy, 2014).

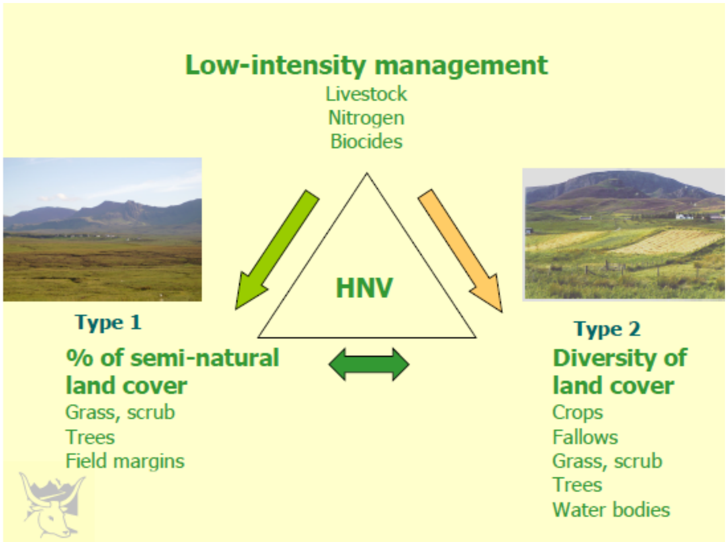

Figure 6 - The continuous process of HNVF types Beaufoy (2014). The three types of HNVF are not precise categories isolated and unconnected, but instead are directly related, influencing each other in a constant process.

The changes that occur on farmlands, and the pressures that agriculture nowadays undergoes, are threatening the biodiversity that depends on this systems (EEA, 2004). This is going to influence agricultural practices, especially the intensification of agriculture, and the abandonment of the lands by farmers, contributing to the decrease of biodiversity, especially having in consideration that two thirds of the bird species that have the vulnerable status of conservation in Europe are present on farmlands (EEA, 2004). Thus, it is essential to find measures that are able to avoid the degradation of HNVf areas (EEA, 2004).

2.2. HNVf and the European Union Environmental Commitments

The High Nature Value Farmland conservation is a clear goal in the EU rural development policy (EC, 2012). The Article number 22 of the EU regulation concerning Europe rural development, defines that it must be given support to the «conservation of high nature value farmed environments which are under threat» (EC, 2012).

On 2003, The Kiev Commitment stated the aims for identifying High Nature Value Farmland areas, which led the European Environmental Agency (EEA) and the United Nations Environmental Programme (UNEP) to define the concept of HNVf areas (Halada *et al.*, 2011). Europe has come up with a several number of important environmental commitments related to the preservation of the environment and maintenance of the countryside (EC, 2005).

The Common Agricultural Policy (CAP) is one of the main tools in helping the conservation of HNVf, and has entered in a new period of management in 2014 that goes to 2020, introducing the environmental component in Pillar 1 that is the one concerning the income support to farmers (EEA, 2004; MAES, 2014). Here, 30% of the direct payments were transferred to the “green” measures, focusing on: the conservation of enduring grasslands, the diversification of the crops and on Ecological Focus Areas (EFAs) (MAES, 2014). High Nature Value farmlands felt the benefits of this change, both positive and negative, particularly in what comes to the intensity of farming, since farmers were no longer forced to practice a more intensive agriculture, just to make sure they received the payments from CAP; and, oppositely, some farmers felt the other way around, since the decoupling of payments could mean a further abandonment of the lands, particularly the farmlands with an important conservation value (EC, 2012).

Besides the CAP, Europe has come up with two directives that aim to halt biodiversity loss in Europe: the Habitats Directive and the Birds Directive, constituting the main foundations of biodiversity policy in Europe (Halada *et al.*, 2011). These two directives are the basis for the establishment of a European network of protected sites that aims to ensure the protection and maintenance of the most threatened and valuable habitats and species in Europe: the Natura 2000 network (Halada *et al.*, 2011). Important Bird Areas (IBAs) and Prime Butterfly Areas (PBA) are also two important tools in maintaining biodiversity in agricultural areas. The Important Bird Areas (IBAs) are a method created by BirdLife International in order to identify the most important places on earth for birds, being considered a very useful tool in what comes to identify the areas of HNVf type 3, since they are support for rare species and concentrated populations (Paracchini *et al.*, 2008). In what concerns PBAs, they occur commonly with High Nature Farmlands, existing more than 27 target species that depend upon extensive agriculture for the maintenance of their habitats (Paracchini *et al.*, 2008). The Habitats Directive, on its turn, is constituted by several Annexes, in which Annex II and Annex IV play an important part in giving information on the identification of HNVf type 3, as Annex I is highly relevant on helping the identification of HNVf type 1 (Halada *et al.*, 2011).

The Natura 2000 network covers about 25 000 sites, being fifth of the territory of the EU (EC, 2012). It is the centre of the European nature and biodiversity policy (EC, 2014) and it does not refer just strictly to nature reserves, including also human activities (2014c). High Nature Value farmlands of type 1, are the ones with a higher proportion of semi-natural vegetation, and therefore are on the basis of the habitat data (Paracchini *et al.*, 2008). Also, High Nature Value farmlands of type 3 support species and a high proportion of European or World populations (Paracchini *et al.*, 2008).

In order to achieve EU biodiversity conservation goals, measures like the Habitats Directive or the Natura 2000 network are not enough, and that is what the HNVf concept emphasises, since a right management cannot be done only by the protection of specific habitats or species, or through the definition of restricted areas to be managed individually (Beaufoy *et al.*, 1994). The maintenance of low-intensity land uses is a vital point in what comes to the dynamics of natural processes, and so it creates opportunities to biodiversity to expand (Beaufoy *et al.*, 1994).

2.3. Assessing High Nature Value farmlands in space and time

The support to low-intensity farming systems, has to rely on a range of measures that were mentioned by (Beaufoy, 2014) as «*needed urgently and set up as quickly as possible*” (Figure 7). The support to this low-intensity farming systems is crucial, and the MS need to take action, since the local-level initiatives have to be prioritised, considering that several approaches have an explicit direct impact in the supporting of HNVf, especially through the involvement of farmers (the LEADER approach, for instance) (Beaufoy, 2014).

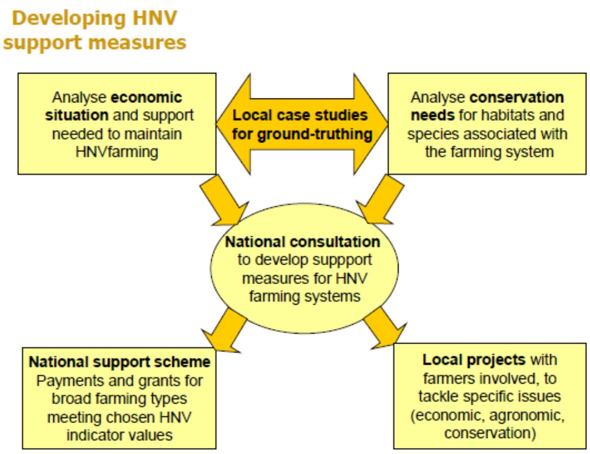

Figure 7 - High Nature Value farmlands support measures. Measures are proposed at a national and local level by Beaufoy and others (1994), in order to support low-intensity farming systems.

Considering the alterations that occurred in the CAP, EU Member States committed themselves to put in practice three important measures that are related to HNVf: identify this type of farming in their regions; support and maintain those systems, with special focus on the Rural Development Programmes (RDPs); and monitor the changes that occur in those areas, as well as the nature value associated with them (Beaufoy *et al.*, 1994).

The creation, design and implementation of an indicator on High Nature Value farmlands, was firstly implemented by the Directorate-General Agriculture and Rural Development in 2006, applying this to agricultural landscapes with traditional farming systems (Paracchini *et al.*, 2008). This was supposed to be used in the Common Monitoring and Evaluation Framework (CMEF), to help on the evaluation of the EU rural development future programmes (Paracchini *et al.*, 2008). The CMEF is divided in three types of indicators, such as “Baseline”, “Result” and “Impact” indicators that work as a tool to control how are the HNVf being managed (Lomba *et al.*, 2014). Particularly, the “Baseline Indicator” concerns the impact of the Rural Development Projects in the support to HNVf that can be measurable; the “Result Indicator” focuses on the number of hectares that are undergoing a successful land management, which is the concretion of land management applied measures that are concentrate in the conservation of biodiversity in agricultural areas; the third and last indicator, the “Impact Indicator” is focus on the modifications that occur on HNVf (Lomba *et al.*, 2014). The existence of this indicators has been encouraged at an European level, since their spatially-explicit component is an important contribution to a more clear understanding of the crop heterogeneity and management practices, but also of the status of biodiversity (Lomba *et al.*, 2014).

There have been several contributions in order to achieve a better efficiency and a more coherent and correct mapping of HNVf, such as the ones provided in “The Nature of Farming” of Beaufoy *et al.* (1994). Here it is defined a scale that aims to identify and map HNVf, defining several indicators that concern low intensity farming systems and give preliminary mapping exercises of HNVf landscapes in several countries (Lomba *et al.*, 2014).

Having in consideration that these data were not sufficient, Andersen *et al.* (2003) study proposed two approaches for identifying and mapping High Nature Value farmlands: one was based on land cover data (CORINE land cover data base) and the other on farm system data (from the Farm Accountancy Data Network – FADN) (Paracchini *et al.*, 2008). However, land cover maps do not give information on the intensity of the land management, and so it is difficult to find differences in the farming intensity, and consequently between HNVf areas and non-HNVf areas (Lomba and others, 2014). The frequency of acquisition and update of the most relevant data sets for land cover and farming systems are not adequate, having a major deficiency in the temporal resolution, constraining the ability to monitor the tendencies and changes in HNVf areas and on the reporting on the HNVf result and impact indicators (Lomba and others, 2014). On its turn, the datasets of biodiversity that are related to HNVf have several limitations that are potentiated by the variation of the spatial and temporal resolution, the geographical extent and the level of detail needed to map correctly these areas (Lomba and others, 2014).

Besides the different approaches that were defined, there has been a continuous improvement in this area, since there are a significant number of supplementary lines in order to produce more realistic and correct mapping and identification of the HNVf areas in Europe, offering multi-scalar information to build the maps (Lomba *et al.*, 2014). The mapping of the distinct types of HNVf relies on this approach, since they can be used to evaluate and monitor farmlands that have an important conservation value at a landscape level, such as protected/sensitive areas that are the most use in mapping of HNVf areas (Lomba *et al.*, 2014). The correct spatial distribution and identification of HNVf must also consider Ecosystem Services (ES) as important indicators, and the impact of HNVf to the maintenance of this services (Frank *et al.*, 2011).

Having all in account, it is clear that at an EU level it does not exist a common methodological approach that can be used by all MS to map HNVf (Andersen *et al.*, 2003). Beside the fact that the guidelines for potential extensive approaches are available, the ones concerning the minimum data standards or the ones related to the national information on HNVf organization are not (Lomba *et al.*, 2014).

2.4. Ecosystem Services: an overview

Ecosystem Services can be defined as the "ability" of ecosystems to provide goods and services in order to fulfil human needs, both in direct and indirect ways (De Groot *et al.*, 2009). The services provided by ecosystems are convertible in economic and monetary terms, and that is why humans tend to alter ecosystems in their favour, making interventions to manipulate them, especially the agro-ecosystems where they are modified to achieve a specific production function (Swift *et al.*, 2004; De Groot *et al.*, 2009). The concept of Ecosystem Services is, therefore, often described as an anthropocentric view of nature value (Schröter *et al.*, 2014).

Beside the fact that this "services" are vital to life on Earth, and particularly to human-life, over the last years people have been taking them for granted and thinking about

them as infinite, which has led to a continuous degradation of ecosystems and the services they provide (MEA, 2005; EEA, 2015). This, has, undeniably, negative impacts on the other functions of ecosystems, in terms of energy matter and biological diversity, affecting also the goods and services (Swift *et al.*, 2004). ES are different concerning the different ecosystem types, but particularly in agricultural areas, i.e. in agro-ecosystems and agricultural landscapes, where services like the maintenance of genetic diversity is essential for the success of crops and animal breeding, the cycle of nutrients, erosion control and sediment retention, and also water regulation (Swift *et al.*, 2004). Ecosystem Services are influenced by each other, being united in a continuous process, like the case of trees, for instance that contribute not only to the reduction of atmospheric pollution, but also to water purification and help in the regulation of the climate (EEA, 2015).

The Millennium Ecosystem Assessment states that about 60% of the ecosystems worldwide are evaluated as being degraded or used unsustainably (MEA, 2005). The various components of Biodiversity such as species richness, composition and interactions, play a crucial role in the Ecosystem Services (ES) supply (Proença and Pereira, 2011). Humans have caused serious changes on ecosystems, especially in the last 50 years of human history (MEA, 2005). The demand for Ecosystem Services grew significantly between 1960 and 2000, due to the increase of human population and its consumptive habits, raising the need for food, water, fiber and fuel, being accompanied by the demand for new technologies (MEA, 2005; Huntsinger and Oviedo, 2014)

There are three ES approaches that are known worldwide: the Common International Classification of Ecosystem Services (CICES), The Economics of Ecosystems and Biodiversity (TEEB) and the Millennium Ecosystem Assessment (MEA). An analysis of this three approaches, suggests that they have different perspectives, particularly in what comes to the analysed Ecosystem Services (Table 1).

Table 1 – Pros and Cons of the International Classifications of Ecosystems: CICES, TEEB and MEA. Information on the characteristics of each one of the classifications was gathered, in order to understand their differences and similarities.

International Classifications	Pros	Cons
CICES	– Hierarchical structure of CICES allows a good organization of the concepts, since the categories at each level are non-overlapping and without redundancy; – It establishes a long term goal of a *combined classification that integrates outputs across ecosystems and from other natural resources;* – It helps in the negotiation of the different perspectives that have evolved around the ecosystem service concept and assist in the exchange of information about them; – The CICES classification provides a framework in which information about supporting or intermediate services can be nested and referenced, which is particularly useful in a mapping context; – The hierarchical structure of CICES is very useful to bundle services at class level on condition that indicators at higher level are available; – The hierarchical structure of CICES allows better reuse of indicators that are developed under other frameworks or reporting streams. In other words, CICES enables operationalization of Ecosystem Services and facilitates mainstreaming to other policies; – The hierarchical structure of CICES facilitates comparisons of assessments of Ecosystem Services across ecosystems and between the different Member States and at different scales.	– Does not include "supporting services"; – Abiotic environmental outputs which often affect ecosystems and their services are not included in the approach; – Distinction between Biotic and abiotic ecosystem outputs. Under the Provisioning theme there are separate classes for biotic and abiotic materials, and for renewable biotic and abiotic energy sources. A similar type of distinction is made under the regulation and maintenance theme; – Applying the CICES classification for marine or freshwater ecosystems is less evident. Many classes are not relevant while some classes lead to difficulties in proper interpretation; – There remain conceptual difficulties with Ecosystem Services delivered by agriculture; – Some users encountered difficulties in distinguishing between the supply and the demand of Ecosystem Services when reporting indicators under the CICES frame; – CICES contains some groups that pose problems to users, in particular "water conditions" and "mediation by biota".
TEEB	– There are currently a large number of TEEB inspired national assessment in the early stages of development and implementation; – It is intended to guide policy makers in designing their own processes for appraising and considering nature's benefits in their policy decisions; – Allows a detailed economic analysis of biodiversity and Ecosystem Services.	– It does not exist one single, standard "TEEB" method or approach; – A commonly used classification is still not evident and many initiatives make their own adaptations of existing classifications from TEEB.
MEA	– The MEA framework states that people are part of ecosystems and that it exists a dynamic interaction between both. The report states that the changes occurring in ecosystems will directly affect human well-being. – The report gathers information from the scientific literature and important datasets and models, compiling also knowledge from the private sector and important stake holders like local communities and indigenous peoples. – It identifies a variety of mechanisms to help on the restoration and conservation of ecosystem services	– Because of the complexity between social and natural systems, the MEA had some difficulty in provide specific measures and information of some of these issues. – Did not pay much attention to the economics of ecosystem, particularly their connection with economic growth;

Ecosystem Services are divided in four typologies: i) supporting services, ii) regulating services, iii) provisioning services, and, iv) cultural services (Madureira *et al.*, 2012).

Supporting services refer to primary production, providing the basis to biodiversity to occur and to allow other ES to exist, and are often put aside in what comes to the economic value of ES, since they are integrated in other ES that are directly connected to human well-being (Madureira *et al.*, 2012). Regulation services involve the relation between ecological processes and final services and benefits, such as climate change, soil quality regulation or water quality regulation (Madureira *et al.*, 2012). Provisioning services consist mostly in final services and include marketable goods such as food, fuel and fibre, but at the same time non-marketable goods such as fresh water or genetic resources (Madureira *et al.*, 2012). Last but not the least, cultural services are the ones that include the aesthetic, spiritual, religious and inspirational value and are seen sometimes as "environmental settings" that emphasise cultural goods and the benefits that people obtain from ecosystems, and therefore give rise to the multidimensional character of ecosystems, including the connection between nature, technology, culture and economy (Madureira *et al.*, 2012). On Table 2 it is represented the different forms of acknowledging these typologies in the different Ecosystem Services international classifications, showing the categories they can be divided in.

Table 2 - Ecosystem Services typologies according to the international classifications (BISE, 2015) .

MEA	TEEB	CICES
Food (fodder)	Food	Biomass
		Biomass (Materials from plants, algae and animals for agricultural use)
Fresh water	Water	Water (for drinking purposes)
		Water (for non-drinking purposes)
Fibre, timber	Raw Materials	Biomass (fibres and other materials from plants, algae and animals for direct use and processing)
Genetic resources	Genetic resources	Biomass (genetic materials from all biota)
Biochemicals	Medicinal resources	Biomass (fibres and other materials from plants, algae and animals for direct use and processing)
Ornamental resources	Ornamental resources	Biomass (fibres and other materials from plants, algae and animals for direct use and processing)
		Biomass based energy sources
		Mechanical energy (animal based)
Air quality regulation	Air quality regulation	Mediation of gaseous/air flows
Water purification and water treatment	Waste treatment (water purification)	Mediation of waste, toxics and other nuisances by biota
		Mediation of waste, toxics and other nuisances by ecosystems
Water regulation	Regulation of water flows	Mediation of liquid flows
	Moderation of extreme events	
Erosion regulation	Erosion prevention	Mediation of mass flows
Climate regulation	Climate regulation	Atmospheric composition and climate regulation
Soil formation (supporting service)	Maintenance of soil fertility	Soil formation and composition
Pollination	Pollination	Lifecycle maintenance, habitat and gene pool protection
Pest regulation	Biological control	Pest and disease control
Disease regulation		
Primary production Nutrient cycling (supporting services)	Maintenance of life cycles of migratory species (incl. nursery service)	Lifecycle maintenance, habitat and gene pool protection
	Maintenance of genetic diversity (especially in gene pool protection)	Soil formation and composition
		Maintenance of water conditions
		Lifecycle maintenance, habitat and gene pool protection
Spiritual and religious values	Spiritual experience	Spiritual and/or emblematic
Aesthetic values	Aesthetic information	Intellectual and representational interactions
Cultural diversity	Inspiration for culture, art and design	Intellectual and representational interactions
		Spiritual and/or emblematic
Recreation and ecotourism	Recreation and tourism	Physical and experiential interactions
Knowledge systems and educational values	Information for cognitive development	Intellectual and representational interactions
		Other cultural outputs (existence, bequest)

The importance of Ecosystem Services worldwide, has increased the need for its mapping and their spatial delimitation, but also their quantification (MEA, 2005). The mapping of ecosystems and their services is the key to understand their variations in space and time (MAES, 2014). The ARIES (Artificial Intelligence for Ecosystem Services) approach aimed to map the potential provision of Ecosystem Services, the usage that is made and the biophysical structures that can reduce the flows in the services (Bagstad *et al.*, 2011). This approach uses deterministic/probabilistic spatial data in order to understand the correct spatial and ecological approach to map Ecosystem Services (Bagstad *et al.*, 2011). On its turn, the MAES defines that this process is made through analysing available land cover data, like Corine Land Cover and the European habitat classification (EUNIS) (MAES, 2014). Mapping Ecosystem Services with this approach allowed a more detailed habitat-related analysis, which provides a more deep comprehension of biodiversity that is expected to be found in each ecosystem type (MAES, 2014).

The mapping of Ecosystem Services is an important tool to give information on biodiversity and on the function of ecosystems, focusing on important issues like: the current situation and future trends regarding the provision of Ecosystem Services and which are the drivers affecting them over time, the different synergies and exchanges between different Ecosystem Services and how the supply and the demand for this services vary in space and time (EC, 2015). Also, in what comes to the needed investments, ES mapping constitutes an important tool in policy-making (EC, 2015). The next step in Ecosystem Services map is to quantify them and assess their physical and biological conditions, concerning that this are the aspects that determine the capability of ecosystems to bring off Ecosystem Services (EC, 2015). The concept of Ecosystem Services Potentials (ESP) is mentioned by Spangenberg *et al.* (2014) as being one phase between Ecosystem Services Functions (ESF) and the Ecosystem Services (ESS). Besides provisioning services, ES are providers of ESP, existing, however, some limitations to attribute a monetary value. To quantify this services is to admit that they can actually produce "marketable" services. Through the attribution of use-values to the ESF, ESP are created. The ESP must have some mobilisation like a monetary investment or of time, energy, labour and material, in order to see if they can have a marketable value, considering that only through the mobilisation they can actually produce services (Spangenberg *et al.*, 2014). If the services are not commoditized by the owners, they still contribute to human well-being and provide physical income. ESP are created through social processes, as seen, and they can define what type of services that are provided (Spangenberg *et al.*, 2014).

Presently and in the future, we face the problem of ecosystems misappropriation, while, on the other hand, the demand for their services continues to increase, which can only be fought and understood through correct policy practices, support of the institutions and an awareness that the degradation of ecosystems and their services is actually happening (MEA, 2005).

2.5. The relation between Ecosystem Services and farmlands

Farmlands are directly connected with Ecosystem Services, and their relation can be seen when pollinator increase agricultural crop yields or when the efforts made towards conservation on agricultural areas provide habitat for species, such as birds (Dale and Polasky, 2007). When the amount of nitrogen is reduced in wetlands, in the surface water, due to agricultural fields, and where we can see that eutrophication reduces fish productivity and increases mortality, we see this relation (Dale and Polasky, 2007).

The relation between Ecosystem Services and agriculture is defined by Dale and Polasky (2007) as having three dimensions: i) agriculture provides valuable Ecosystem Services like food or soil; ii) agriculture beneficiates from Ecosystem Services like pollination that come from other farmlands, for instance; iii) and some Ecosystem Services that are not connected with agricultural systems can be swayed by agricultural practices.

The intensification of agriculture contributes, as said before, to the loss of biodiversity, retreating some important Ecosystem Services that are the key motors to biodiversity, for instance, to provide shelter for important species (Swift *et al.*, 2004). Here, is where the role of farmlands gets really important, particularly the low intensity ones like High Nature Value farmlands, that contribute to the maintenance of biodiversity outside conservation areas (Schneiders *et al.*, 2012). Schneiders *et al.* (2012) classified ecosystem management practices in three different areas: areas characterised by high levels of biodiversity with the need for special approaches, and low intensity practices; multifunctional agricultural areas with important ES needing special attention; urbanized areas and intensive managed farmlands that need technological approach.

In Portugal, the majority of the agriculture is characterize by areas of traditional management, with special focus on Trás-os-Montes and Beira-Interior, for instance, that are predominantly composed by low-intensity farming, creating diverse landscapes mosaics of arable land, pastures and trees (almond, chestnut, fig and olive, for example) (Beaufoy *et al.*, 1994). The northern half of Portugal is characterise by large mountains areas where the farming is most extensive with cattle, sheeps and goats, but the main characteristic of this systems are the predominance of *Lameiros*, which are systems with a particular nature conservation interest that include flooded meadows and are characteristic of the north west of Portugal (Beaufoy *et al.*, 1994). In these areas, it has been identified two types of high-altitude pastures and small areas of grazing at lower altitudes (Beaufoy *et al.*, 1994).

The importance of HNVf to the maintenance of biodiversity also concerns bird species that depend upon extensive mountain livestock (Beaufoy *et al.*, 1994). The region of Alentejo, on its turn, is one of the most important areas of HNVf in Europe, due to the presence of extensive areas of *montados* (wooded pastures with some sporadic cultivation) similar to the Spanish *dehesas*, but also being characterized by low-intensity cereal cultivation that are home to several important bird species (Beaufoy *et al.*, 1994). The *montado* has a high conservation value, since it gathers endemic species, rare species and threatened one that upon this systems to exist, such as the Iberian imperial eagle (Beaufoy *et al.*, 1994). Also, important species like the Lynx or the Iberian Wolf, are linked to the traditional pasture management, since they allow the maintenance of open areas in the mountains that have an alongside vegetation and therefore it helps the fixation of certain mammals that are the food basis of these species (Beaufoy *et al.*, 1994). In Algarve, due to the intensive and irrigated horticulture the non-irrigated fruit farms are less frequent, especially in the littoral areas that are more urbanized (Beaufoy *et al.*, 1994). Also important are the olive groves areas, that are predominant in Alentejo and Trás-os-Montes, and have a high conservation value, providing habitats with a low perturbation that are favourable to the presence of particular bird species (Beaufoy *et al.*, 1994).

The tendencies in rural areas in Europe are the abandonment of the lands, due to the depopulation process that affects the countryside (Beaufoy, 2014). This trend will affect the natural value of the lands, resulting in the loss of semi-natural vegetation, consequently affecting bird populations, for instance, that work as indicators of overall biodiversity due to their dependence on semi-natural vegetation areas, especially on food and shelter (Beaufoy, 2014). The Ecosystem Services introduction in HNVf mapping, comes from the need to analyse how ecosystem function is related to human actions, and since it is like this, how can society associate value to this services (what is the best way to do so) (Madureira *et al.*, 2012).

The integrating role of ES as gaining attention over the last few years in the scientific investigation, and has been targeted to influence policy-making in order to demand policy makers to adopt a transdisciplinary approach in the matter of ecosystem degradation (Madureira *et al.*, 2012). The Millennium Ecosystem Assessment together with TEEB was crucial to the divulgation of ES perspective, putting the ES approach on the table in

Europe, promoting the economic dimension in ecosystem and biodiversity management (Madureira *et al.*, 2012).

All in all, the situation of ES in Europe, nowadays, is very vulnerable, since we are before a malfunctioning of allocating mechanisms, both political and economic, that do not encourage the conservation of ES (Westhoek *et al.*, 2013). Instruments that focus on the "marketing" of ES are being developed in Europe, such as Payments for Ecosystem Services, which are increasingly present in the agenda of the several EU political institutions (Westhoek *et al.*, 2013).

An ecosystem service perspective is the key to make significant changes in the effective management of natural resources in agriculture (TEEB, 2010). Decisions regarding natural resources in agriculture cannot be taken only at an individual level (farmers, families, companies, tourism operators…), but besides EU, the local governments are a preponderant tool in the managing of natural resources towards the valuation of ES, gathering the HNVf information with ES and understand which areas need to have a more discriminative management (TEEB, 2010TEEB, 2010).

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Chapter 3: Can High Nature Value farmlands contribute to Ecosystem Service provision in the EU countryside? A preliminary meta-analysis

Abstract

Agriculture constitutes one of the main causes for worldwide biodiversity and habitat loss. With agricultural areas being one of the dominant land-use types at the global scale, they have been acknowledged as one of the most important areas for halting biodiversity loss. In the last decades, an increase of human population, and thus food demand, has been observed with a consequent increase of agriculture intensification.

In Europe, the relationship between agriculture and biodiversity has been having particular attention, being developed some new approaches and policies aiming to bring back the “nature value” to agriculture, considering its importance on Biodiversity and conservation of the species.

On this study, in order to comprehend how Ecosystem Services have been assessed on farmlands, we paid special attention on the potential of High Nature Value farmlands as providers of Ecosystem Services. This study was carried out to achieve insights on the connection between these two variables, through a meta-analysis, gathering information on 40 case–studies. The case-studies provided us useful information such as the spatial explicit indicators used in their study region and the agricultural management practices, having as main purpose understand the potential of farmlands as suppliers of relevant ES at a landscape level and their role in the context of the European Union environmental commitments.

Keywords: Ecosystem Services; High Nature Value farmlands; biodiversity conservation; meta-analysis; spatially-explicit indicators.

3.1. Introduction

Over the last 50 years, humans impacted ecosystems more severely than in any other period of human history, mainly due to an increasing demand for resources such as food, timber, fresh water and fuel (MEA, 2005). As a result, there has been significant loss and degradation of worldwide biodiversity and ecosystems (MEA, 2005).

Humans depend upon ecosystems not only because of their intrinsic resources, but also due to the importance of ecosystems to support human survival and quality of life (Swift *et al.*, 2004). Even though human impact on nature is widely known, they are an integrant part of the landscape, not only by adapting to it, but also by impacting and shaping it (Vallés-Planells *et al.*, 2014). This has brought an increasing interest on the relation between the ecological and economical dimensions of ecosystems and landscapes (Madureira *et al.*, 2012). Agricultural landscapes constitute one of the best examples of socio-ecological systems, since they have been shaped by humans for centuries.

Agricultural landscapes correspond to ca. 40% of the EU territory, which highlights the importance of "agro-ecosystems" to provision of ES and ultimately to human well-being. Additionally to food production, regulation and aesthetic, services like support for biodiversity, genetic resources, biological control of pests or the existence of habitat for species have been considering as part of those provided by farmlands (TEEB, 2010). As a consequence, the relevance of agricultural landscapes as providers of such ecosystem services has been highlighted in the EU context (TEEB, 2010). However, the provision of agricultural areas to contribute to the provision of ES seems to differ according to their characteristics, result from both biophysical conditions and management practices (Dale and Polasky, 2007).

Traditional agricultural landscapes are, by definition, multifunctional landscapes and thus they have been described as potentially rich in what concerns Ecosystem Services provision (TEEB, 2010) (Dale and Polasky, 2007). Some of the most interesting areas for biodiversity conservation in Europe correspond to agricultural areas (Beaufoy and Cooper, 2008). Extensively managed farmlands have been highlighted as relevant to EU countryside protection, and such acknowledgments converged to the definition of the High Nature Value farmlands (HNVf) in Europe. High Nature Value farmlands are defined by Tsaruk *et al.* (2007) as «*unique landscapes*», not only because of the characteristics mentioned above, but also due to their potential for harbour ecosystems, communities and species (Tsaruk *et al.*, 2007). High Nature Value farmlands are usually described as low-intensity farming systems, where a high proportion of semi-natural habitats exists (like semi-natural grasslands, for instance) and often agricultural patches are found intermingled with small-scale landscape features, such as woodlands and edges (Beaufoy, 2014) (Mackey *et al.*, 2011). HNVf type 1 consists in areas predominantly occupied by semi-natural vegetation, with low-intensity farming practices associated with livestock fostering; Type 2, on its turn, refers to landscapes that have a lower proportion of semi-natural vegetation and count with the presence of arable and permanent crops, that when are low-intensively managed are responsible for providing a wide range of habitats, increasing nature value; Type 3, refers to areas that harbour important species of conservation concern, that often are under more intensive farming practices and that otherwise would not be included (Beaufoy, 2014).

The Ecosystem Services (ES) concept devise the benefits that human can achieve from ecosystems (MEA, 2005). Currently, three ES classifications have been discussed: (i) the Millennium Ecosystem Assessment (MEA); (ii) the Common International Classification of Ecosystem Services (CICES); and, (iii) The Economics of Ecosystems and Biodiversity (TEEB). In short, MEA results from research developed between 2001 and 2005, aiming to determine the impact of ecosystem changes in human well-being, and specific conservation efforts and sustainable use of ecosystems required to assure it (MEA, 2005). MEA was built on the definition that ecosystem services are the benefits people obtain from ecosystems (MEA, 2005). It includes the full range of ecosystems, from natural forests to mixed landscapes characterized by human presence, such as agriculture and urban areas (MEA, 2005). The CICES classification was drawn by the European Environment Agency (EEA) (CICES, 2012) to accommodate different the existing visions of the ecosystem services concept and, therefore, debating this idea (CICES, 2012), and, over the last years, several upgrades have been done in the context of EU Mapping and Assessment of Ecosystems and their Services (MAES). Additionally, TEEB classification of ecosystem services, was decided by the G8+5 and carried out by Germany and the EU Commission, based on MEA (TEEB, 2010). Main differences between TEEB and MEA are the result from a stronger economic component given to the loss of biodiversity and the degradation of ecosystems, in the first case (TEEB, 2010).

Overall, ES classifications classify them in four categories: (i) Supporting; (ii) Regulating; (iii) Provisioning; and (iv) Cultural Services (De Groot, 2010). Provisioning services are those focusing on the nutritional matter, materials and energy (e.g. food, fiber and fresh water). Regulating services describe the aspects that mediate and/or moderate the physical environment (air quality regulation, pollination and pest regulation). Finally, cultural services that concern the non-material and non-consumptive outputs of ecosystems, that are related to the physical and mental state of people (aesthetic values, recreation and tourism) (MEA, 2005; CICES, 2012). Ecosystem services and agriculture have, therefore, a very much important connection that can be seen in three different perspectives: the ability of a farmland to provide a specific ES, the possibility for farmlands to beneficiate from the ES that can be generated elsewhere, and the influence that farmlands have on ES that are not directly connected with them (Schneiders *et al.*, 2012).

Here, we assess how ES have been tackled on farmlands, targeting specifically the potential of High Nature Value farmlands as ES providers. Overall, 40 case-studies were analysed for a set of pre-defined criteria, such as the geographic distribution of the research, sets of indicators used and their spatial-explicit character, and the management intensity of the farmlands, aiming to understand not only the potential of such farmlands as providers of relevant ES at the landscape level, but also how can they be assessed in the context of the EU environmental commitments. Implications are then discussed in the context of Rural Development Programs.

3.2. Methods

In this case-study, we used a simplified meta-analysis to synthesize information on how Ecosystem Services (ES) have been targeted and quantified in farmlands, specifically focusing on extensively managed areas such as High Nature Value farmlands.

An analysis of 40 published case-studies, ranging from more intensively to more extensively managed farmlands, was carried out considering a set of predefined criteria expressing their assessment of ES. Here, we consider as legible publications journal and reports built on the ES international classifications CICES, TEEB and MEA.

3.2.1. Data collection and analysis

A dataset was first built based on 40 research references gathered from the Web of Knowledge™, ScienceDirect®, and ResearchGate (see detailed information in Appendix 1). The chosen research papers were selected after some research on articles and reports on extensive agricultural practices and intensive agriculture, and its relation with Ecosystem Services. The references were then selected considering their relevance to the theme in order to reach the goals of this work. These studies were selected considering the three mainstream international ES classifications (CICES, TEEB and MEA), and each case-study was first analysed for them, and then for the specific type of analysis of service performed (either quantitative, either qualitative).

The performed study allowed us to develop a more detailed analysis of the information, giving us more evidence on the data type, ES classifications and typologies, and also allowed us to gather more detailed information as the type of agricultural management - extensive or intensive - (as extensive management we considered agricultural areas under extensive agricultural practices, organic farming and High Nature Value farmlands), the spatial information and ecosystem services predominance. With the spatial information having such a great importance in our study, it was of extreme importance to analyse the spatial indicators that were used to build the mapping in the several references that mentioned it. Therefore, we collect the spatial indicators we found in the references (see Appendix 2) and compiled the ones with more relevance, i.e., with more than one presence in all the 40 articles.

Specifically, in each case-study, data was gathered according the following criteria: Ecosystem Services international classification; Region analysis; Ecosystem Services typologies; Type of agricultural management; Data type (qualitative or quantitative);

Spatial indicators analysis; and Targeted Ecosystem Services (see detailed information regarding the types of data analysed in Table 3). The collected information was then analysed to understand the potential of farmlands as providers of relevant ES at the landscape level. The analysis of the data was made through a univariate statistical analysis with the use of Excel©. Table 3 shows the groups of data and the procedures implemented for their analysis.

Table 3 - Groups of information analysed relating Ecosystem Services and Agriculture. The table presents the sets of analysed data as well as the general procedure implemented to their statistical analysis.

Analysed Data	Procedure
Ecosystem Services international classification analysis	Its number of presences was registered on the 40 research papers (some references had more than one).
Region analysis	This analysis focused on the information gathered from the study areas present in each article that respect different regions around the globe, with a special focus on Europe. Here, we estimated the number of articles per region and performed a study on the predominant ES Classification per region.
Ecosystem Services typologies analysis	The number of presences of each typology in the 40 articles was assessed, having in consideration that some articles do not mention some specific typologies and other mentioned more than one. Afterwards, we made a more particular analysis, focusing on the number of presences of each particular service typology in the analysed references.
Type of agricultural management	Information was collected from the texts on what type of farming practices each article focus on. Therefore, from extensive to intensive, with a special regard on organic agriculture and High Nature Value farmland areas, the agricultural practices that were more commonly denoted in the 40 references were selected (with special attention to extensive practices, since it is the most useful data to our approach), notwithstanding some of them indicate more than one type of agricultural management.
Data type (qualitative/quantitative)	The type of data was examined in order to understand its relation with spatial component. The data type present in each article (qualitative and quantitative) was examined in order to understand its relation with spatial component. Some of the articles also presented both types in their studies.
Spatial indicators	The spatial component gave us information on the indicators used to assess Ecosystem Services in agriculture. An analysis of those indicators was carried out considering their predominance on extensive and intensive agricultural systems.
Targeted Ecosystem Services	The number of presences of each ES in all the references was collected. With this, we reached the number of times that a certain ES was indicated in the reviewed literature. Several particular analyses were made for each Ecosystem Services typologies (Provisioning services, Regulating services, Cultural services and Supporting services). An analysis to reach the most predominant ES in extensive and intensive agricultural managing systems was also made.

3.3. Results

a. Overview of the analysed case-studies

Information regarding the 40 research studies analysed is presented on Table 4, with special focus on the indicators and ES that are useful for our analysis on the potential of farmlands as providers of important Ecosystem Services at a landscape level.

Table 4 – Information collected on the 40 references studied, considered to highlight indicators and ES that can be used on the potential of farmlands as providers of relevant Ecosystem Services at a landscape level. The 40 references were analysed focusing on: the region of their case studies, the type of agricultural management, the type of data, the spatial indicators used and international Ecosystem Services classification used.

References	**Region of the case studies**	**Agricultural management**				**Data type**	**Spatial indicators**[1]	**Ecosystem Services classifications used**
		Extensive			**Intensive**			
		Only extensive	**Organic**	**High Nature Value farmland**				
Frank *et al.* (2011)	Germany, REGKLAM region	✓	×	×	✓	Qualitative	Habitat/supporting functions; Effective mesh size; Hemeroby index; Cost-distance-analysis; Shannon's diversity index; Edge contrast index; Core area index; Shape index; Information functions (natural scenery, recreation); Shape index; Edge contrast index; Total Area; Number of Patches; Degree of compactness.	TEEB and MEA.
Sandhu *et al.* (2007)	Canterbury, New Zealand.	×	✓	×	×	Quantitative	Approximate distribution of HNVf in Europe (%).	MEA.
Balbi *et al.* (2014)	Llanada Alavesa, Basque Country.	✓	×	×	✓	Qualitative/Quantitative	No spatial component.	MEA.
Schulte *et al.* (2013)	Ireland	✓	×	×	✓	Qualitative/Quantitative	No spatial component.	MEA.
Palm *et al.* (2013)	Sub Saharan Africa and South Asia.	✓	×	×	×	Qualitative/Quantitative	No spatial component.	MEA.
Smith and Sullivan (2013)	Wilsons River, Australia	✓	×	×	✓	Qualitative	No spatial component.	MEA.
Andersson *et al.* (2015)	Sweden	✓	×	×	✓	Qualitative/Quantitative	No spatial component.	MEA.
Mózner *et al.* (2011)	Hungary and The Netherlands	✓	×	×	✓	Quantitative	No spatial component.	TEEB and MEA.
Tsonkova *et al.* (2015)	Germany	✓	×	×	✓	Qualitative/Quantitative	No spatial component.	MEA.
Schneiders *et al.* (2012)	Flanders	✓	×	×	✓	Qualitative/Quantitative	Biodiversity; Land use intensity score; weighted mean ecosystem services score.	TEEB and MEA.
Lamarque *et al.* (2014)	Central French Alps	✓	×	×	✓	Qualitative	No spatial component.	TEEB.
Dominati *et al.* (2014)	New Zealand, Waikato	✓	×	×	✓	Qualitative/Quantitative	No spatial component.	TEEB and MEA.
Lopes *et al.* (2014)	Portugal	✓	×	×	✓	Qualitative/Quantitative	No spatial component.	TEEB and MEA.
Opdam *et al.* (2015)	Hoeksche Waard, The Netherlands	×	✓	×	✓	Qualitative/Quantitative	No spatial component.	MEA.
González-Esquivel *et al.* (2015)	Purhépecha plateau, in the State of Michoacán, Mexico	✓	×	✓	✓	Qualitative	No spatial component.	MEA.
Cimon-Morin *et al.* (2014)	Lower North-Shore Plateau and Central Labrador ecoregion of boreal eastern Canada	✓	×	×	×	Qualitative	No spatial component.	MEA.
Kirchner *et al.* (2014)	Austria	✓	×	×	✓	Quantitative	Shannon Diversity Index; Total biomass production on agricultural land; Soil organic carbon (SOC) in topsoil layer; GHG emissions from agriculture; Degree of naturalness; Area weighted mean species richness of vascular plants.	CICES and MEA.
Reed *et al.* (2014)	Kalahari rangelands, southwest Botswana	×	×	×	✓	Qualitative	No spatial component.	MEA.
Felipe-Lucia and Comín (2015)	River Piedra, Spain	✓	×	×	✓	Qualitative/Quantitative	No spatial component.	MEA.
Grossman (2015)	Paraguayan Paraná Interior Atlantic Forest (Atlantic Forest) ecoregion	×	×	×	✓	Quantitative	No spatial component.	MEA.
Huntsinger and Oviedo (2014)	California's Mediterranean rangelands	✓	×	×	✓	Qualitative/Quantitative	No spatial component.	MEA.
Sinare and Gordon (2014)	Sudano-Sahelian West Africa	×	×	×	✓	Qualitative/Quantitative	No spatial component.	MEA.
Arovuori and Saastamoinen (2013)	Finland	✓	×	×	✓	Qualitative	No spatial component.	CICES.
Firbank *et al.* (2011)	United Kingdom	✓	✓	×	✓	Qualitative/Quantitative	No spatial component.	MEA.
Rodríguez-Loinaz *et al.* (2014)	Basque Country, Spain	×	×	×	✓	Qualitative/Quantitative	Density of head of cattle (N /100 ha); Agricultural production (Ton/ha); Timber in forest plantations (m3/ha); Runoff renewable water supply (mm); Stored C in soil and biomass (Ton C/ha); Organic C in soil (Ton C/ha); Evapotranspiration (mm); Soil water storage capacity (mm); Soil water infiltration capacity (cm/h); Cover of riparian forest in river margins (% in 25m buffer); Cover of natural forest (% of municipality's surface); Areas without erosion problems (% of municipality's surface); Density of rural tourism establishments (N /km2); Special protection area (% of municipality's surface); Habitat of community interest (% of municipality's surface).	MEA.
Ma and Swinton (2011)	Michigan, USA	×	×	×	✓	Quantitative	No spatial component.	MEA.
Sandhu *et al.* (2010)	Canterbury, New Zealand.	×	✓	×	×	Qualitative/Quantitative	No spatial component.	MEA.
Catharin *et al.* (2014)	European Union	✓	✓	✓	✓	Qualitative/Quantitative	Land cover.	CICES.
Silva *et al.* (2014)	Steart Peninsula, United Kingdom	✓	×	×	✓	Qualitative/Quantitative	No spatial component.	TEEB and MEA.
Sandhu *et al.* (2015)	New Zealand	✓	✓	×	✓	Quantitative	No spatial component.	MEA.
Lee *et al.* (2014)	Taiwan	✓	×	×	×	Qualitative/Quantitative	Land cover and land use.	MEA.
Islam *et al.* (2014)	Ganges Delta, Bangladesh	✓	×	×	×	Quantitative	No spatial component.	MEA.
Garbach *et al.* (2014)	Costa Rica	✓	×	×	✓	Qualitative	Land use; Pest control value.	TEEB and MEA.
Horrocks *et al.* (2013)	United Kingdom	✓	×	×	×	Qualitative	No spatial component.	MEA.
Williams and Hedlundb (2012)	Scania, Sweden	×	✓	×	✓	Quantitative	No spatial component.	MEA.
Fontana *et al.* (2014)	South Tyrol (Alps), Italy	✓	×	×	✓	Quantitative	No spatial component.	TEEB and MEA.
Song *et al.* (2015)	North China Plain, China	×	×	×	✓	Quantitative	Climate data, energy substitution method, average cost of reservoir construction, saved inputs in agricultural production, the value of conserving soil fertility, the value of reducing soil sedimentation in river channels, and value of reduced surface soil, values of gas regulation.	MEA.
Page and Bellotti (2015)	New South Wales, Australia	✓	✓	×	×	Qualitative/Quantitative	Types of agriculture.	MEA.
(Glavan *et al.*, 2015)	River Drava, Slovenia.	×	×	×	✓	Qualitative/Quantitative	Land use.	MEA.
(Turner *et al.*, 2014)	Denmark	✓	×	✓	✓	Qualitative/Quantitative	Number of roadkill in a grid cell; Wetland water purification indicator; land use and land cover data.	MEA.

[1] The spatial indicators in the table follow the designation used in the respective publication. Exceptionally, the indicators "Land Use" and "Land Cover" were consider as one indicator for further analysis, since there was not enough information on their exact meaning to consider them separately.

In order to comprehend the importance of the ES International Classifications in the different regions, we started to do a correspondence to the number of articles and their classification (Figure 8). Overall, the Millennium Ecosystem Assessment (MEA) was found to be the most predominant classification across all analysed articles, with ca. 93% of the references citing it.

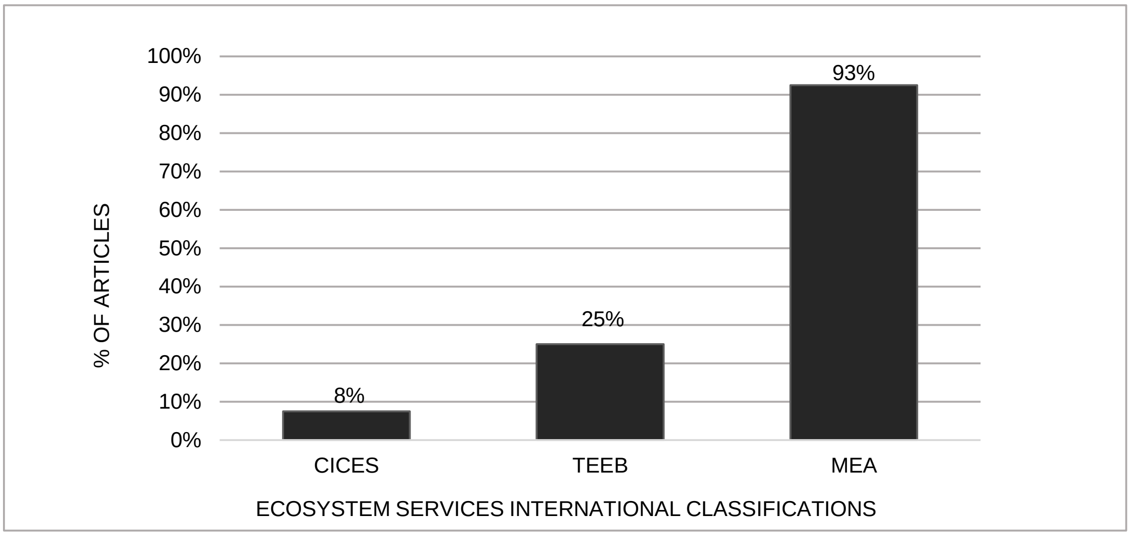

Figure 8 - Articles per Ecosystem Service international classification (%). This graph shows the most predominant Ecosystem Services international classification mentioned in the 40 analysed references.

As for the geographic distribution, from 40 selected studies, most were related to European regions (with 58% of the studies), followed by Australia and New Zealand and Africa and Asia (with 15% of the studies, each), Latin America (8% of the studies), and finally North America and Canada (5% of the studies) (Figure 9).

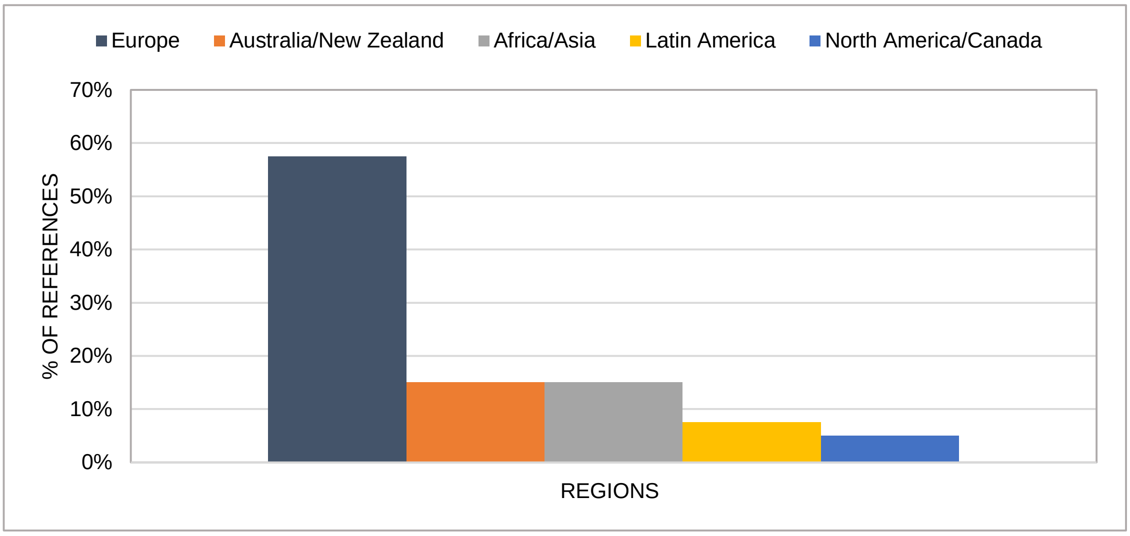

Figure 9 - Regions analysis: predominance of regions analysed in the references case studies (%). This graph gives us information on the predominance of the different regions from the case studies in the references.

The analysis of the predominance of ES international classifications, per region (Figure 10) showed us the prevalence of the CICES classification in Europe, since the only region that mentions it is Europe, in 3 references. Also TEEB is predominantly applied in Europe studies, with 7 references mentioning it, but also Australia/New Zealand and Africa/Asia that have a reference mentioning it. The MEA classification was used in ca. 37 of the case-studies spread across all geographic regions.

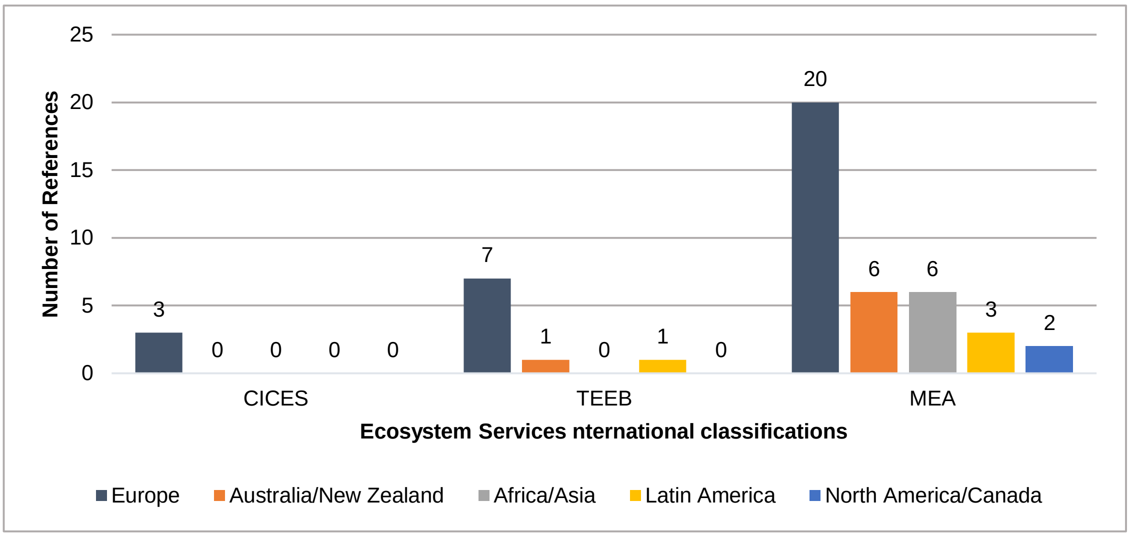

Figure 10 - Predominance of Ecosystem Services international classifications, per region: number of references per classification. This analysis showed that the MEA has an undeniable prevalence, in all the regions, but the Common International Classification of Ecosystem Services (CICES) only appeared in references focusing on Europe.

b. Ecosystem services, spatially-explicit indicators and farming practices

As for the predominant ES typologies allowed, the Regulating Services were found to be the most predominant across the considered CS, accounting for 33%. Provisioning Services followed with 27%, and Cultural and Supporting were found to be less representative (Figure 11). On Figure 11 we see the predominance of ES typologies in the two different types of agricultural management and the pattern of predominance of the typologies in all the analysed references. On the references focusing on extensive management, we can see the predominance of Regulating Services (34% of the 40 references), followed by Provisioning (28%) and finally Cultural and Supporting services, accounting for 20% and 18% respectively. Similar patterns were found when analysing data for intensively managed agricultural areas. Regulating services dominate with about 32% of the references focusing on them, and also important are Provisioning services with 25% of the references. Cultural services present 21% and Supporting services present 22%, being Cultural services the less connected to intensive management agriculture. The percentages are similar to the analysis of the extensive practices, showing similarities in the type of services the references focused on, since some of the references focused on both extensive and intensive practices.

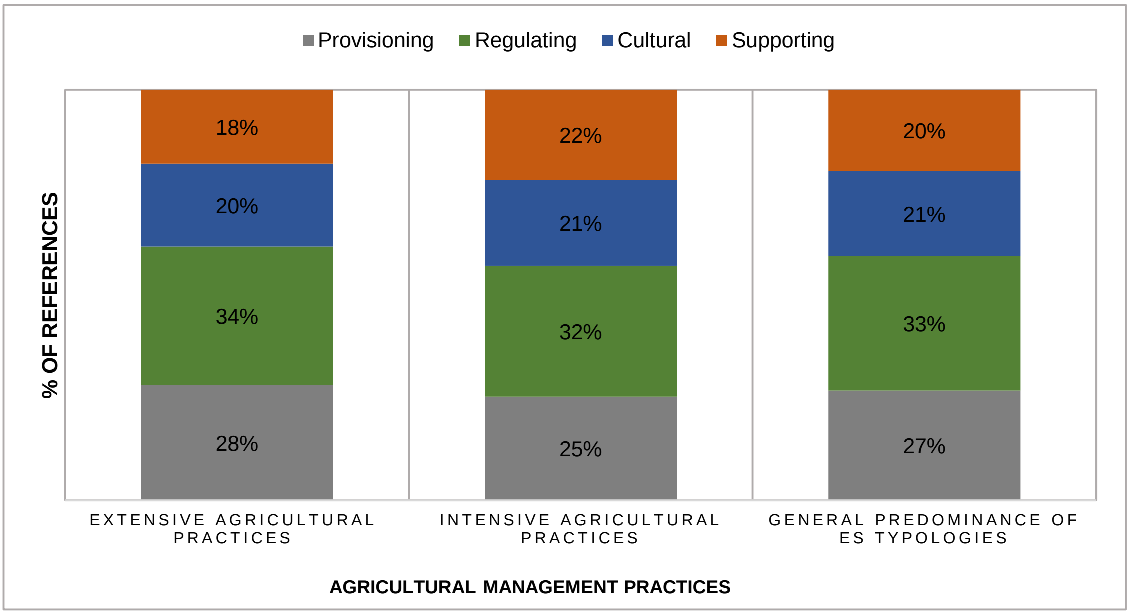

Figure 11 - Predominance of Ecosystem Services typologies across the considered case-studies, per agricultural management practices.

Assessing the most predominant Ecosystem Services in the analysed literature and on the ES international classifications is one of the most important steps of our study. Figure 12 shows us the predominance of the Ecosystem Services that were more mentioned, grouping them in their typologies (the services were counted for each reference, being considered as belonging to the typology that each reference mentioned). We can see the services that are most predominant, which are the ones that were more mentioned in the 40 references. In the Provisioning services the predominance of “food” and “fresh water” is clear; in the Regulating services we can see that “pollination”, “biological control of pests and diseases”, “Global/local climate and air quality regulation” and “carbon sequestration and storage” are the services that appear more often referenced in the analysed literature; concerning Cultural services, we can see the predominance of the services “Recreation and mental and physical health” as well of “Aesthetic quality of the landscape”; and last but not the least, we see that in the Supporting services the ones that outcome the most are “Habitats for species” and “Soil”.

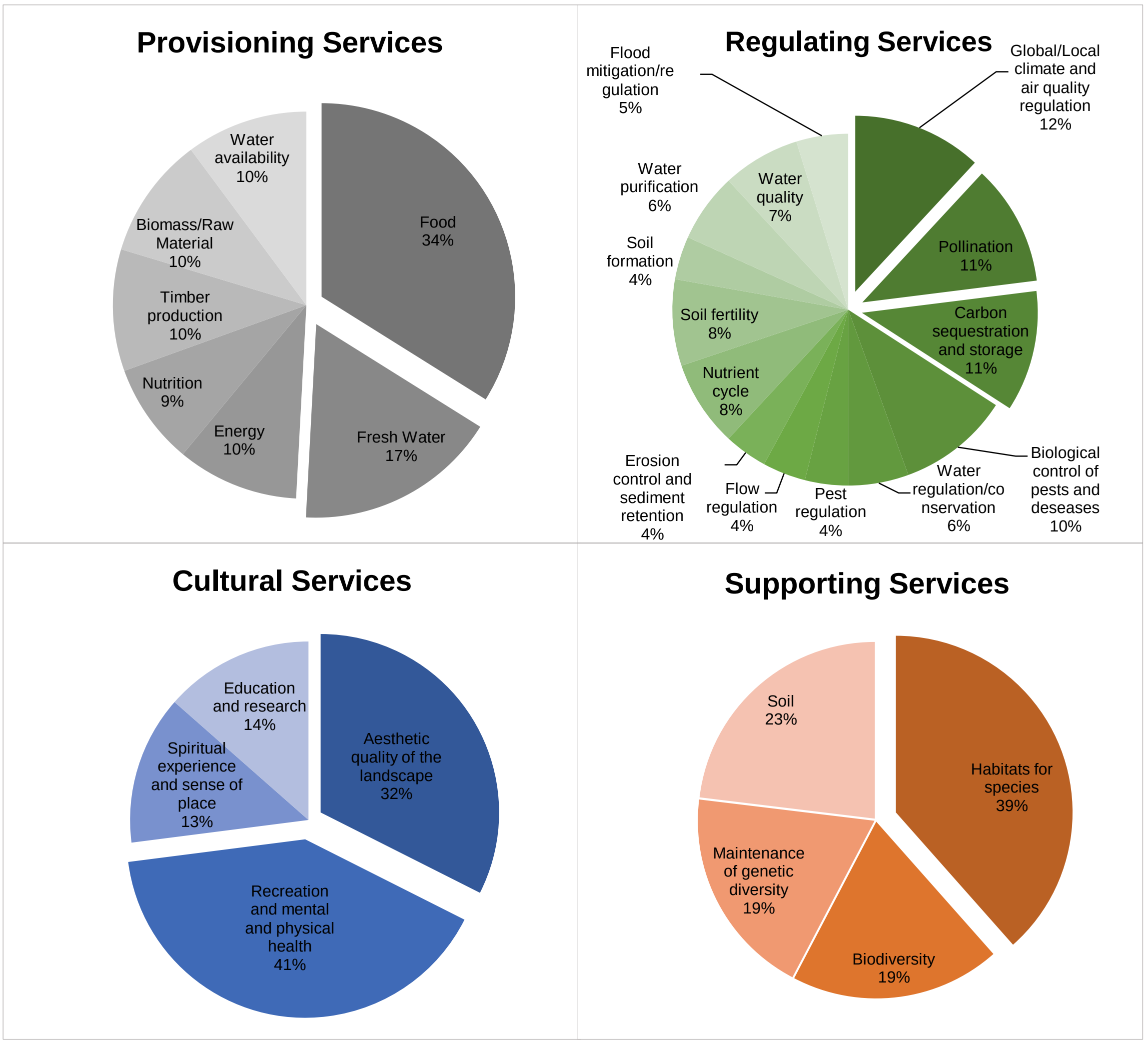

Figure 12 - Most predominant Ecosystem Services in the references concerning the ES international classification and references.

On Figure 13 we can see these indicators and the predominance of the Land Use/Land Cover as the most commonly used spatial indicators, with 14% respectively, followed by Shannon's diversity index, total edge contrast index and total core area index with 14% predominance.

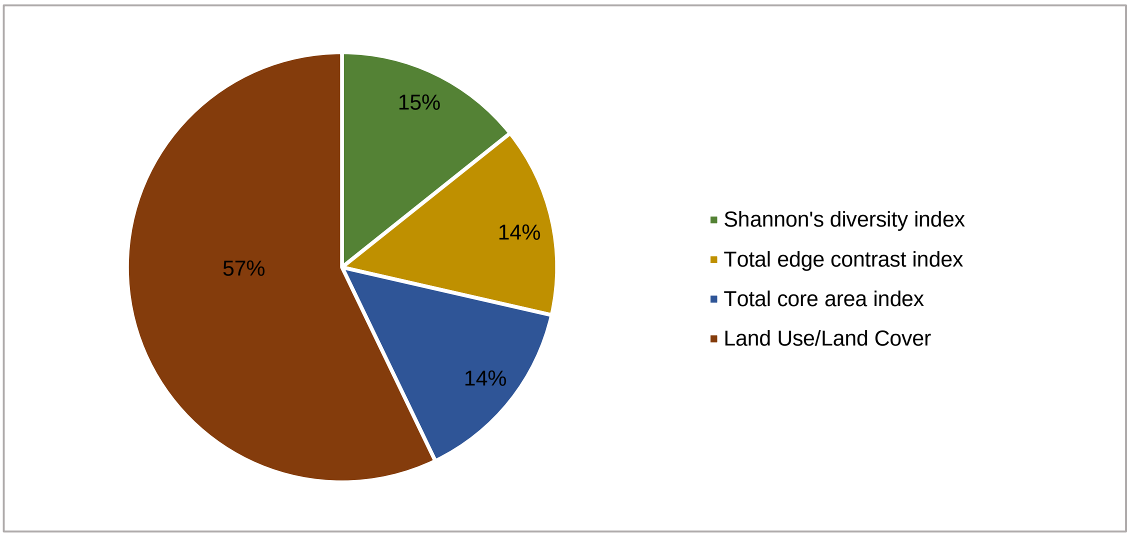

Figure 13 – Most predominant spatial indicators (%).

We made a selection of the spatial indicators that focused on extensive and organic practices and on High Nature Value Farmland areas, and also the ones that focused mainly in Intensive practices mapping. Figure 14 shows the percentage of these indicators and therefore their relative importance. Here, we see that Land Cover/Land Use is the predominant indicator, with 54%, followed by the Shannon's diversity index with 16% predominance.

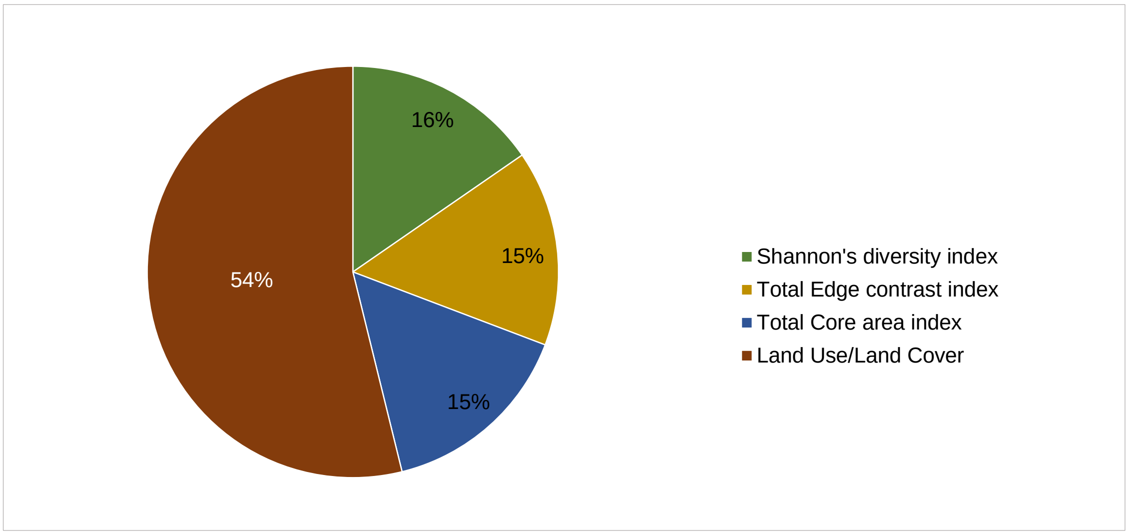

Figure 14 - Predominant spatial indicators in references focused on extensive agricultural practices (%).

In what concerns the spatial indicators that are more common in spatial explicit information concerning Intensive farming practices, Land Use/Land Cover is the most predominant, as seen in the previous scenarios, as well as Shannon's diversity index with 16% of predominance (Figure 15).

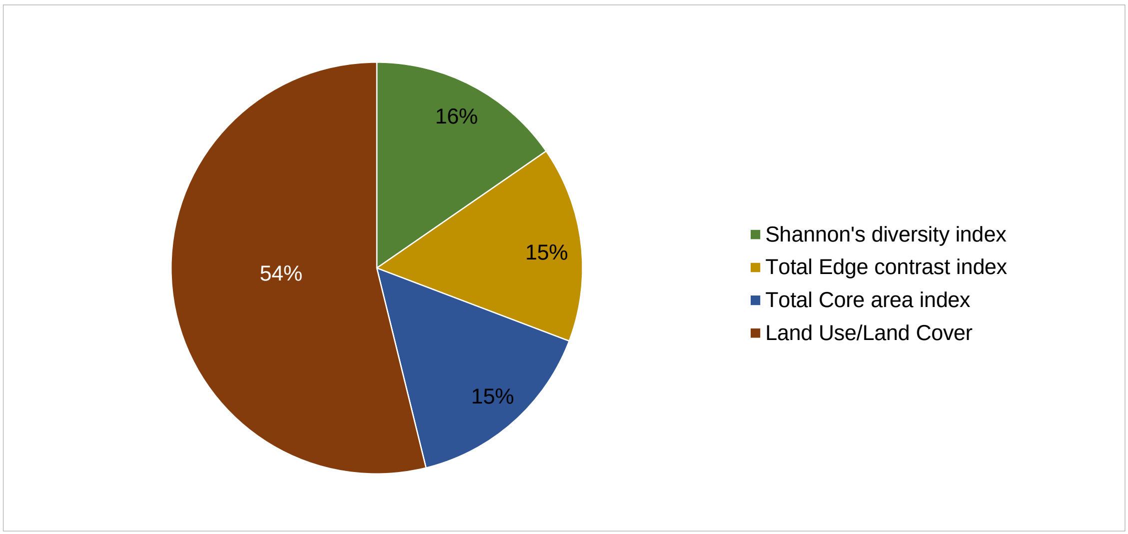

Figure 15 - Predominant spatial indicators in references focused on intensive agricultural practices (%).

The type of management of agricultural lands is a very important factor to consider when studying High Nature Value farmlands and extensive agricultural practices, as well as the Ecosystem Services associated with them. Figure 16 shows the predominance of these farming practices in the analysed references. We can see the predominance of extensive practices with more than a half (52%) of the references focusing on them.

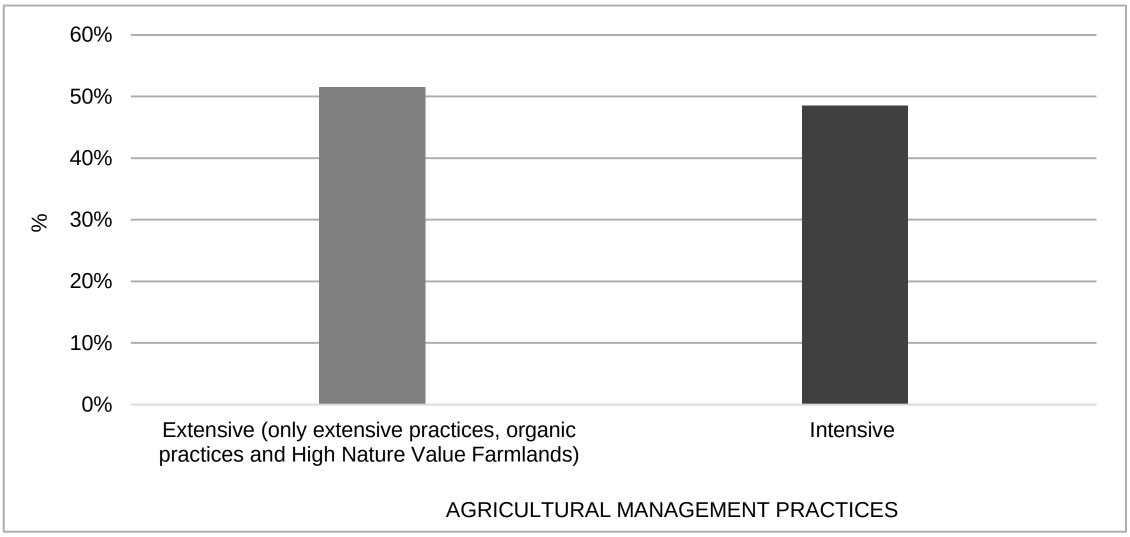

Figure 16 - Type of agricultural management practices mentioned in the references (%). This graph shows the predominance of extensive practices in the analysed references.

The following graphs (Figure 17) shows the percentage of articles that concern these farming practices, relating them with the existence of spatial component, i.e., the articles that refer low-input farming practices are more interesting to connect with the existence of spatial analysis in the case study. In this case, we see that “only extensive” (39%) agricultural practices, plus “organic farming” (13%) and “HNVf areas” (9%), together, dominate the articles with spatial component, which is very helpful to our future work in mapping ES and HNVf. The intensive practices are also very much present in the references with spatial component, having the same percentage of references as the only extensive practices (39%). Moreover, it is important to highlight the absence of High Nature Value Farmland in the references with no spatial explicit information and also the 9% of references that focuses on HNVf and have spatial explicit data.

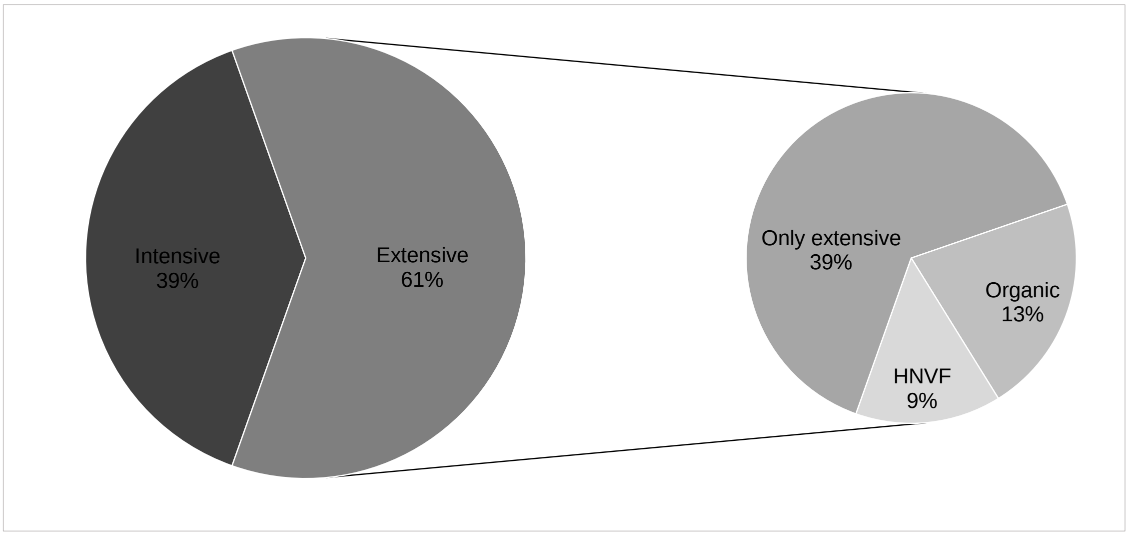

Figure 17 - Type of agricultural management: predominance in references with spatial component (%). On the references with spatial component “only extensive” practices and “intensive” have the same percentage, but organic and High Nature Value Farmland areas combined with “only extensive” practices have predominance over the intensive practices. However, the articles with no spatial component focus more on intensive practices than in only extensive practices, although extensive practices combined still have more importance.

3.4. Discussion and Conclusions

Due to the specificity of the information we needed, compiling information on extensive agriculture and ecosystem services led us to examine several articles from around the world. This allow us to determine the possible differences and matches between ecosystem management in agricultural areas in different regions of world, giving us a more specific information on what are the main objectives in each country and region. This also gave us information on the disparity/similarity of the constraints of managing ES in agricultural lands, especially the ones with a special focus on extensive farming systems and agricultural areas with high nature value of conservation.

It is important to evaluate which literature focus on the extensive practices and if it is more likely to have spatial explicit information, or if, on the other hand, it happens with articles referring to more intensive management practices.

The region analysis that we carried out, allowed us to understand which are the regions of the world that focus on this type of issues and which ones provide good examples of management and policy making. Europe was the predominant area of study we found, also due to its relation with more extensive management practices and especially with High Nature Farmland areas. However, our aim was to find references more focus on HNVf and most of the studies we found were focus on extensive practices and only a few only on HNVf. This happens because the relation of HNVf with Ecosystem Services is a question that only recently has been studied and so our analyses studies are very recent.

We assembled a series of spatial indicators that were used to map ecosystem and their services in the references we analysed, so that we could then understand the ones more related to extensive practices. Also, intensive practices are very much present in the references with spatial component, having the same percentage of references as “only extensive practices”, which could mean that the assessment of ES in agricultural areas is made at all levels of agricultural management. Moreover, it is important to highlight the absence of High Nature Value farmland in the articles with no spatial explicit information and also the presence of 3 articles that focuses on HNVf and have spatial explicit data.

The most predominant spatial indicators that we found in the references, focusing on the mapping of ecosystems were: Land use and Land cover, followed by Shannon’s diversity index, total edge contrast index and total core area index. The predominance of Land use happens in both farming management systems: extensive (that includes HNVf) and intensive farming.

Since the spatial component is a major subject in our study, as well as the importance of the data type associated to it, we analysed the data type that is mostly utilized to transpose spatial explicit information regarding ecosystem services in agricultural areas. In order to produce spatial information, we see that in the analysed references it is more often used quantitative data since they present better conditions to represent the indicators and variables, predominating in 63% of the references with spatial component. The qualitative data is present in about 38% of the references analysed. Some articles use both data types in their analysis and it is important to understand their utility in building the spatial explicit information on ES and agriculture.

The relation between ecosystem services and extensive agriculture that we were able to measure has Regulating services as main focus, and, of course, provisioning services. We realised that from all the references we studied, the ones more focus on extensive agricultural practices had focus on important services like pollination or fresh water. This shows the importance that services like pollination have in the actual European agriculture and conservation, being expected that pollinator conservation will overcome the «traditional opposition between economic imperatives and conservation» (Melathopoulos *et al.*, 2014).

Also, we made a relation between the type of farming management and the existence of spatial component, showing that the references that refer low-input farming practices are more interesting to connect with the existence of spatial analysis in the case study. It was important to evaluate which literature focused on the extensive practices and if it is more likely to have spatial explicit information, or if, on the other hand, it happened with articles referring to more intensive management practices.

High Nature Value farmlands and the provision of ES in the EU countryside

In this study, we carried out a meta-analysis with the intention of combine information on Ecosystem Services (ES) that are most frequently related to extensive managed agricultural areas, with a special focus on areas regarding High Nature Value farmlands. In order to achieve that, we carried out an analysis that included the 3 international classifications of Ecosystem Services (The Common International Classification of Ecosystem Services (CICES, 2012), The Economics of Ecosystems and Biodiversity (TEEB, 2010) and Millennium Ecosystem Assessment (MEA, 2005)) and 40 case-studies related to agriculture and its Ecosystem Services, that were our main focus here.

These case studies were chosen having in consideration the type of agricultural practices they mentioned, as well as the ES derived from them and its ability to provide useful information on their relation. Hence, they provided information on their case-studies, their geographical distribution and spatial-explicit analysis to allow us to reach the nature of these farmlands to provide important Ecosystem Services.

The mapping of ecosystem and their services is a very important part of this process, and its relations with areas of extensive agriculture, particularly HNVf areas is of remarkable importance.

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Chapter 4. Assessing the coincidence between High Nature Value farmlands and Ecosystem Services: the case-study of River Vez Watershed

Abstract

The relationship between ecosystems and agriculture is of great importance, gaining special attention over the last years. The importance of agricultural areas to the conservation of biodiversity is clear, being the degradation of agricultural areas one of the main responsible aspects for the declining of biodiversity in Europe and in the world.

The necessity of new measures at a political level as rise, and so societies have grown to be more conscious about the importance of guaranteeing a sustainable agriculture, in order to contribute to nature conservation and human well-being. So, High Nature Value farmland (HNVf) areas have become preponderant in the maintenance of high levels of biodiversity, being crucial to the provisioning of Ecosystem Services.

In order to analyse this relation, our study aims to analyse the spatial coincidence between Ecosystem Services and High Nature Value farmland areas in the River Vez watershed, departing from two previous studies. Here, we performed the analysis of the spatial information of the two variables, which showed us the areas of the watershed where the selected Ecosystem Services coincide with High Nature Value farmland areas. Seeing that this exercise was performed at the watershed level, hydrological services had a special focus. The analysis that was carried out involved some univariate statistics, in order to comprehend the relation between Ecosystem Services and High Nature Value farmland areas and Non-HNVf areas in the Vez watershed. The spatial coincidence was analysed and gave us information on the Ecosystem Services that are mostly present in areas with HNVf, being associated with the unique characteristics of this areas.

Keywords: Ecosystem Services; High Nature Value farmlands; spatial-explicit information; watershed.

4.1. Introduction

Mapping ecosystem services has been highlighted as an important task to a better decision-making, landscape planning and development of local policies (MAES, 2014). Whilst quantifying and mapping Ecosystem Services (ES) is still a challenging task, a preliminary EU approach has been presented in 2013. Overall, such ES map was built on Corine Land Cover data, and results from the joint analysis of the European habitat classification and information on biodiversity expected to be found in each type of targeted ecosystem (MAES, 2014).

Changes in agriculture related ecosystems have been pinpointed as one of the main causes for biodiversity loss, not only due to farming intensification, but also because of the abandonment of marginal and extensively managed farmlands (Carvalho Santos *et al.*, 2010). In fact, agricultural areas support numerous ecosystem services (not only provisioning services but also cultural services, for instance) that are being loss due to land use change (Gulickx *et al.*, 2012).

Agriculture covers about 40% of the land cover in the world. In recent years, farming activities have been associated with worldwide biodiversity loss (EC, 2014). However, low intensity agriculture has been recognized as supporting hgh levels of biodiversity, and thus has been referred as essential to maintain and enhance species and habitats in the EU countryside(EC, 2014; Lomba *et al.*, 2015). The important role of agriculture to nature conservation has been acknowledged with the definition of the High Nature Value farmlands (HNVf) concept, which highlighted the importance of these areas to the maintenance and enhancement of biodiversity (EC, 2014; Lomba *et al.*, 2015).

The concept of High Nature Value farmlands can be related to the conceptual framework underlying Ecosystem Services, not only because farmlands provide food, water or may contribute to soil quality, but also because they support high levels of biodiversity (Carvalho Santos *et al.*, 2010). Mapping and modelling trade-offs and relations between ES and land use has, therefore, gained higher importance (Carvalho Santos, 2014). Assessing the spatial distribution of HNVf is often difficult to determine, since available data is usually characterized by low thematic and spatial low resolution and there are no common guidelines to do such assessment, thus creating impediments on an «EU-wide perspective on the extent and condition of HNVf» (EC, 2014).

The EU Biodiversity Strategy defends the integration of biodiversity issues into the Common Agricultural Policy, particularly in what concerns the Pillar II, which highlights «restoring, preserving and enhancing biodiversity, including Natura 2000 areas, (...) High

Nature Value farmland, and the state of European landscapes; (...)» as one of the most urgent goals (MAES, 2014).

Here, our aim was to assess the putative spatially-explicit coincidence between High Nature Value farmlands and Ecosystem Services and in the River Vez watershed, in the Northwest of Portugal. The assessment of Ecosystem Services was made by Carvalho Santos (2014), which focused on the spatial distribution of the provision of several ecosystem services at the level of River Vez watershed. Carvalho Santos (2014) performed the mapping of such services through a SWAT modelling tool, evaluating their interchanges with biodiversity conservation. The spatially-explicit expression of ES previously determined by Carvalho Santos (2014) was then analysed against a map of High Nature Value farmlands, built on the framework described by Lomba *et al.* (2015) in the context of IND_CHANGE project. Overall, the analysis of the spatial coincidence between HNVf and ES aimed to determine whether this farmlands have the potential to be providers of other ecosystem services that may contribute to their future social-ecological sustainability.

5.1. Methods

5.1.1. Framework of the study

Our study was based on the work of Carvalho Santos (2014), in which it is made a spatially-explicit approach of the hydrological Ecosystem Services present in the Vez watershed through SWAT modelling tool (Soil and Water Assessment Tool) Also, through spatial information on High Nature Value farmlands, we were able to perform a spatial coincidence analysis of their distribution in the study area understanding its relation with the distribution of ecosystem services in the watershed. The underlying methodological framework is presented in Figure 18.

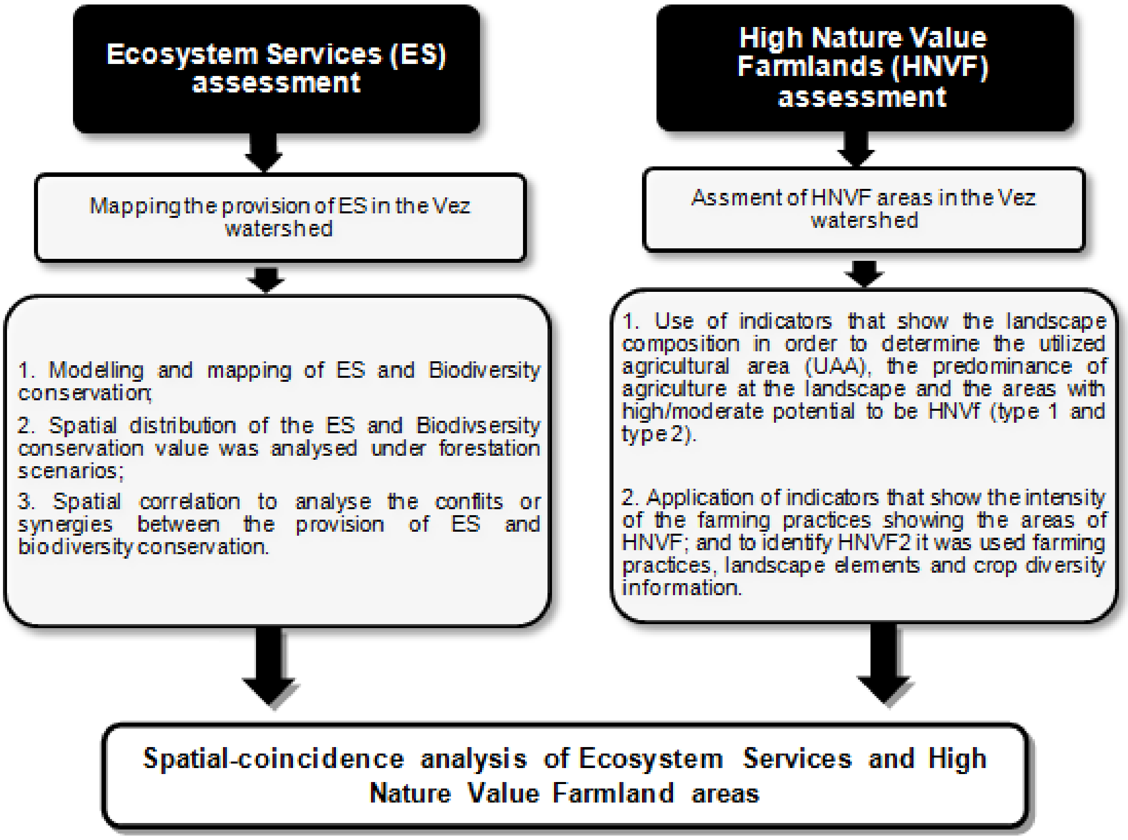

Figure 18 - Overview of the approach followed to analyse the potential spatially-explicit coincidence between High Nature Value farmlands and Ecosystem Services provision In the Rio Vez watershed.

5.1.2. Study area

This study area of this research was the river Vez watershed located in NUT III Minho-Lima, in the Northwest of Portugal (cf. Figure 19). The river Vez watershed has 252 km^2 and runs down through the Soajo and Peneda mountains (Figure 19). The river Vez is a tributary from the river Lima, which is a major river from the northwest Iberian Peninsula (Carvalho Santos, 2014), and its watershed is characterized by marked slopes.

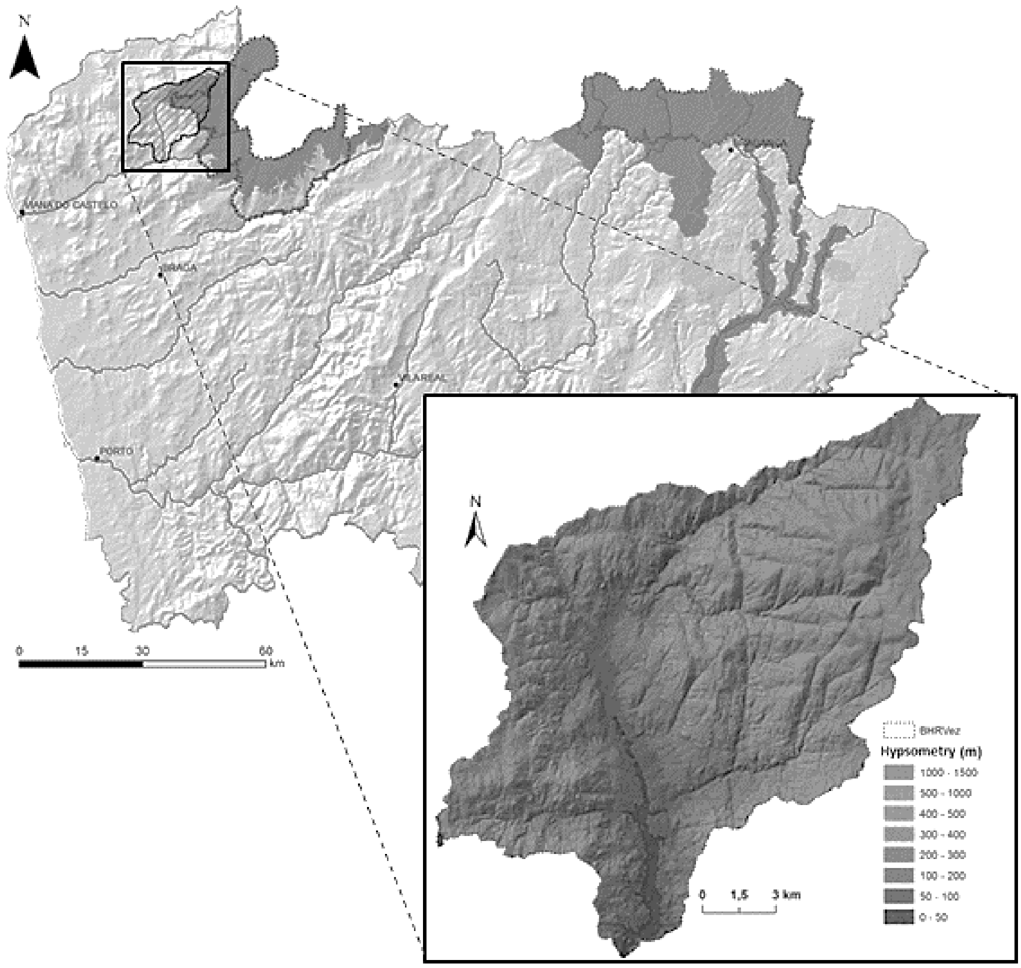

Figure 19 - Location of the study-area in the North Region of Portugal, and hypsometry of the Vez watershed.

The annual average temperature of the watershed is about 10ºC and the annual average precipitations ranges between 2000 mm to 2400 mm, with the exception of the areas in the Peneda mountain, where sometimes precipitation values higher than 2400 mm are registered (mostly in the autumn and winter months) (Vieira, 2011; Carvalho Santos, 2014). As for the topography, the study-area is characterised by elevations ranging from 30m to 1400m. Overall, granites and schist constitute the dominant geologies. The action of the atmospheric agents over the granitic rocks of this area is the origin of the embedded valleys headed to several directions with a rectilinear layout, making the river paths being conditioned by the main fractures that affect the granite massif (Carvalho Santos, 2014). The rivers are one of the main responsible for the configuration of the field, since they are the ones that build the inner valleys of this municipality (Vieira, 2011). The types of soils that predominate in the watershed area are: humic regosols (67%) and leptosols (9%) occurring mainly in highlands, and dystric antrosols (22%), fluvisols (1%) and urban (0.56%) in the lowland areas. As for land cover and land use, the Vez watershed has open areas of bare rock and moorlands occupying the top of the mountains. In the highlands shrublands can be observed with dispersed areas of woodland, and the agricultural areas alternate with forest cover, the last mainly dominate by the European oak (*Quercus robur* L.), the Maritime pine (*Pinus pinaster* Aiton), and Eucalypts (*Eucalyptus globulus* Labill) (Figure 20).

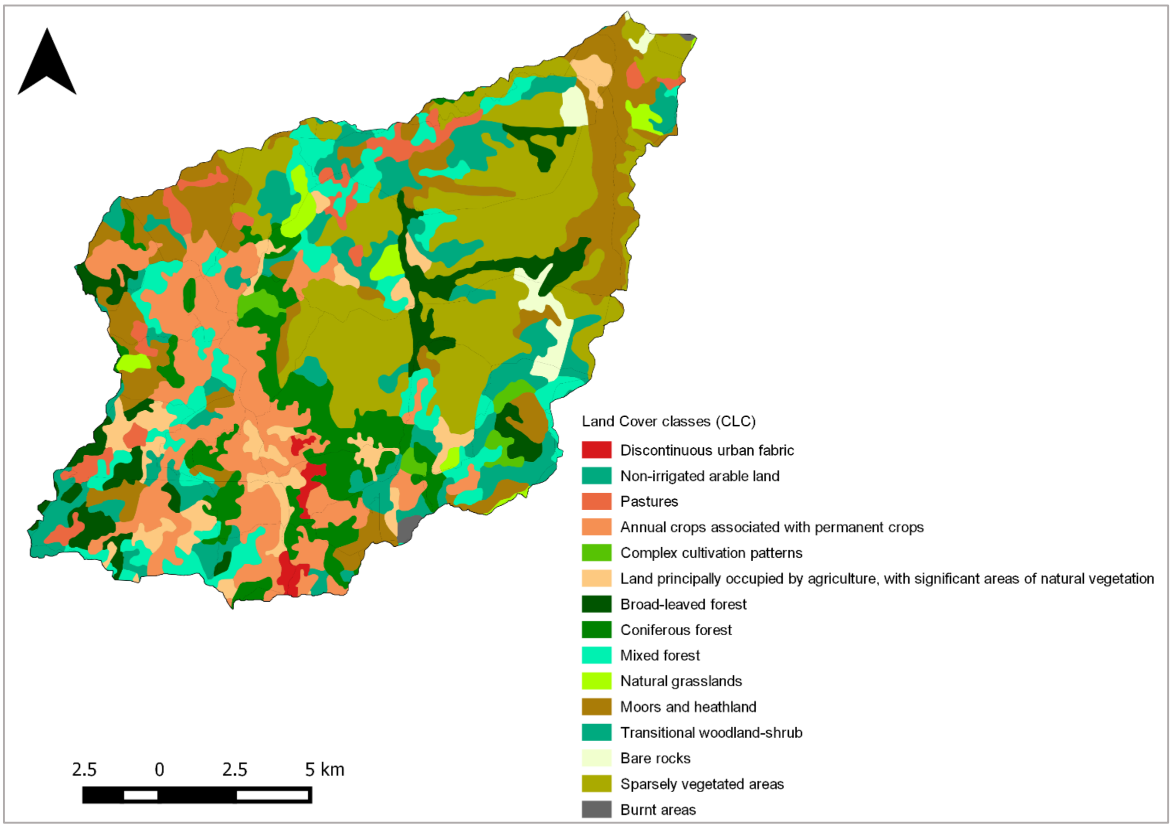

Figure 20 - Land cover map (Corine Land Cover 2000) showing location and main land cover classes represented in the River Vez watershed.

About one third of the watershed, including part of the mountains and the river Vez itself, are classified as Site of Community Importance (SCI) within EU Natura 2000 network (http://natura2000.eea.europa.eu/), the SCI Peneda-Gerês (PTCON0001) and SPA Serra do Gerês (PTZPE0002), because of its habitat diversity and the species they harbour (Vieira, 2011). Together with the Peneda-Gerês National Park, located in the upper part of the watershed, these areas are very relevant since several species and habitats under conservation protection (Figure 21), such as the Iberian wolf (*Canis lupus signatus* L.), roe deer (*Capreolus capreolus* L.) and several birds of prey, depend on them (Carvalho Santos, 2014).

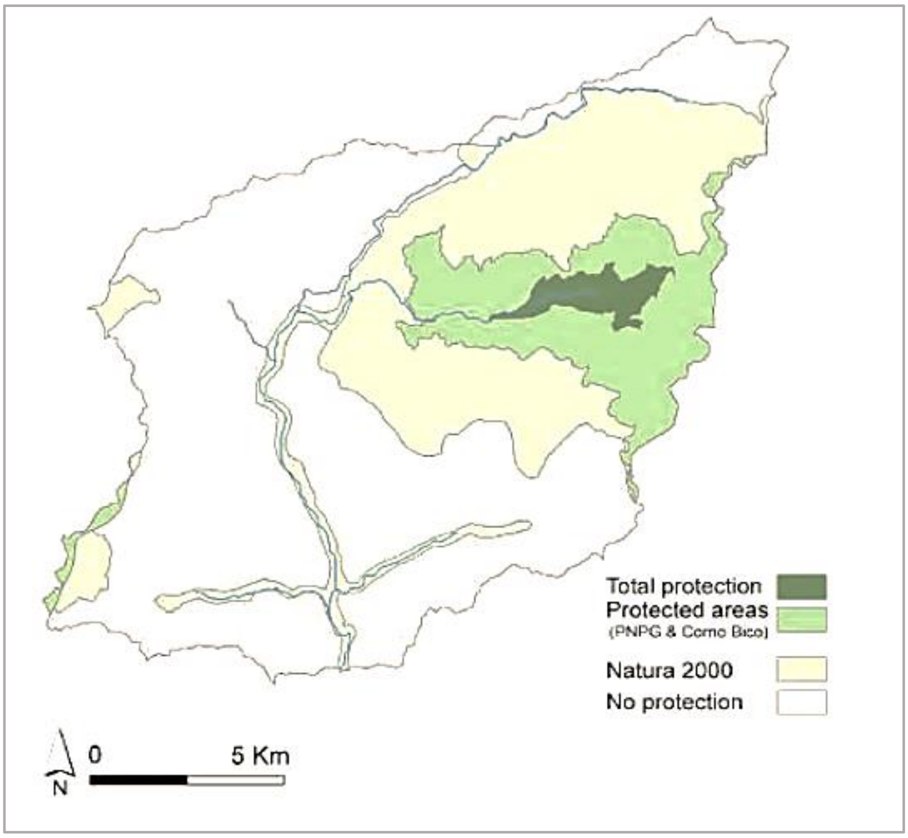

Figure 21 - Areas of the watershed with a special conservation concern. Here we can see that the Peneda-Gerês National Park has a specific regulation and special guidelines for conservation, and also that mountainous areas and the river Vez itself are part of the EU Natura 2000 network, which makes them areas with a very important and specific protection concerning biodiversity conservation (Carvalho Santos, 2014).

5.1.3. Assessment of Ecosystem Services and High Nature Value farmlands in the river Vez watershed

Here, spatial information of Ecosystem Services was available from the research of Carvalho Santos (2014), in which three types of Ecosystem Services were assessed: 1) hydrological services; 2) biomass production; and, 3) carbon storage (climate regulation).

Carvalho Santos (2014), built on Carvalho Santos *et al.* (2010), focused on the provision of water supply and water damage mitigation has ecosystem services to be modelled and mapped in the context of the Vez watershed. Overall, hydrological services seem to predominate in the watershed, and have been referred as Ecosystem Services Potentials (ESP). These are ES that contribute to the provision of other goods and services, generating a monetary return. In the Vez watershed, hydrological services are considered providers of several Ecosystem Services Potentials, but are, however affected by the «use-value» that is attributed to such potentials, which in turn can change rapidly, creating, a different service potentials than the one given at a specific time (Spangenberg *et al.*, 2014).

Carvalho Santos (2014) considered several spatial explicit units in the Vez watershed. The watershed was first divided into sub-basins (Figure 22) and then such sub-basins divided into Hydrologic Response Units (HRUs). HRUs refer to areas with the same characteristics in what concerns land cover, the type of soil and slope classes, regardless of the fact that they don't have the same dimension. Such units were defined using the SWAT modelling tool (Soil and Water Assessment Tool). SWAT is not a fully distributed model, and thus HRUs can be found in different, even non adjacent (Carvalho Santos, 2014).

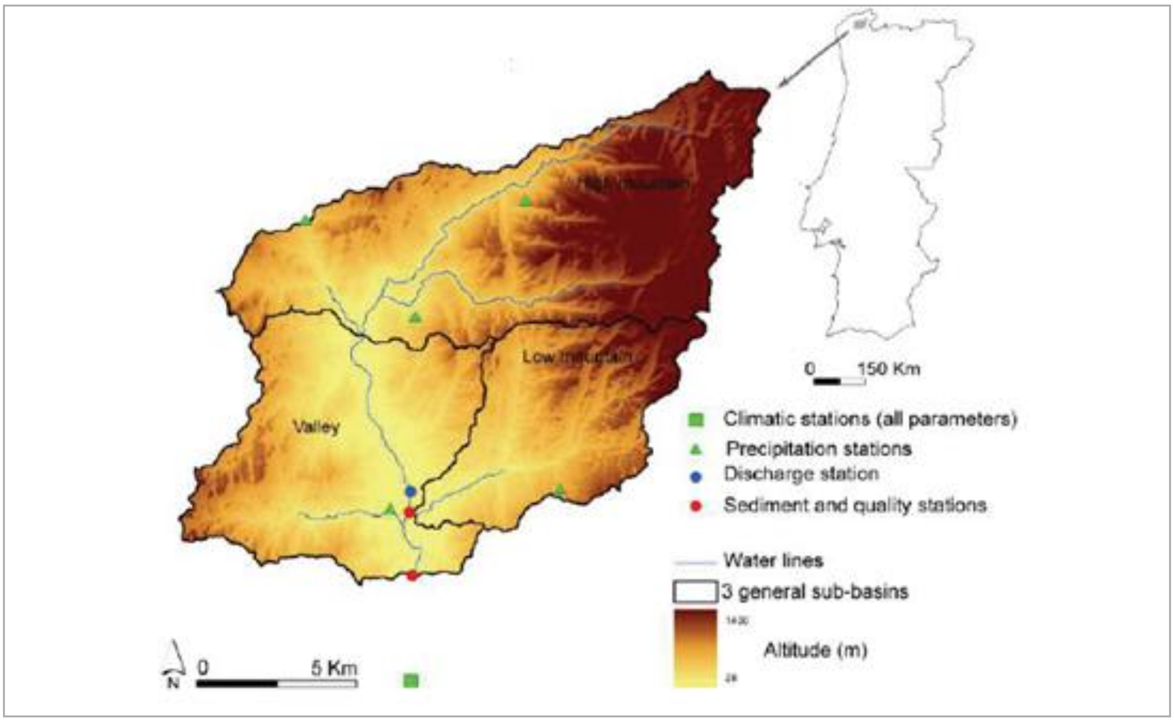

Figure 22 - Spatial representation of the three main sub-basins of the watershed, data stations used in the SWAT model and range of altitude (Carvalho Santos, 2014).

As a result from model and parameterization setup of the SWAT tool, the watershed was divided into 10 sub-basins, making a total of 500 HRUs. The final outputs of ESP were than analysed at the HRU and sub-basin level, for each of the ecosystem services targeted. Table 5 shows the SWAT outputs, respective units and rationale underlying indicators used for ecosystem services provision in the Vez watershed.

Table 5 - Ecosystem Services, SWAT outputs and respective units, indicators and underlying rationale for ecosystem services provision used in the Vez watershed .(as described by (Carvalho Santos, 2014).

Ecosystem Service	SWAT outputs (HRU)	Indicators for service provision (rationale)
Water supply		
Quantity	WYLD - Water yield (mm)	Contribution of each HRU in delivering water for the stream.
Timing	SW_END - Soil water content (mm)	Amount of water in the soil profile, indicating soil storing capacity and water available for use.
Quality	Total nitrates (N kg/ha. yr) (sum of: ORGP; NSURQ; NLATQ; NO3GW)	The lower the exports, the higher contribution to the water quality (1/total nitrates).
Water damage mitigation		
Soil erosion control	SYLD - Sediment exports (t/ha. yr)	The higher the exports, the lower contribution to the soil erosion control service (1/ SYLD).
Flood regulation	SURQ_GEN - Surface runoff (mm)	Flash floods are mainly generated by the surface runoff. The lower the surface runoff, the higher the contribution (1/ SURQ_GEN).
Biomass production	BIOM - Total biomass (t/ha.yr)	Aboveground and roots biomass reported as dry weight.
Carbon storage (climate regulation)	Fraction of total biomass (tC/ha.yr)	Carbon stored in vegetation as a fraction of 50% of dry matter.

Data on the spatially-explicit extent of High Nature Value farmlands was available from IND_CHANGE project. Overall, HNV farmlands assessment was built on the framework recently described by Lomba *et al.* (2015), which highlights three sets of indicators essential to target farmlands with high nature value: 1) landscape elements; 2) extensive practices; and, 3) crop diversity, to inform on the landscape structure and composition, the extensive character of farming systems, and diversity of crops, respectively. Several spatially-explicit indicators in each of the sets are then analysed according to a multi-criteria approach, resulting in a map of farmlands which underlying farming systems and resulting landscape patterns are more likely to exhibit high nature value.

5.1.4. Spatial and statistical analysis

As the overarching goal of this study was to assess a putative spatially-explicit coincidence between Ecosystem Services and High Nature Value farmlands, the storage and management of spatial information was essential. As so, the software QuantumGis® was used through all analysis and outputs elaboration.

First, an intersection between the spatial data concerning Ecosystem Services[2] and High Nature Value farmlands[3] areas was made. This allowed us to join the information needed to approach our goal. After this, areas were recalculated and the sum of the area (in hectares, Ha) of HNVf in each HRU was obtained (through the “Basic Statistics” tool).

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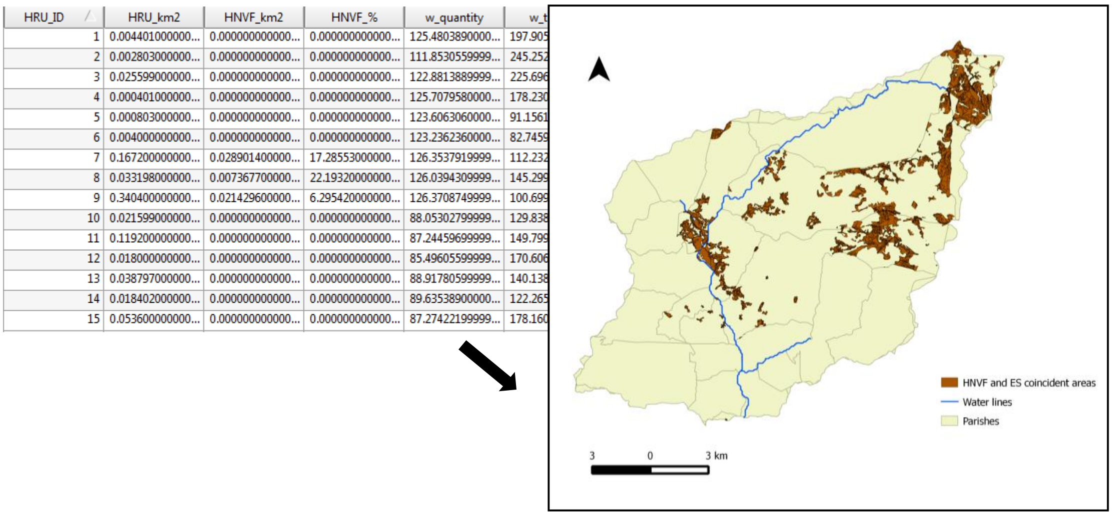
[2] Spatially-explicit information for targeted Ecosystem Services in the Vez watershed were those described as actual land use scenario (Carvalho Santos (2014)), and thus considering the actual land use and land cover of the River Vez watershed.

[3] The spatial information on High Nature Value farmlands was provided by the IND_CHANGE project.

After, the area covered by HNVf per each HRU was calculated into Km^2 and then, to calculate its representation in each HRUs in percentage, an equation[4] was applied using the functionality "Field Calculator", that was repeated to the 193 HRUs with HNVf presence. With this, we were able to calculate the total area of HNVf within each HRU and ascertain the corresponding percentage (%).

As an outcome, we achieved the spatial-explicit representation of the High Nature Value farmlands and Ecosystem Services Potentials for each HRU, expressed as a table containing all requested information (Figure 23).



HRU_ID	HRU_km2	HNVF_km2	HNVF_%	w_quantity	w_t
1	0.004401000000...	0.000000000000...	0.000000000000...	125.4803890000...	197.905
2	0.002803000000...	0.000000000000...	0.000000000000...	111.8530559999...	245.252
3	0.025599000000...	0.000000000000...	0.000000000000...	122.8813889999...	225.696
4	0.000401000000...	0.000000000000...	0.000000000000...	125.7079580000...	178.230
5	0.000803000000...	0.000000000000...	0.000000000000...	123.6063060000...	91.1561
6	0.004000000000...	0.000000000000...	0.000000000000...	123.2362360000...	82.7459
7	0.167200000000...	0.028901400000...	17.28553000000...	126.3537919999...	112.232
8	0.033198000000...	0.007367700000...	22.19320000000...	126.0394309999...	145.299
9	0.340400000000...	0.021429600000...	6.295420000000...	126.3708749999...	100.699
10	0.021599000000...	0.000000000000...	0.000000000000...	88.05302799999...	129.838
11	0.119200000000...	0.000000000000...	0.000000000000...	87.24459699999...	149.799
12	0.018000000000...	0.000000000000...	0.000000000000...	85.49605599999...	170.606
13	0.038797000000...	0.000000000000...	0.000000000000...	88.91780599999...	140.138
14	0.018402000000...	0.000000000000...	0.000000000000...	89.63538900000...	122.265
15	0.053600000000...	0.000000000000...	0.000000000000...	87.27422199999...	178.160

Figure 23 - Outputs achieved for assessing the spatial coincidence between Ecosystem Services and High Nature Value farmlands.

Overall, the analysis performed at the HRUs level included areas highlighted as High Nature Value farmlands and non-HNVf areas. As so, the variation of each Ecosystem Service Potential across HRUs was analyzed (and represented through boxplots), and related to the presence of High Nature Value farmlands.

Detailed information on the performed analysis, for each one of the 500 HRUs, is presented in Appendix 3. Data analysis included three steps: 1) quantitative analysis of Ecosystem Services Potentials; 2) Spatial coincidence between High Nature Value farmlands and ESP in each HRU; and, 3) variation of ESP in High Nature Value farmlands. In the first step, for each of the 500 HRUs, the predominant Ecosystem Services Potentials were identified, and analyzed for their variation.

As a result, from the 500 HRUs analyzed, we selected those exhibiting the highest (see Appendix 4; Table 1 for detailed information) and the lowest values (Appendix 4; Table

[4] The used equation was: [(HNVf área in Km$^{2)}$*100)/Area of each HRU].

2) of Ecosystem Services Potentials, reflected as each one of the indicators previously referred. In step 2, from the HRUs with the highest and lowest values of Ecosystem Services Potentials, those coincident with High Nature Value farmlands were identified and represented as Table 6 and Table 7.

Table 6 - HRUs with percentage of HNVf areas (in HRUs with the highest values of Ecosystem Services in the watershed).

Highest Values			
HRU ID	HRU area (Km^2)	HNVf areas per HRU (Km^2)	HNVf area (%)
7	0,1672	0,0289	17,29
8	0,0332	0,0074	22,19
9	0,3404	0,0214	6,30
62	0,1916	0,0181	9,44
175	0,0224	0,0011	4,91
188	0,1592	0,0043	2,68
190	0,0168	0,0004	2,12
191	0,0032	0,0004	12,50
192	0,0060	0,0052	87,48
196	0,2828	0,0244	8,64
255	1,1300	0,0128	1,13
310	1,1844	0,0172	1,45

Table 7 - HRUs with percentage of HNVf areas (in HRUs with the lowest values of Ecosystem Services in the watershed).

Lowest Values			
HRU ID	HRU área (Km^2)	HNVf areas per HRU (Km^2)	HNVf area (%)
109	0,0272	0,0043	15,73
117	0,2932	0,1459	49,79
121	0,2220	0,2082	93,77
203	3,7160	0,5044	13,57
204	2,0680	0,2391	11,56

Table 6 shows the HRUs that have the highest values and Table 7 the ones with the lowest values of Ecosystem Services Potentials that contain some percentage of HNVf areas within them. The assessment of HNVf potential to provide multiple Ecosystem Services was also done through the analysis of this table. Finally, in order to understand the prevalence of Ecosystem Services in the Vez watershed, the number of each output for the ES per HRU was summed. With this, we were able to obtain information on the ES that were present in each HRU, allowing us to comprehend if the different HRUs are providers of one or more services. On Appendix 5 is presented the information regarding the presence or the absence of Ecosystem Services for each of the 500 HRUs.

Step 3, consisted in the analysis of patterns of ES distribution. Therefore, we analyzed the HRUs spatial relation, so as to comprehend their relation with Ecosystem Services. The highest values registered in the outputs of the Ecosystem Services are represented on the table of Appendix 6 and they give us information on the pattern of the provision of Ecosystem Services in the Vez watershed. On this table we have the highest values of Ecosystem Services for each HRU (five highest) where we can see the relation between the values and the location of the HRUs, showing the existence of a pattern of the values for each Ecosystem Service in HRUs with closer IDs, and also their differences.

The spatial relation between the values of Ecosystem Services and the location of the Hydrological Response Units (HRUs) was established, gathering areas of all the 500 HRUs, as it can be seen on Figure 24. This figure shows the expression of HRU size (area, expressed as km^2) across the Vez watershed.

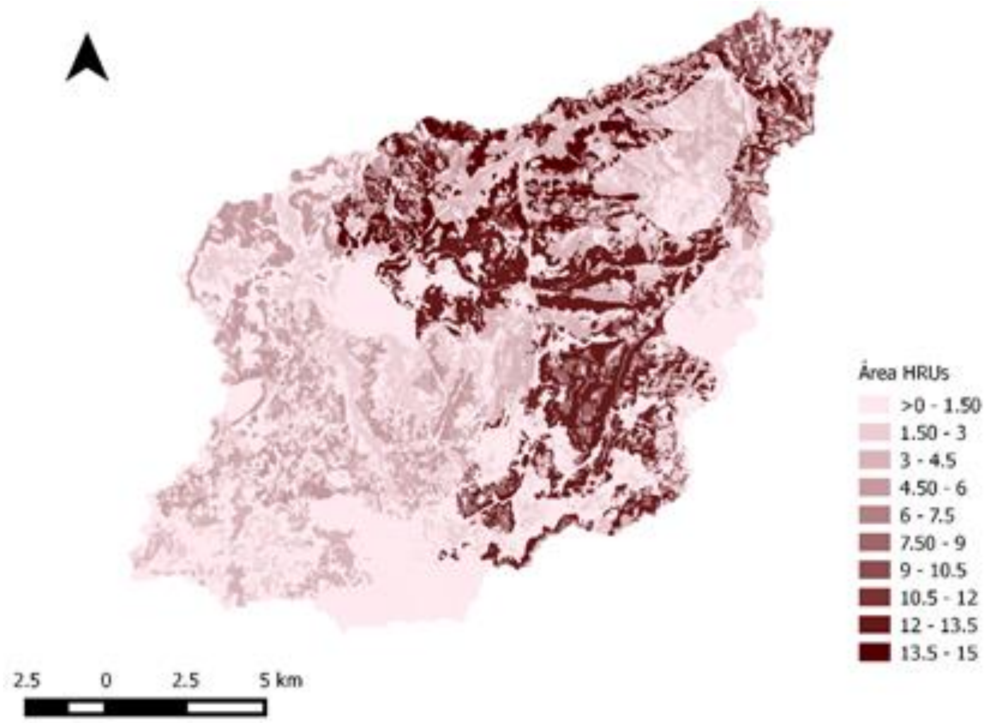


Figure 24 - Spatial representation of the three main sub-basins of the watershed, data stations used in the SWAT model and range of altitude (Carvalho Santos, 2014)

To perform the spatial analysis we studied the spatial distribution of each Ecosystem Service through the watershed and build several boxplots, in order to analyse the pattern of their distribution, concerning all type of Land Covers of the watershed., Here, a spatial analysis of the ES distribution through the watershed was made, in order to see the correspondence between High Nature Value farmland areas and the provision of this service. Non-HNVf areas combine all the other land covers that do not include High Nature Value farmlands.

5.2. Results and Discussion

5.2.1. Patterns of Ecosystem Services distribution

Overall, the provision of Ecosystem Services in the Vez watershed appears to follow a pattern of distribution, even though some important and visible differences in their provision.

5.2.1.1. Water Supply

The service Water Supply was analysed concerning three services used in its quantification by Carvalho Santos (2014): water quantity, water timing and water quality. Figure 25 shows this relation.

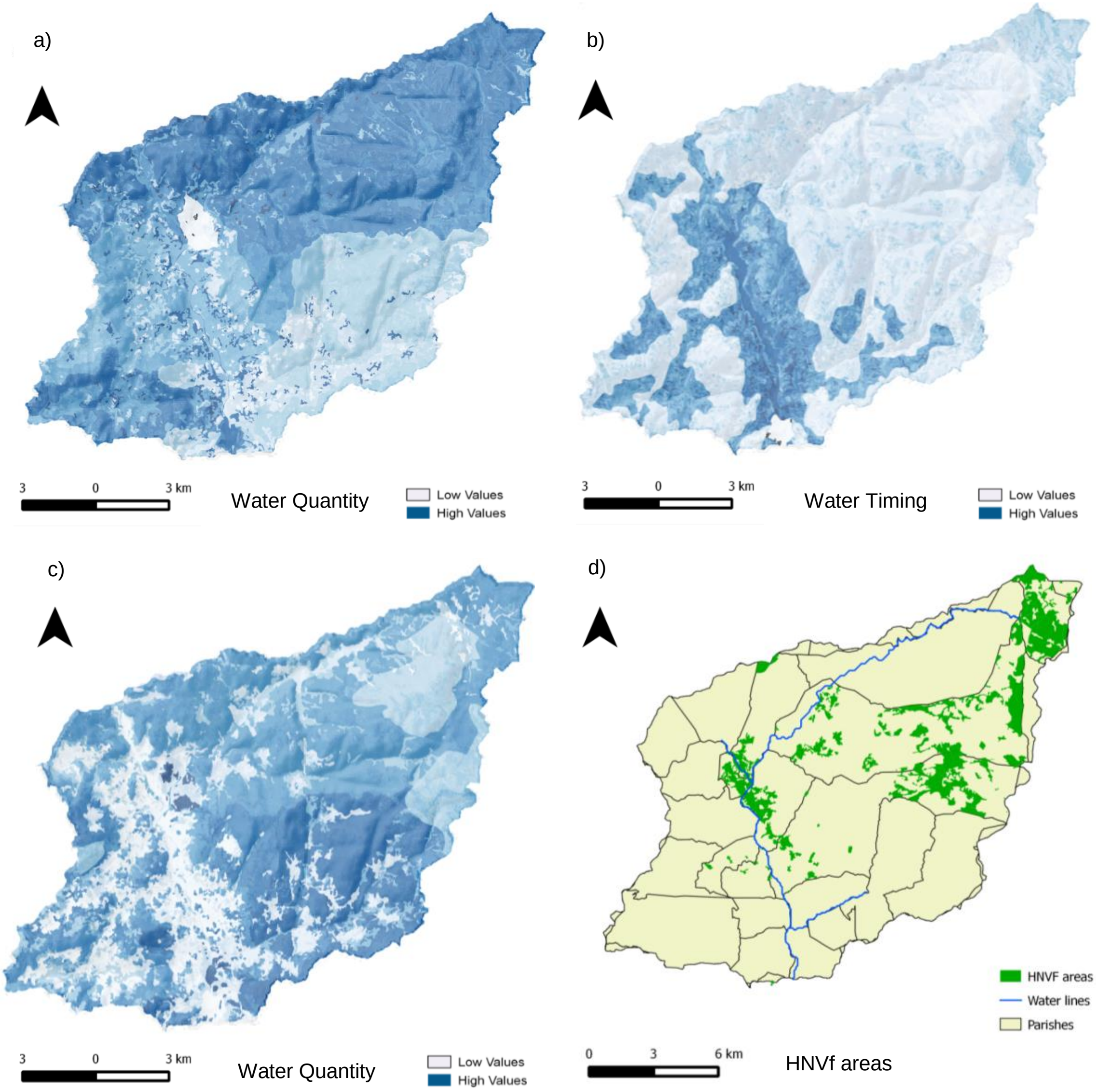


Figure 25 - Spatial distribution of the provision of the service Water Supply in the Vez watershed: a) Water Quantity; b) Water Timing; and c) Water Quality. The map with the areas of HNVf in the Vez watershed (d) allows us to see the spatial coincidence between them and this service, showing their presence or absent in this areas.

For water quantity the HRUs with the highest values (IDs: 4, 7, 8, 9 and 62) are located in the same area (see Figure 25), near the water line that is the River Vez. Besides the fact that the HRU IDs are near, the HRU 62 differs from the others, regardless of the fact that it has similar values for this ES and the location is near the ones mentioned above. The HRUs are located mostly in the North are of the watershed, where there is an higher altitude and therefore the levels of humidity and precipitation are higher, contributing significantly to the pattern in this service.

In what concerns water timing, the HRUs with the highest values (196, 246, 348 and 439 - number 348 presents the highest value) correspond to areas where the slope is bigger. Through Figure 25 we can see that the higher values are located in more declivous areas that concern the valleys of the water courses, with special focus on the River Vez, and where the water runoff is also bigger. On its turn, the lower values are located in areas with higher altitude.

The HRUs with the higher values for water quality are very proximally located (188, 189, 190, 191 and 192). These HRUs are located in valley areas, particularly the ones with bigger slope, indicating the presence of the River Vez and other water lines. However, they do not constitute a major polygon since that can be found disperse in the watershed, covering urbanized areas and, therefore, areas with a more intense human presence.

The heterogeneity and variability of the HRUs showed that the analysis of the differences in the provision of ecosystem services was important, especially between HNVf areas and Non-HNVf areas.

The graphs represented on Figure 26, Figure 27 and Figure 28 give us information on the predominance of this service, focusing particularly on the three services used to describe it. In all the boxplot we can see the differences that exist between HRUs that concern non-HNVf areas and the ones with a percentage of HNVf areas. The graphs show the values of the HRUs with Non-HNVf (307 HRUs) and with HNVf areas (193 HRUs). The areas concerning non-HNVf not only represent agricultural landscapes without HNV but also forest landscapes and mostly sparsely vegetated areas and woodland shrubs that are the main land cover (Figure 20) (Carvalho Santos, 2014). Also, the class “land mainly occupied agriculture with significant areas of natural vegetation” predominates in the landscape, particularly in the areas near the water lines, in this case near the River Vez.

In what concerns Water Quantity (Figure 26), we can see that in the boxplot concerning Non-HNVf areas we have 25% of the values lower or equal to 67.05, correspondent to the 1st quartile, and other 25% that refer to the 3rd quartile, with values that are bigger or equal to 87.31. On its turn, 50% of the values are between 67.05 and 87.31. With this, we can see that the majority of the values are located between 67.05 and 76.6 (median). The areas on the North of the watershed are the ones with higher values of this service, not only the ones with HNVf but also the ones with Non-HNVf. The boxplot on the right concerns the values for the HRUs that contain HNVf areas. Here we can see that 25% of the values are inferior or equal to 70.82 (1st quartile), and also 25% of the values are bigger or equal to 91.13 (3rd quartile). 50% of the observed values are within a range of 70.82 to 91.13. The majority of the values of this sample range between 82.5 (median) and 91.13. With this, we can see that there is a predominance of higher values of water quantity in the areas with HNVf (values between 82.5 and 91.13) than in areas of Non-HNVf (with values between 67.05 and 76.6).

Through Figure 25 we see that the “Valley” sub-basin presented by Carvalho Santos (2014) (see Fig 23) besides its lower contribution to the provision of ecosystem services, as an important role in the provision of the water quantity service. Once again, the areas considered to be Non-HNVf have a high contribution to the provision of high values of water quantity.

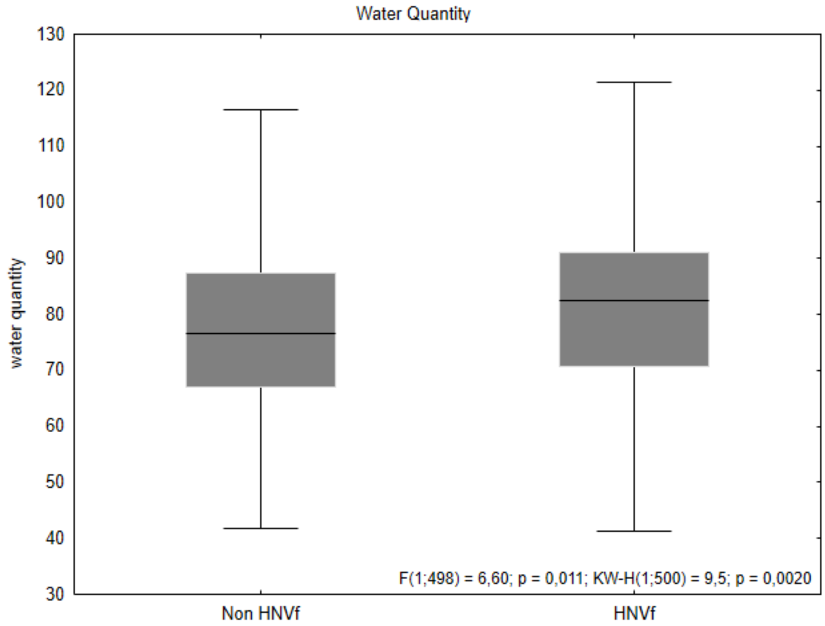


Figure 26 - Relation between Water Quantity and HNVf areas. The first vertical axis expresses the values for Water Quantity (mm) present in areas with Non-HNVf and the one on the right expresses the values for HNVf areas. The boxes represent the values of the 1st and 3rd quartile and the ones between them. The whiskers represent the minimum and maximum of the values.

On the graph of Figure 27, it is shown that 25% of the values for the Water Timing service on HRUs with Non-HNVf areas are lower or equal to 73.77 (1st quartile). Also, other 25% are higher or equal to 155.7 (3rd quartile). Half of the values of the HRUs with no HNVf have values between 73.77 and 155.7. Most importantly, we can see that the majority of the values of the HRUs for this service are located between 118.6 (median) and 155.7. On its turn, on HRUs with HNVf areas, this services has 25% of its values lower or equal to 71.04 (1st quartile). Also, another 25% concerning the 3rd quartile have values higher or equal to 131.6. 50% of the values of these HRUs are comprehended between 71.04 and 131.6. Most of the values in this areas are between 71.04 and 96.55 (median). This analysis shows that Non-HNVf areas have a greater contribute to the service Water Timing. Areas considered to be Non-HNVf actually present some higher values of this services since their land cover is more suitable to retain more water in the soil (Figure 20). The HRUs that are located near the water lines, have higher values for Water

Timing, particularly in the summery period, on particular near the River Vez (Figure 25). This means that there is an increase of water to aquifers and surface waters.

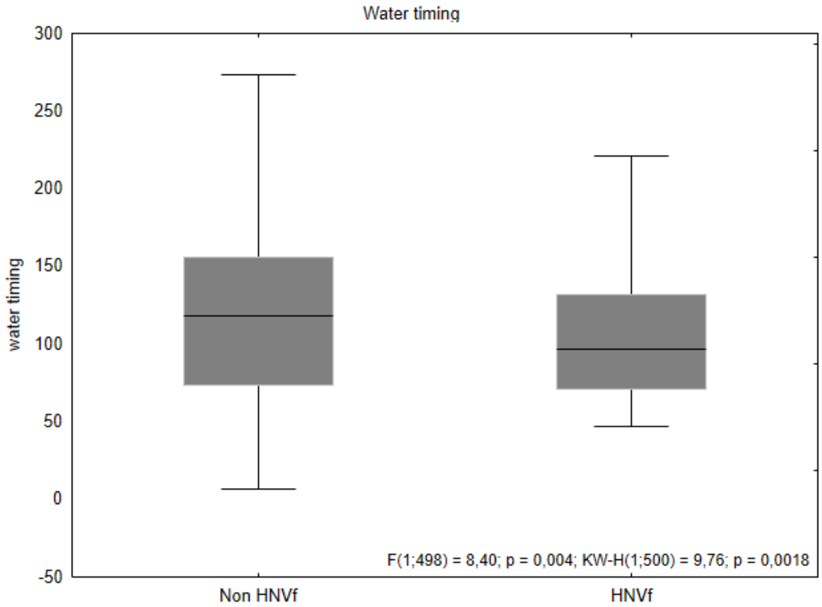


Figure 27 - Relation between Water Timing and HNVf areas. The first vertical axis expresses the values for Water Timing (mm) present in areas with Non-HNVf and the one on the right expresses the values for HNVf areas. The boxes represent the values of the 1st and 3rd quartile and the ones between them. The whiskers represent the minimum and maximum of the values.

Concerning the Water Quality service represented on Figure 28, we can see that 25% of the values of the HRUs concerning Non-HNVf areas are lower or equal to 0.33, corresponding to the 1st quartile. The 3rd quartile has 25% of the values, being higher or equal to 3.97. 50% of the values are between the values 0.33 and 3.97. The greatest part of the values are concentrated between the values 2.6 (median) and 3.97. This shows that although these areas are not of HNV they actually contribute to the maintenance of water quality. The data concerning HNVf areas, has 25% of the values of the 1st quartile as lower or equal to 0.31. Also, the values of the 3rd quartile, 25%, are considered to be higher or equal to 3.38. 50% of the values are located between 0.31 and 3.38. The majority of the values of this services for HNVf are located between the values 2.07 (median) and 3.38. The differences between this two areas are not very significant, having both areas an almost equal importance to the maintenance of water quality. However, there is a higher contribution of HNVf areas to the maintenance of water quality, since they present lower values of exports. The relation between ES and agriculture is of particular concern, in particular the relation between both and water in all its dimensions (Qiu and Turner, 2013).

The areas that concern the sub-basin "Low-Mountain" defined by Carvalho Santos (2014) are characterized by having high values for water quality in the watershed, as it can be seen through Figure 25, since this areas are predominantly occupied by oak and pine forest (Figure 20).

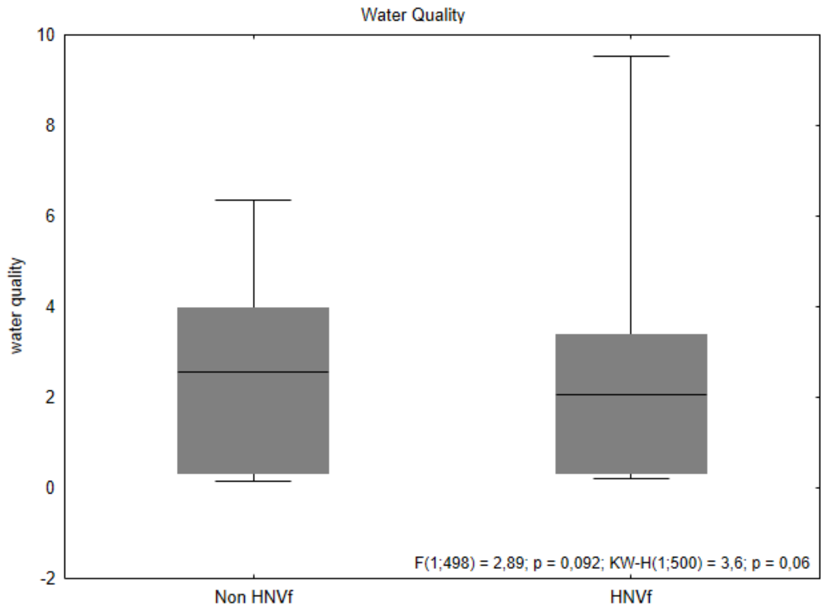


Figure 28 - Relation between Water Quality and HNVf areas. The first vertical axis expresses the values for Water Quality (Nkg/ha.yr) present in areas with Non-HNVf and the one on the right expresses the values for HNVf areas. The boxes represent the values of the 1st and 3rd quartile and the ones between them. The whiskers represent the minimum and maximum of the values.

5.2.1.2. Water Damage Mitigation

The Water Damage Mitigation was evaluated concerning the soil erosion control and the flood regulation. For these two outputs the values varied considerably through the watershed (Figure 29).

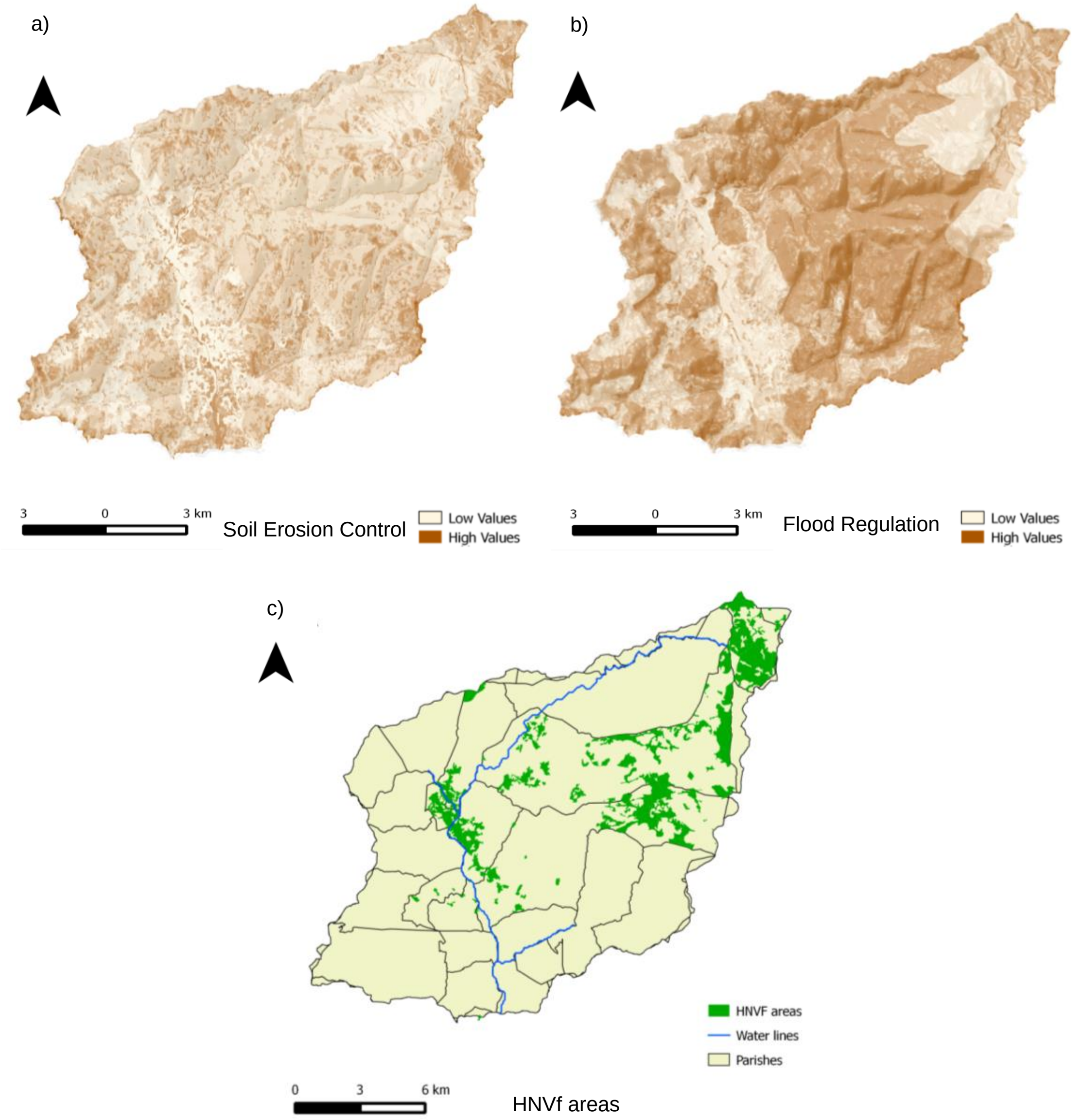


Figure 29 - Spatial distribution of the provision of the service Water damage mitigation in the Vez watershed. The map with the areas of HNVf allows us to compare the spatial coincidence between them and this service, showing their presence or absent in this areas, as well as their predominance. a) Soil Erosion Control; b) Flood Regulation; and c) HNVf areas.

The HRUs with highest values of soil erosion control (IDs numbers: 74, 338, 416, 419 and 422) are the ones that show the lower contribution to this service. These are middle high areas, having the lower values located by the valley of the River Vez, suggesting a more contribution to this service in this areas (Carvalho Santos, 2014). In the areas where the higher values are more present we can see that the contribution to the service is lower, having less importance to the control of soil erosion. The areas with bigger altitude show, for that reason, a lower contribution to this service.

Regarding the flood regulation, the HRUs with the highest values (IDs: 175, 177, 178, 310 and 462) show a smaller contribution to this service. On the other hand, HRUs with the lowest value (ID: 109) show a greater contribution to this service, being located near the River Vez. The lower the surface runoff, the bigger contribution to the flood regulation. Also, some of the HRUs with the lowest values (as HRU 58 and 59) are located in the areas belonging to the Peneda Gerês National Park.

Analysing the boxplots focusing on the Water Damage Mitigation service (Figure 30 and 31), we have the analysis of two important ecosystem services: Soil Erosion Control and Flood Regulation. For the first one, we have for HRUs with Non-HNVf areas, where the 1st quartile concerns the 25% of the values that are lower or equal to 80.99. The 25% corresponding to the 3rd quartile have higher or equal values to 67.90. Half of the values of this analysis is located between 80.99 and 672.90. The majority of the values for these areas belong to a range between 80.99 and 236.84 (median). In what concerns the values of the HRUs with HNVf areas for this service, we have the 1st quartile with 25% of the values of the HRUs, being lower or equal to 47.06. The 3rd quartile has 25% of the values higher or equal to 393.44. 50% of the values are between 47.06 and 393.44. The majority of the values is located between 47.06 and 133.83 (median). So, we see that the Non-HNVf areas higher values in what concerns the Soil Erosion Control, which means that they have a lower contribution to the maintenance of this service. On the other hand we see that HNVf areas have lower values and therefore are a major contributor to the control of soil erosion.

The Vez watershed is characterised by the presence of “socalcos” in the agricultural areas (Moreno *et al.*, 2015) that are a major contribute in preventing soil erosion, which, combined with farmlands with HNV, constitutes a very important factor to the soil erosion control.

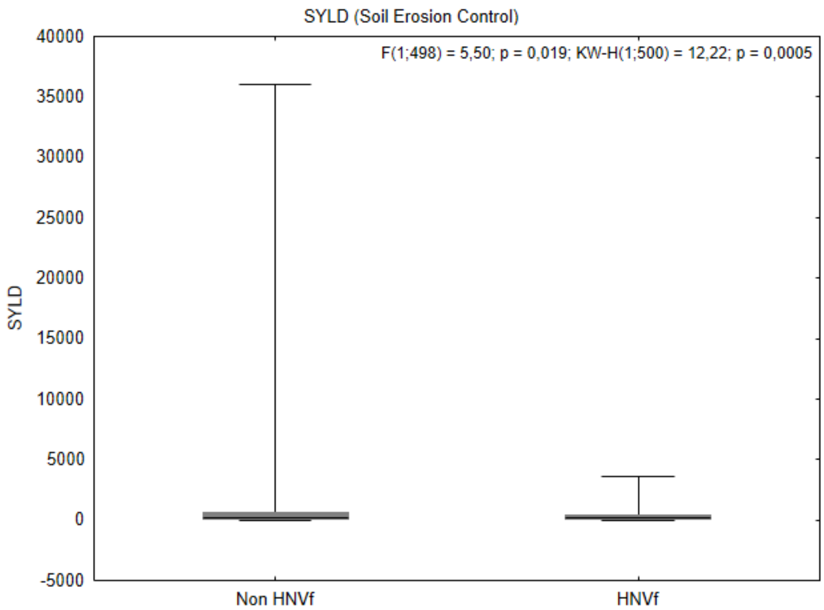


Figure 30 - Relation between Soil Erosion Control and HNVf areas. The first vertical axis expresses the values for Soil Erosion Control (t/ha.yr) present in areas with Non-HNVf and the one on the right expresses the values for HNVf areas. The boxes represent the values of the 1st and 3rd quartile and the ones between them. The whiskers represent the minimum and maximum of the values.

The Flood Regulation service is also used to quantify the Water Damage Mitigation service. Figure 31 shows the values for this service in HRUs without and with HNVf areas. For Non-HNVf areas, the boxplot shows us that the first 25% correspond to values that can be lower or equal to 0.019, corresponding to the 1st quartile. The 3rd quartile has 25% of the values and can be higher or equal to 0.030. 50% of the values are between 0.020 and 0.030. On its turn, the majority of the values are between 0.019 and 0.024 (median). In what concerns HNVf areas, the 1st quartile has 25% of the values lower or equal to 0.019, too. The 3rd quartile has 25% of the values higher or equal to 0.03. 50% of the values are between 0.019 and 0.024. The majority of the values vary between 0.019 and 0.024 (median). The difference between the two areas is not significant, contributing both equally to the flood regulation.

The "Low-Mountain" sub-basin is a major important area to the provision of this service, since the forest cover that predominates this sub-basin decreases the runoff, contributing consequently to the control of soil erosion and flood regulation (Figure 23).

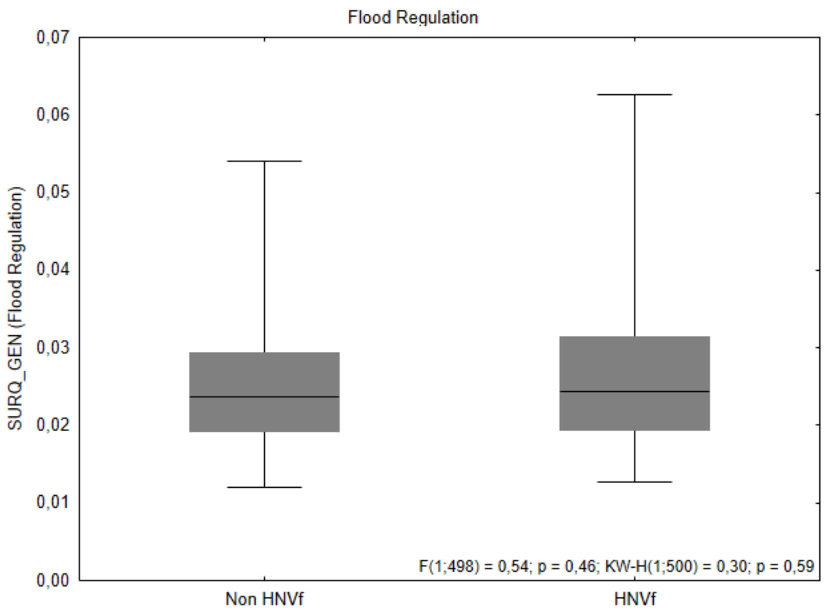


Figure 31 - Relation between Flood Regulation and HNVf areas. The first vertical axis expresses the values for Flood Regulation (mm) present in areas with Non-HNVf and the one on the right expresses the values for HNVf areas. The boxes represent the values of the 1st and 3rd quartile and the ones between them. The whiskers represent the minimum and maximum of the values.

5.2.1.3. Biomass Production and Climate Regulation

The services Biomass Production and Climate Regulation were analyzed concerning the biomass and carbon storage, respectively. On Figure 32 it is represented the spatial distribution of this two services, and the map with HNVf areas in order to see their spatial coincidence.

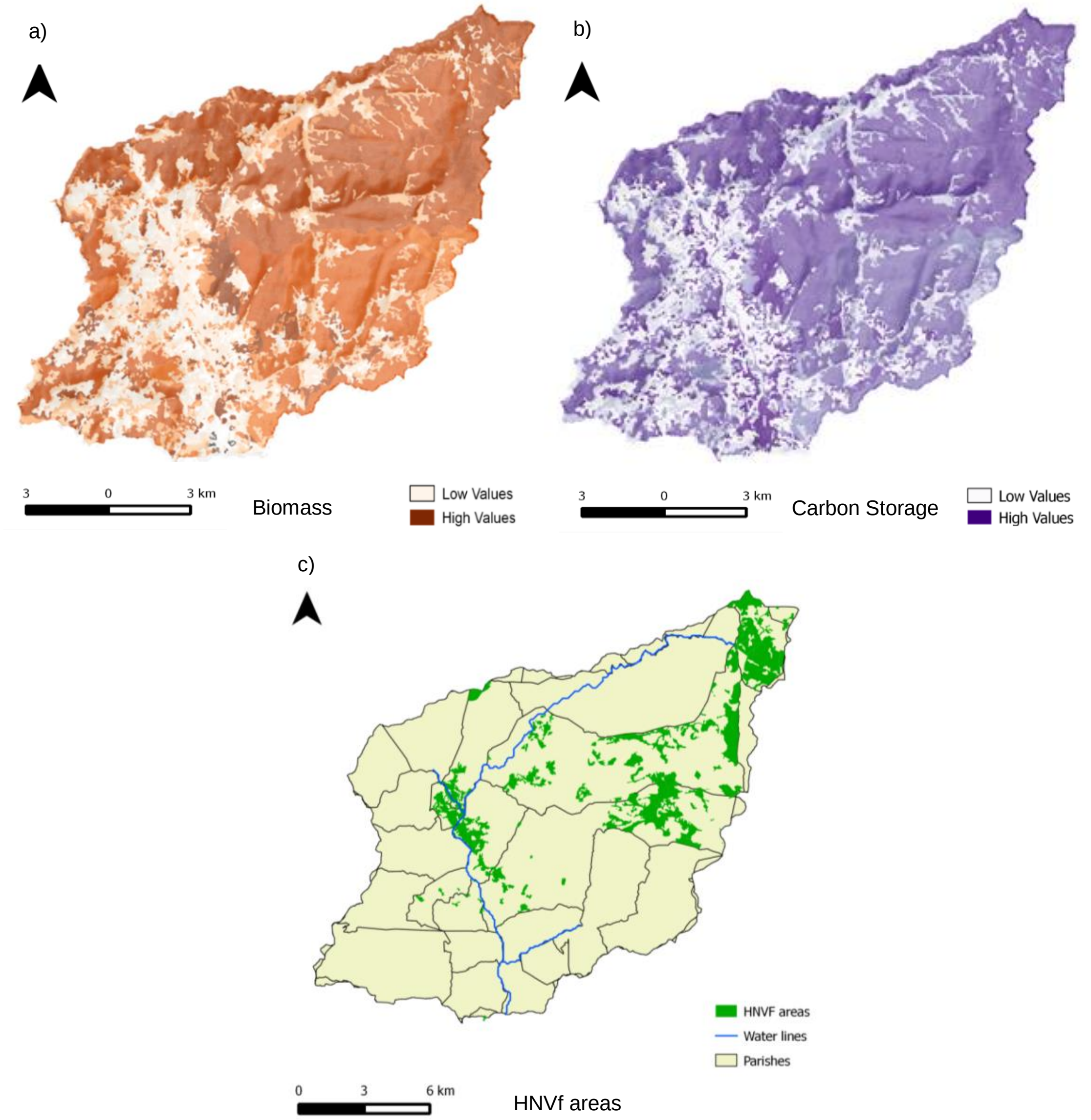


Figure 32 - Spatial distribution of the provision of the services Biomass Production and Climate Regulation in the Vez watershed. The map with the areas of HNVf allows us to compare the spatial coincidence between them and this service, showing their presence or absent in this areas, as well as their predominance. a) Biomass; b) Carbon Storage; and c) HNVf areas.

Concerning the Biomass Production Service, the HRU with the higher value is located in an area with very high inputs of biomass: Atlantic shrubland (80%) with mixture shrubland with sparse trees (20%) (Carvalho Santos, 2014).The HRUs that are located near the Peneda Gerês National Park also have higher values.

The Climate Regulation service is indicated by the carbon storage output, and it follows the same pattern as the previous service, having similar values in the same HRUs. They are connected since the carbon storage is a fraction of the Biomass production: the carbon storage in the vegetation with a fraction of 50% of organic matter.

The boxplot represented on Figure 33 shows that for Biomass Production the areas of Non-HNVf the 1st quartile contains 25% of the values lower or equal to 2.11. The 3rd quartile has 25% of the values higher or equal to 32.90. 50% of the values are between 2.11 and 32.90. The major part of the values is located between 27.76 (median) and 32.90. In what concerns HNVf areas, 25% of the values are lower or equal to 2.15, belonging to the 1st quartile. Others 25% concerning the 3rd quartile correspond to higher or equal values to 37.3. 50% of the values are between 2.15 and 37.3. The majority of the values are between 27.5 (median) and 37.3. There is no significant difference between the areas of Non-HNVf and the ones with HNVf, existing, however, a slightly higher contribution to Biomass production from HNVf areas.

The Climate Regulation service is indicated by the Carbon Storage service (Figure 34), and it follows the same spatial pattern as the Biomass production service. On the 1st quartile of HRUs with Non-HNVf we have values lower or equal to 1.05. The 3rd quartile has 25% of the values higher or equal to 16.45. 50% of the values are between 1.05 and 16.45. The majority of the data is between 13.88 and 16.45. The HRU with areas of HNVf have the 25% correspondent to the 1st quartile with lower or equal values to 1.07. The 3rd quartile has its 25% corresponding to higher or equal values to 18.65. Half of the values correspond to values between 1.07 and 18.65. Most of the values vary from 13.76 and 18.65. The Carbon Storage services does not presents many differences in the two different types of areas, being registered only a small predominance of HNVf areas in what concerns the storage of carbon.

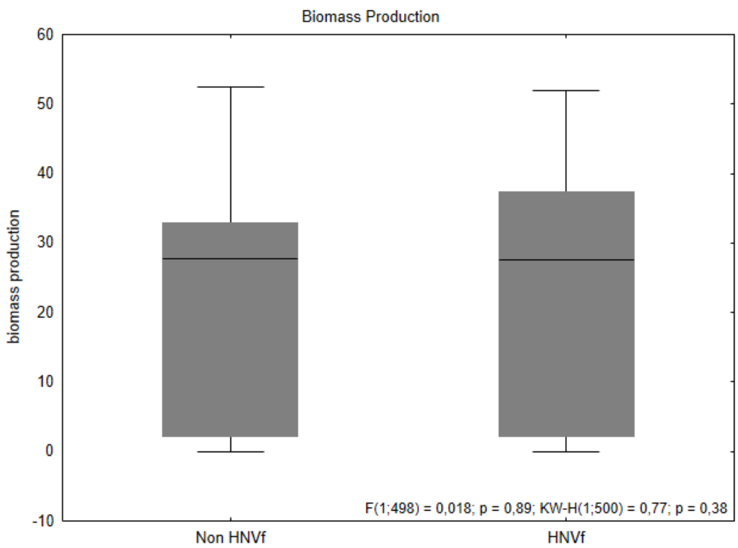


Figure 34 - Relation between Biomass Production and HNVf areas. The first vertical axis expresses the values for Biomass Production (t/ha.yr) present in areas with Non-HNVf and the one on the right expresses the values for HNVf areas. The boxes represent the values of the 1st and 3rd quartile and the ones between them. The whiskers represent the minimum and maximum of the values.

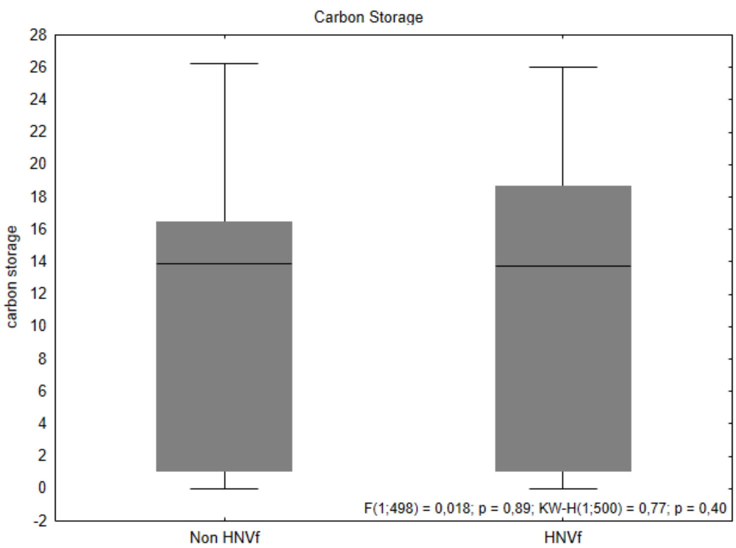


Figure 33 - Relation between Carbon Storage and HNVf areas. The first vertical axis expresses the values for Carbon Storage (tC/ha.yr) present in areas with Non-HNVf and the one on the right expresses the values for HNVf areas. The boxes represent the values of the 1st and 3rd quartile and the ones between them. The whiskers represent the minimum and maximum of the values.

On Appendix 5 we can see a table with the information of the ES that exist in each HRU, showing the tendency of the distribution. We see that most of the HRU have some contribution to all of the Ecosystem Services, with the exception of the ones gathered on Appendix 7. The HRUs that cannot gather all of the ES are represented on the table, in order to show that some of the HRUs do not have the presence of all the ES. Biomass Production and Climate Mitigation are the services that show fewer presences. This happens also because they are typical of areas with specific characteristics (forest areas, Peneda Gerês National Park...) (Carvalho Santos, 2014).

From the 35 HRUs selected has having values of Ecosystem Services, 12 of them coincide with HNVf areas (Figure 24). The HRU with the ID 192 has about 87% of its total area cover with HNVf, having one of the highest values of water quality. However, none of the HRUs with the highest value for each of the 7 analysed outputs has HNVf. HRU 109, on its turn, has the lowest value on flood regulation which means it has a higher contribution to this service, and it has 15% of its area cover with HNVf. HRU 121 has 93% of HNVf area and it has one of the lowest values in what concerns the soil erosion control. In this service the lowest the value, the higher the contribution. This shows the importance of HNVf areas to control the soil erosion.

In the “Valley” sub-basin there was a low provision of soil erosion control and water quality services, since in this area of the watershed is a major concentration of agricultural land, according to Carvalho Santos (2014).

On the other hand, the “High Mountain” was consider the sub-basin with the most balanced provision of all the services, since it provided the highest contribution to the provision of water quantity, biomass and carbon storage. On the upper areas of the watershed there is a major potential to yield a great amount of biomass production and carbon storage, due to the highest humidity, which suggests that the water quantity here is associated with the higher rates of precipitations registered in this area, and also with a lower water demand from shrublands which are also more frequent here (Carvalho Santos, 2014). For last, the “Low Mountain” sub-basin presented the best area to the control of erosion, regulation of flood events and water quality services provision. Since this is an area with patches of oak and pine forest (Carvalho Santos, 2014), it is more connect with moderate slopes making the surface runoff be lower and, therefore, contributing to the predominance of these services.

5.2.2. Contributions and relations between HNVf areas and Ecosystem Services

Having in consideration the previously performed analysis to understand the relation between HNVf areas and Ecosystem Services present in the Vez watershed, the potential of HNVf areas to provide the studied Ecosystem Services of HNVf areas to the provision of the studied Ecosystem Services.

On Table 8 we gathered the information concerning the contribution of each one of the area types analysed, in order to see which of the areas has a major contribution to the provision of Ecosystem Services.

Table 8 - Analysis of the contribution of HNVf areas to the provision of Ecosystem Services in the Vez watershed. This table gathers the information on the Median and Inter Quartile Range (IQR) of the HRUs with Non-HNVf areas and the ones with HNVf in the Vez watershed. The information on the contribution of HNVf areas for the provision of Ecosystem Services comes from the boxplot analysis performed previously. The symbols represent: ↑- Higher contribution ↓ - Lower contribution **0** – Not significant

Ecosystem Services	Non-HNVf areas	HNVf areas	Contribution of HNVf areas to the provision of the ES (in comparison with Non-HNVf areas)
	Median ± IQR	Median ± IQR	
Water Supply			
Water Quantity (mm)	76,61 ± 84,02	82,41± 89,54	↑
Water Timing (mm)	118,56 ± 321,18	96,55 ± 240,64	↓
Water Quality (N kg/ha. yr)	2,57 ± 8,86	2,07 ± 9,88	↑
Water Damage Mitigation			
Soil Erosion Control (t/ha. yr)	236,84 ± 72000,00	133,83 ± 4800,00	↑
Flood Regulation (mm)	0,02 ± 0,06	0,02 ± 0,06	**0**
Biomass Production			
Biomass (t/ha. yr)	27,76 ± 55,38	27,52 ± 52,85	↑
Carbon Storage (Climate Regulation)			
Carbon Storage (tC/ha. yr)	13,89 ± 27,69	13,76 ± 26,42	↑

We can see that in HNVf areas, certain services like Water Quality and Soil Erosion Control, have a major contribution regardless of the fact that HNVf areas have lower values of this services. For instance, in what concerns Water Quality, the service is analysed regarding the Total of Nitrates, which means that the higher the values of the nitrates, the lower the water quality is, which makes HNVf have a higher contribution to this service. On its turn, the Soil Erosion Control service is evaluated concerning the Sediment Exports, which means that the higher the exports, the lower the contribution, and that is why HNVf areas have a major contribution to this service, since they present the lowest values.

Since our study is focus on studying the role of HNVf as providers of Ecosystem Services, on Table 8 we show the contribution of this areas to the provision of ES, in comparison to the areas of Non-HNVf. The arrows represented on the table indicate if the contribution of each service is positive, negative or not significant in the areas of HNVf in comparison with non-HNVF areas. This analysis was made considering the values that predominate in each one of the areas (Non-HNVf and HNVf) for each Ecosystem Service studied in the boxplots presented formerly.

Overall, through this analysis we can assume that HNVf predominate as providers of Ecosystem Services, comparatively with areas with other land uses in the Vez watershed.

5.3. Conclusions

The assessment and mapping of ES was an important task to lead us to our conclusions in what concerns HNVf and their relations with Ecosystem Services. For a start, we saw that the mapping of ES (especially at a watershed level) is a major important task in order to understand the priorities at a local management level, leading us to identify the most relevant ES in the study areas, understanding which were the ones needing some improvement and special attention. Almost every HRUs with HNVf combines the totality of the Ecosystem Services here studied (see Appendix 5 and 7). So, the HRU gave us important information on this, and allow us to conclude that the “High Mountain” sub-basin was the sector of the watershed that provided the highest levels of water quantity. The values of rainfall in the mountain are higher than in other areas of the watershed, which associated with shrubland as dominant vegetation, is sufficient reason to guarantee this prevalence.

The Ecosystem Services assessment that our study was based on, made very clear that any change in the actual scenario of the watershed would have completely different results in what concerns the provision of Ecosystem Services. Therefore, Carvalho Santos (2014) presents several alternative scenarios to see what would be the different, especially focusing on changes in land cover/land use. Carvalho Santos (2014) suggested, that a scenario under the eucalyptus/pine influence, which would have decrease the biodiversity conservation value very dramatically, whereas in the oak scenario it would have increase due to its natural value.

The biomass production and carbon storage have a high potential in the Vez watershed, regardless of the fact that this area is very suitable to fire and can be destroyed by them, concerning also that climate change contribute to this, as well. The Vez watershed has areas of forest located in the north areas, and in the Peneda Gerês National Park located in the northeast of the watershed. Unfortunately the Vez watershed has been affected by fires in a very long time, and they constantly contribute to the degradation of these processes.

Concerning the distribution of the biodiversity conservation value in the Vez watershed, Carvalho Santos (2014) states that the higher values were located in the “High Mountain” sub-basin, since this are the areas that match with the areas belonging to the Natura 2000 network and the Peneda-Gerês National Park. The “Low Mountain” areas present both low and high values for this ES, and, at least, the “Valley” sub-basin was the one presenting lower biodiversity conservation values since it was the area with the bigger presence of agricultural areas and with the presence of villages, therefore diminishing its biodiversity conservation value.

The importance of the Vez watershed to plant and bird diversity is very high, especially in the areas where the oak forests predominate, which creates conditions for the presence of areas of High Nature Value farmlands.

High Nature Value farmlands are, in its majority, low-intensity farming systems, which gives them an important role in the conservation of the countryside biodiversity , existing, however, some efforts needed to be made (Bignal and McCracken, 1996). The value of farmlands for conservation has gain some attention, and things are changing (Bignal and McCracken, 1996), besides the fact that some of the datasets that are used in the identification of HNVf in Europe have shown some limitations since the mapping of HNVf is being made in different scales over the EU, which may led to different kinds of mapping, conditioning the correct assessment of this areas in Europe (Carvalho Santos *et al.*, 2010). In order to achieve the Biodiversity goals that the EU has committed itself, HNVf areas have major importance, helping in the reverse of the current trends in biodiversity loss in Europe (Haines-Young and Potschin, 2009). The Rural Development Programs attributed an important role to HNVf in what concerns the protection of biodiversity in agricultural areas, which shows the importance that this farming systems have been gaining over the last years in the political agricultural context of the EU (Carvalho Santos *et al.*, 2010).

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Chapter 5. Discussions, Conclusions and Future Perspectives

The extensive character of agricultural practices and the importance of Ecosystem Services in agriculture have been particularly important research topics, especially in Europe, where a considerable number of extensive and diverse low-intensity land-use systems can be found in Spain and Portugal (Plieninger *et al.*, 2006).

In CS1, the literature review gave us an idea of the actual investigation on ES and the importance of ecosystem services to agriculture. We reached the conclusion that according to analysed literature, spatially-explicit approaches are more frequent in research on extensively managed farming systems (ranging from only extensive, organic farming and HNVf) than on intensively managed farmlands. Overall, the spatially-explicit indicator across all references was “Land Use/Land Cover”. As expected, while provisioning services are directly connected with agriculture, a predominance of regulating services in extensive and intensive practices was observed, highlighting the importance of farming practices in the potential of farmlands to provide these services in agro-ecosystems.

The EU Biodiversity Strategy to 2020 defined the mapping and assessment of ecosystems and their services has main goal (EC, 2011). This is a very important communication tool and crucial to a correct management and decision-making (MAES, 2014). In fact, they are particularly relevant for High Nature Value farmlands, as they are often “Less Favoured areas”, which face specific geomorphological challenges. This is a very important step in order to ameliorate the management of such vulnerable areas as the Vez watershed, study area of our Case-Study 2. Here, land use is changing, reflecting the support for exotic species like eucalypts, through forestry plantation, and also for farming expansion, which is expected to cause tremendous impacts in the future, contributing to the disappearance of HNVf areas (Carvalho Santos, 2014). Also, the Vez watershed has been under frequent fire events, that have contributed to soil erosion over the last years (Proença *et al.*, 2010). Scrub and heath are a sign of the presence of wildfires in the watershed, that affect not only the biotic interactions and wildlife, but also the provision of ecosystem services in the watershed (Proença *et al.*, 2010). These are areas that have a very special value for conservation, and that is why they must have a much greater focus in the future. The value of the services they provide and their sustainable management are the tools to guarantee economic sustainability, an informed valuation and prioritization in what concerns their underlying social-ecological systems. In this CS a coincidence between ES and HNVf was perceived, highlighting the importance of this areas to agro-biodiversity and to the provision of relevant Ecosystem Services, like in the case of the service Water Quantity, where there is a predominance of higher values in the areas with HNVf (values between 82.5 and 91.13) than in areas of Non-HNVf (with values between 67.05 and 76.6).

The area of the Vez watershed has an important forest cover in its extension, and forests have been related to the provision of hydrological ecosystem services. Forests require more water than other vegetation types, and together with HNVf areas have a vital role to the provision of this services, and also to soil services (quality, soil erosion control or flood prevention) (Thorsen *et al.*, 2014). The quantification of Ecosystem Services (especially the ones considered as “non-marketed”) has great importance, since the politics focusing this services, need to ensure a link between what is being provided and social demands (Thorsen *et al.*, 2014). This services are not just important to the natural processes that occur in this areas, but also to upkeep the day to day activities of the populations that live in the rural agglomerates nearby.

High Nature Value farmlands monitoring is the key to understand the impact of policy interventions in what concerns biodiversity conservation and ecosystems that depend upon traditional agricultural systems and rural landscapes (Eurostat, 2015). Several approaches have been proposed to assess HNVf current areas and in the future, so that their nature value can be maintained even under scenarios of land-use change (Lomba *et al.*, 2015). A bottom-up framework to a collaborative monitoring of HNVf is one approach that aims to define levels of information and standards for an effective monitoring of HNVf areas, at an European level (Lomba *et al.*, 2015). In the future, this will allow to track agricultural-related habitats and ecosystems with an important natural/conservation value (Lomba *et al.*, 2015)

The mapping of Ecosystem Services is still a challenge, and additional data and research is required, since that at an European level it is important to establish management goals that contribute to social and natural capital (Maes *et al.*, 2012). However, currently there is no detailed and accurate quantification of ES in Europe, which may be reflected as malfunctioning of allocating mechanisms, both political and economic (Westhoek *et al.*, 2013). Instruments that focus on the “marketing” of ES are being developed in Europe, such as payments for Ecosystem services, which are increasingly present in the agenda of the several EU political institutions (Westhoek *et al.*, 2013).

Our analysis is, therefore, to be used in the future in order to understand in which areas a special conservation concern is needed, focusing policy making and management on those areas, with special focus on the areas of extensive agriculture, with particular emphasis on High Nature Value farmland areas and their relation with Ecosystem

Services. It is important to understand that these areas need special attention from a conservational point of view, in order to achieve EU biodiversity goals, and also to increase human well-being and the maintenance of healthy ecosystems, giving them its real value.

5.1. References

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Appendices

Appendix 1. Detailed structure and contents of the database used within CS1. This table, built on 40 bibliographic references considered for CS1, includes information from several indicators, which were analysed following a presence/absent analysis (0 – no presence; 1 – presence).

References			Agriculture Intensity				Spatial Component	Spatial Component: Indicators	Data type		Used ES Classification			Provisoning																						
			Extensive			Intensive																														
Ecosystem services International Classifications			Extensive	Organic	HNVf				Qualitative	Quantitative	CICES	TEEB	MEA	Nutrition	Livestock	Biomass/Raw material	Mineralization of plant nutrients	Materials	Energy	Food	Fibers	Timber production	Fuel	Fish	Firewood	Fresh Water	Medicine Resources	Bio-resource provision and contribution to human health and well being	Mitigation of Climate Change impact	Water availability	Forage quality and quantity	Litter quantity	Hunting	Fishing inland	Resin	Water use for irrigation
CICES			0	0	0	0	0	0	0	0				1	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
TEEB			0	0	0	0	0	0	0	0				0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
MEA			0	0	0	0	0	0	0	0				1	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Author	Country/Region	Title																																		
Susanne Frank, Christine Fürst, Lars Koschke, Franz Makeschin	Germany, REGKLAM region	*A contribution towards a transfer of the ecosystem service concept to landscape planning using landscape metrics*	1	0	0	1	1	Habitat or supporting functions; Effective mesh size; Hemeroby index; Cost-distance-analysis; Shannon's diversity index; Edge contrast index; Core area index; Shape index; Information functions (natural scenery, recreation); Shape index; Edge contrast index; Total Area; Number of Patches; Degree of compactness.	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0
Harpinder S. Sandhua, Stephen D. Wratten, Ross Cullen, Brad Case	Canterbury, New Zealand.	*The future of farming: The value of ecosystem services in conventional and organic arable land. An experimental approach*	0	1	0	0	1	Aproximate distirbution of HNVF in Europe (percentage)	0	1	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
Stefano Balbi, Agustin del Prado, Patricia Gallejones, Chandanathil Pappachan Geevan, Guillermo Pardo, Elena Perez-Minana, Rosa Manrique, Cuitlahuac Hernandez-Santiago, Ferdinando Villa.	Llanada Alavesa, Basque Country.	*Modeling trade-offs among ecosystem services in agricultural production systems*	1	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Rogier P.O. Schulte, Rachel E. Creamer, Trevor Donnellan, Niall Farrelly, Reamonn Fealy, Cathal O'Donoghue, Daire O'hUallachain	Ireland	*Functional land management: A framework for managing soil-based ecosystem services for the sustainable intensification of agriculture*	1	0	0	1	0	0	1	1	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cheryl Palma, Humberto Blanco-Canqui, Fabrice DeClerck, Lydiah Gatere,Peter Grace	Sub Saharan Africa and South Asia.	*Conservation agriculture and ecosystem services: An overview*	1	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Helen F. Smith, Caroline A. Sullivan	Wilsons River, Australia	*Ecosystem services within agricultural landscapes—Farmers' perception*	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Erik Andersson, Bjorn Nykvist, Rebecka Malinga, Fernando Jaramillo, Regina Lindborg	Sweden	*A social–ecological analysis of ecosystem services in two different farming systems*	1	0	0	1	0	0	1	1	0	0	1	1	0	0	0	0		1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Zsófia Mózner, Andrea Tabi, Mária Csutora	Hungary and The Netherlands	*Modifying the yield factor based on more efficient use of fertilizer—The environmental impacts of intensive and extensive agricultural practices*	1	0	0	1	0	0	0	1	0	1	1	1	0	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Penka Tsonkova, Christian Böhm, Ansgar Quinkenstein, Dirk Freese	Germany	*Application of partial order ranking to identify enhancement potentials for the provision of selected ecosystem services by different land use strategies*	1	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anik Schneiders, Toon Van Daele, Wouter Van Landuyt, Wouter Van Reeth	Flanders	*Biodiversity and ecosystem services: Complementary approaches for ecosystem management?*	1	0	0	1	1	Biodiversity (number of Red List plant species per grid cell); Land use intensity score with a range from 0 (least intensive human use) to 1 (most intensive human use); weighted mean ecosystem services score based on the ecosystem services ranking with a range from 0 (no landscape capacity to provide ES) to 5 (high landscape capacity to provide ES)	0	1	0	1	1	0	0	0	0	0	0	1	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0
Penélópe Lamarque, Patrick Meyfroid, Baptiste Nettier, Sandra Lavorel	Central French Alps	*How Ecosystem Services Knowledge and Values Influence Farmers' Decision-Making*	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	
E. Dominati, A. Mackay a, S. Greenb, M. Pattersonc	New Zealand, Waikato	*A soil change-based methodology for the quantification and valuation of ecosystem services from agro-ecosystems: A case study of pastoral agriculture in New Zealand*	1	0	0	1	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Luis Filipe Gomes Lopes, João Manuel R. dos Santos Bento, Artur F. Arede Correia Cristovão, Fernando Oliveira Baptista	Portugal	*Exploring the effect of land use on ecosystem services:The distributive issues*	1	0	0	1	0	0	1	1	0	1	1	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	1	1	1	0
Paul Opdama, Ingrid Coninx, Art Dewulf, Eveliene Steingröver,Claire Vos, Merel van der Wal	Hoeksche Waard, The Netherlands	*Framing ecosystem services: Affecting behaviour of actorsin collaborative landscape planning?*	0	1	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Carlos E. González-Esquivel, Mayra E. Gavito, Marta Astier, Martin Cadena-Salgado, Ek del-Val, Laura Villamil-Echeverri, Yair Merlín-Uribe and Patricia Balvanera	P'urhépecha plateau, in the State of Michoacán, Mexico	*Ecosystem service trade-offs, perceived drivers, and sustainability in contrasting agroecosystems in central Mexico*	1	0	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jérôme Cimon-Morina, Marcel Darveaub, Monique Poulin	Lower North-Shore Plateau ecoregion and in a southern portion of the Central Labrador ecoregion of boreal eastern Canada	*Towards systematic conservation planning adapted to the local flow of ecosystem services*	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Mathias Kirchner, Johannes Schmidt, Georg Kindermann, Veronika Kulmer, Hermine Mitter, Franz Prettenthaler, Johannes Rüdisser, Thomas Schauppenlehner, Martin Schönhart, Franziska Strauss, Ulrike Tappeiner, Erich Tasser, Erwin Schmid	Austria	*Ecosystem services and economic development in Austrian agricultural landscapes — The impact of policy and climate change scenarios on trade-offs and synergies*	1	0	0	1	1	Shannon Diversity Index; Total biomass production on agricultural land; Soil organic carbon (SOC) in topsoil layer; GHG emissions from agriculture; Degree of naturalness; Area weighted mean species richness of vascular plants	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
M.S. Reed, L.C. Stringer, A.J. Dougill, J.S. Perkins, J.R. Atlhopheng, K. Mulale, N. Favretto	Kalahari rangelands in southwest Botswana	*Reorienting land degradation towards sustainable land management: Linking sustainable livelihoods with ecosystem services in rangeland systems*	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
María R. Felipe-Lucia, Francisco A. Comín	River Piedra, Spain	*Ecosystem services–biodiversity relationships depend on land usetype in floodplain agroecosystems*	1	0	0	1	0	0	1	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jake J. Grossman	Paraguayan Paraná Interior Atlantic Forest (Atlantic Forest) ecoregion	*Ecosystem service trade-offs and land use among smallholder farmers in eastern Paraguay*	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lynn Huntsinger and José L. Oviedo	California's Mediterranean rangelands	*Ecosystem Services are Social–ecological Services in a Traditional Pastoral System: the Case of California's Mediterranean Rangelands*	1	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Hanna Sinare, Line J. Gordon	Sudano-Sahelian West Africa	*Ecosystem services from woody vegetation on agricultural lands in Sudano-Sahelian West Africa*	0	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kyösti Arovuori, Olli Saastamoinen	Finland	*Classification Of Agricultural Ecosystem Goods and services in Finland*	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Les Firbanka, Richard B. Bradbury, David I. McCracken, Chris Stoate	United Kingdom	*Delivering multiple ecosystem services from Enclosed Farmland in the UK*	1	1	0	1	0	0	1	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Gloria Rodríguez-Loinaz, Josu G. Alday, Miren Onaindia	Basque Country, Spain	*Multiple ecosystem services landscape index: A tool for multifunctional landscapes conservation*	0	0	0	1	1	Density of head of cattle (N /100 ha); Agricultural production (Ton/ha); Timber in forest plantations (m3/ha); Runoff ¼ renewable water supply (mm); Stored C in soil and biomass (Ton C/ha); Organic C in soil (Ton C/ha); Evapotranspiration (mm); Soil water storage capacity (mm); Soil water infiltration capacity (cm/h); Cover of riparian forest in river margins (% in 25 m buffer); Cover of natural forest (% of municipality's surface); Areas without erosion problems (% of municipality's surface); Density of rural tourism establishments (N /km2); Special protection area (% of municipality's surface); Habitat of community interest (% of municipality's surface).	1	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Shan Ma, Scott M. Swinton	Michigan, USA	*Valuation of ecosystem services from rural landscapes using agricultural land prices*	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Harpinder S. Sandhu, Stephen D. Wratten, Ross Cullen	Canterbury, New Zealand.	*The role of supporting ecosystem services in conventional and organic arable farmland*	0	1	0	0	0	0	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Catharina J. E. Schulp, Benjamin Burkhard, Joachim Maes, Jasper Van Vliet, Peter H. Verburg	European Union	*Uncertainties in Ecosystem Service Maps: A Comparison on the European Scale*	1	1	1	1	1	Expert-based classification of land cover data	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lia Vieirada Silva, Mark Everard, Robert G. Shore	Steart Peninsula, United Kingdom	*Ecosystem services assessment at Steart Peninsula, Somerset UK*	1	0	0	1	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harpinder Sandhu, SteveWratten, Robert Costanza, Jules Pretty, John R. Porter and John Reganold	New Zealand	*Significance and value of non-traded ecosystemservices on farmland*	1	1	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ying-Chieh Leea, Jack Ahern, Chia-Tsung Yeh	Taiwan	*Ecosystem services in peri-urban landscapes: The effects of agricultural landscape change on ecosystem services in Taiwan's western coastal plain*	1	0	0	0	1	Land cover and land use	1	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G.M. Tarekul Islam, A.K.M. Saiful Islam, Ahsan Azhar Shopan, Md Munsur Rahman, Attila N. L az ar, Anirban Mukhopadhyay	Ganges Delta, Bangladesh	*Implications of agricultural land use change to ecosystem services in the Ganges delta*	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
K Garbach, JC Milder, M Montenegro and DS Karp, FAJ DeClerck	Costa Rica	*Biodiversity and Ecosystem Services in Agroecosystems*	1	0	0	1	1	Land use; Pest control value.	1	0	0	1	1	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Claire A.Horrocksa, Jennifer A.J. Dungait, Laura M. Cardenas, Kate V. Heal	United Kingdom	*Does extensification lead to enhanced provision of ecosystems services from soils in UK agriculture?*	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alwyn Williams, Katarina Hedlund	Scania, Sweden	*Indicators of soil ecosystem services in conventional and organic arable fields along a gradient of landscape heterogeneity in southern Sweden*	0	1	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veronika Fontana, Anna Radtke, Janette Walde, Erich Tasser, Thomas Wilhalm,Stefan Zerbe, Ulrike Tappeiner	South Tyrol (Alps), Italy	*What plant traits tell us: Consequences of land-use change of a traditional agro-forest system on biodiversity and ecosystem service provision*	1	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wei Song, Xiangzheng Denga, Yongwei Yuan, Zhan Wang, Zhaohua Li	North China Plain, China	*Impacts of land-use change on valued ecosystem service in rapidlyurbanized North China Plain*	0	0	0	1	1	Climate data, energy substitution method, average cost of reser-voir construction, saved inputs in agricultural production, the value of conserving soil fertility, the value of reducing soil sedimentation in river channels, and value of reduced surface soil, values of gas regulation.	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Girija Page, Bill Bellotti	New South Wales, Australia	*Farmers value on-farmecosystemservices as important, butwhat are the impediments to participation in PES schemes?*	1	1	0	0	1		1	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Matjaz Glavan, Marina Pintar, Janko Urban	River Drava, Slovenia.	*Spatial variation of crop rotations and their impacts on provisioning ecosystem services on the river Drava alluvial plain*	0	0	0	1	1	Land use.	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Katrine Grace Turner, Mette Vestergaard Odgaard, Peder K. Bøcher,Tommy Dalgaard, Jens-Christian Svenning	Denmark	*Bundling ecosystem services in Denmark: Trade-offs and synergies in a cultural landscape*	1	0	1	1	1	Number of roadkill in a grid cell; Wetland water purification indicator; land use and land cover data.	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
TOTAL			**28**	**8**	**3**	**32**	**12**		**27**	**32**	**3**	**9**	**37**	**5**	**1**	**6**	**2**	**3**	**6**	**20**	**3**	**6**	**3**	**1**	**1**	**10**	**2**	**1**	**1**	**6**	**1**	**1**	**3**	**1**	**1**	**1**
														90																						

Regulating/Maintenance

Grazing resources for livestock or wildlife	Crops	Biochemicals	Physical support	References with presence of Provisioning Services	Reliable weather	Regulation of wastes	Waste decomposition	Maintenance of soil health	Flow regulation	Pollination	Water regulation/conservation	Regulation of physical environment	Pest regulation	Regulation of biotic environment	Biological control of pests and deseases	Erosion control and sediment retention	Global/Local climate and air quality regulation	Nutrient cycle	Erosion regulation	Soil retention	Carbon sequestration and storage	Hydrological flow	Soil fertility	Nitrogen fixation/mineralization	Soil formation	Moderation of extreme events	Waste water treatment	Water purification	Soil structure and composition	Waste assimilation	Maintaining healthy waterways
0	0	0	0	1	0	1	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	0	0	0	0
0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0
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0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0
0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
1	2	1	1	34	1	2	1	1	5	14	7	2	5	1	13	5	15	10	4	3	14	1	10	2	5	1	2	8	1	1	1
																													177		

Natural azard regulation	Water quality	Date of flowering onset	Flood mitigation/regulation	Filtering of nutrients and contaminants	Detoxification and reclycling of wates	Regulation of N2O and CH4	Waterhsed production	Soil organic carbon (SOC)	Gas regulation	Protecting endangered species	Air quality	Soil nutrient	Soil water content	Shade	Green House Emissions	Soil drainage	Disturbance prevention	Wildlife habitat	Infiltration	Greenhouse gas emissions	Medicinal plants	Nitrate leaching	**References with Regulating Services**	Symbolic	Aesthetic/Esthetic quality of the landscape	Intelectual and Experimental	Recreation and mental and physical health	Tourism	Aesthetic appreciation and inspiration for culture, art and design	Spiritual experience and sense of place	Rural lifestyles	History/ Cultural heritage
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	1	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	1	1	1	1	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	1	0	1	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**	0	1	0	0	0	0	0	0	0
0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	1	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	1	0	0	0	0	0	0	0
0	0	0	0	0	0	1		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0
0	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	1	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	**1**	0	1	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	1	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	1	0	1	0	1	1	0	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**1**	0	1	0	1	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	1	0	0	0	0	0	0	1
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**1**	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	1	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**1**	0	1	0	0	0	0	1	0	0
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	1	0	1	0	0	0	0	1
0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	1	1	0	1	0	0
2	**9**	**1**	**6**	**2**	**1**	**2**	**1**	**4**	**2**	**1**	**2**	**1**	**1**	**1**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**40**	**1**	**12**	**1**	**14**	**3**	**4**	**5**	**1**	**3**

Cultural														Supporting																	
Enjoying popular species	Cultural site for First Nations subsistence uptake	Landscape diversity	Education and research	Scenic beauty	Traditional use	Farm Gross margins	Employment	Social relations	Nature appreciation	Summer cottages	Hunting	Farmers identity	**References with Cultural Services**	Habitats for species	Maintenance of genetic diversity	Contribution to the ecological functioning	Services provided by shelterbelts and hedges	Seed dispersal	Plant diversity	Existence value of woodland caribou	Species richness of vascular plants	Degree of naturalness	Soil	Forest birds	Biodiversity	Composite	Water cycling	Primary production	Photosynthesis	Aboveground net	**References with Supporting Services**
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
0	0	0	0		0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	0	0	0		0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	1	**1**	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	**1**
1	1	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	0	0	0	0	0	0	0	0	1	0	**1**	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**1**
0	0	1	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	1	1	0	0		0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**1**
0	0	0	1	0	0	0	0	0	0	0	0	0	**1**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0		1	1	0	1	0	0	0	1	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	1	1	1	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	1	0	0	0	1	1	0	0	0	0	**1**	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	1	0	1	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
0	0	0	1	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	**1**
0	0	0	0	0	0	0	0	0	1	1	1	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
1	**1**	**1**	**5**	**1**	**2**	**0**	**1**	**1**	**1**	**1**	**2**	**1**	**25**	**10**	**5**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**6**	**1**	**5**	**1**	**2**	**2**	**1**	**1**	**25**
62														**66**																	

Appendix 2. Indicators with spatially-explicit component, referred throughout bibliographic references and considered for CS1. Indicators, including name, and meaning were gathered from the original manuscripts.

Indicators used in the spatial analysis, per article	
Ref. 1	Habitat or supporting functions; Effective mesh size; Hemeroby index; Cost-distance-analysis; Shannon's diversity index; Edge contrast index; Core area index; Information functions (natural scenery, recreation); Shape index; Total Area; Number of Patches; Degree of compactness.
Ref. 2	Approximate distribution of High Nature Vaue farmlands (HNVf) in Europe (percentage)
Ref. 10	Biodiversity (number of Red List plant species per grid cell); Land use intensity score with a range from 0 (least intensive human use) to 1 (most intensive human use); weighted mean ecosystem services score based on the ecosystem services ranking with a range from 0 (no landscape capacity to provide ES) to 5 (high landscape capacity to provide ES)
Ref. 17	Landscape shape index (LSI), Shannon's diversity index (SHDI), mean patch fractal dimension (MPFD), total core area index (TCAI) and total edge contrast index.
Ref. 25	Density of head of cattle (N /100 ha); Agricultural production (Ton/ha); Timber in forest plantations (m3/ha); Runoff ¼ renewable water supply (mm); Stored C in soil and biomass (Ton C/ha); Organic C in soil (Ton C/ha); Evapotranspiration (mm); Soil water storage capacity (mm); Soil water infiltration capacity (cm/h); Cover of riparian forest in river margins (% in 25 m buffer); Cover of natural forest (% of municipality's surface); Areas without erosion problems (% of municipality's surface); Density of rural tourism establishments (N /km2); Special protection area (% of municipality's surface); Habitat of community interest (% of municipality's surface).
Ref. 28	Expert-based classification of land cover data
Ref. 31	Land cover and land use
Ref. 33	Land use; Pest control value.
Ref. 37	Climate data, energy substitution method, average cost of reservoir construction, saved inputs in agricultural production, the value of conserving soil fertility, the value of reducing soil sedimentation in river channels, and value of reduced surface soil, values of gas regulation.
Ref. 38	Types of agriculture (diverse agricultural operations)
Ref. 39	Land use.
Ref. 40	Number of roadkill in a grid cell; Wetland water purification indicator; land use and land cover data.

Appendix 3. Detailed information considered for CS2. Information includes the 500 HRUs identified in the Vez watershed, area of High Nature Value farmlands (HNVf) occurrence within each HRU and values for targeted Ecosystem Services.

HRU ID	HRU area (Km2)	HNVf areas per HRU (Km2)	HNVf area (%)	Water Supply			Water damage mitigation		Biomass Production	Climate Regulation
				Water Quantity	Water Timing	Water Quality	Soil Erosion Control	Flood Regulation	Biomass	Carbon Storage
1	0,004401	0,000000	0,000000	125,480389	197,905986	0,271606	36,308623	0,015643	0,000000	0,000000
2	0,002803	0,000000	0,000000	111,853056	245,252806	0,268944	255,319149	0,012387	0,000000	0,000000
3	0,025599	0,000000	0,000000	122,881389	225,696722	0,310032	64,285714	0,013572	0,000000	0,000000
4	0,000401	0,000000	0,000000	125,707958	178,230319	0,247277	81,172492	0,024834	0,000000	0,000000
5	0,000803	0,000000	0,000000	123,606306	91,156125	0,145718	90,338770	0,014135	0,000000	0,000000
6	0,004000	0,000000	0,000000	123,236236	82,745958	0,162169	33,582090	0,015534	0,000000	0,000000
7	0,167200	0,028901	17,285530	126,353792	112,232306	0,252285	130,909091	0,021339	0,000000	0,000000
8	0,033198	0,007368	22,193200	126,039431	145,299403	0,243251	537,313433	0,016580	0,000000	0,000000
9	0,340400	0,021430	6,295420	126,370875	100,699917	0,253954	49,416609	0,024302	0,000000	0,000000
10	0,021599	0,000000	0,000000	88,053028	129,838681	0,235084	13,859480	0,020420	1,723417	0,861708
11	0,119200	0,000000	0,000000	87,244597	149,799222	0,233719	27,617952	0,017804	1,462181	0,731090
12	0,018000	0,000000	0,000000	85,496056	170,606875	0,209927	4,386499	0,015764	1,921931	0,960965
13	0,038797	0,000000	0,000000	88,917806	140,138222	0,248072	41,836142	0,021928	1,778250	0,889125
14	0,018402	0,000000	0,000000	89,635389	122,265236	0,274731	21,582734	0,025478	2,338139	1,169069
15	0,053600	0,000000	0,000000	87,274222	178,160542	0,206537	6,136538	0,017419	1,486486	0,743243
16	0,261600	0,035196	13,454010	90,488542	64,527514	0,202388	29,268293	0,015097	2,218306	1,109153
17	0,313200	0,023190	7,404180	91,785847	59,473333	0,205185	10,809188	0,016110	2,147375	1,073687
18	0,058402	0,015802	27,056780	89,106889	72,498056	0,164786	6,887316	0,013873	2,585222	1,292611
19	1,586000	0,311194	19,621280	91,471444	79,806861	0,302313	85,409253	0,023217	2,500889	1,250444
20	0,414800	0,091331	22,018180	89,283861	102,263889	0,281346	25,227751	0,018759	2,839194	1,419597
21	3,147200	0,493426	15,678250	92,686847	71,104319	0,301109	25,210084	0,026212	2,461431	1,230715
22	0,002401	0,000000	0,000000	70,492278	114,782472	2,598996	158,940397	0,029475	35,921250	17,960625
23	0,003197	0,000000	0,000000	68,506000	130,764917	2,696427	378,947368	0,024535	36,109236	18,054618
24	0,002000	0,000000	0,000000	71,895986	109,947083	2,759995	347,826087	0,054077	35,916792	17,958396
25	0,000803	0,000000	0,000000	70,850542	117,154389	2,805705	666,666667	0,047462	36,112417	18,056208
26	0,069600	0,000653	0,938790	78,631583	51,978875	1,791178	89,663761	0,024435	30,682069	15,341035
27	0,063600	0,000000	0,000000	76,962750	58,542097	1,747742	223,602484	0,021065	30,678431	15,339215
28	0,236400	0,009691	4,099410	73,833472	89,027306	2,511774	2666,666667	0,027735	32,999472	16,499736
29	0,659200	0,021634	3,281780	76,976000	69,415653	2,687871	648,648649	0,037467	32,311250	16,155625
30	1,758000	0,025149	1,430560	79,973083	57,367875	2,788644	171,428571	0,050282	31,354500	15,677250
31	0,003197	0,000000	0,000000	80,703264	136,479944	1,937254	525,547445	0,028192	31,257736	15,628868
32	0,026402	0,000000	0,000000	78,166403	192,876819	1,850519	1500,000000	0,018477	30,413111	15,206556
33	0,067600	0,014578	21,565240	86,415556	72,820569	1,079023	1028,571429	0,014914	25,263889	12,631944
34	0,574400	0,000000	0,000000	88,900639	52,283333	1,324479	40,268456	0,020248	26,046042	13,023021
35	0,168800	0,003348	1,983290	87,102167	61,316347	1,308639	188,976378	0,017271	25,793833	12,896917
36	0,293600	0,025977	8,847720	84,786583	94,248972	1,812050	1846,153846	0,021502	28,230472	14,115236
37	3,896000	0,041692	1,070130	89,418361	61,260194	2,015283	94,240838	0,033446	27,228306	13,614153
38	0,868000	0,030418	3,504320	87,056514	72,489653	1,993742	428,571429	0,027534	27,760806	13,880403
39	0,016402	0,000000	0,000000	81,677042	69,799000	2,690382	791,208791	0,028279	32,182847	16,091424
40	0,082002	0,001837	2,240310	84,780292	57,598861	2,737226	142,011834	0,035035	31,293264	15,646632
41	0,000401	0,000000	0,000000	79,484681	79,119625	2,558726	0,000000	0,025046	32,845444	16,422722
42	0,482800	0,001845	0,382150	90,956056	83,690750	2,048189	273,764259	0,014439	41,229153	20,614576
43	1,814800	0,017133	0,944090	92,721806	71,042542	1,950004	47,058824	0,017153	39,374875	19,687437
44	2,898000	0,039982	1,379620	94,224319	62,854125	1,521845	15,430776	0,019907	38,072792	19,036396
45	0,786800	0,110700	14,069610	92,415153	112,787722	3,423355	571,428571	0,021144	42,469264	21,234632
46	2,908000	0,229744	7,900410	94,578875	85,373708	3,502457	128,801431	0,028688	40,307361	20,153681
47	5,091200	0,190170	3,735280	95,794000	73,291708	3,112033	39,625757	0,035525	40,199375	20,099688
48	0,009599	0,000000	0,000000	85,255861	163,925264	3,979660	250,000000	0,025020	50,058028	25,029014
49	0,010000	0,000000	0,000000	82,592722	192,184167	4,196538	521,739130	0,020234	51,499861	25,749931
50	0,382800	0,052051	13,597360	87,548194	76,830042	2,210352	349,514563	0,014910	42,136458	21,068229
51	3,919600	0,351535	8,968640	91,961514	60,014500	1,730187	20,997375	0,019340	38,548944	19,274472
52	1,709600	0,194291	11,364700	89,982764	67,104958	2,132449	66,728452	0,017047	40,091208	20,045604
53	3,742800	1,498481	40,036360	90,139861	105,139514	3,517342	654,545455	0,020721	43,615181	21,807590
54	9,563200	2,989368	31,259080	92,822528	83,204458	3,567359	169,014085	0,026243	41,285764	20,642882
55	14,955000	1,537212	10,278910	94,059958	70,566250	3,222774	45,627376	0,032053	41,194347	20,597174
56	0,027600	0,000000	0,000000	121,905528	231,218319	0,314175	73,022312	0,013476	0,000000	0,000000
57	0,002400	0,000000	0,000000	124,548167	203,585389	0,268692	46,511628	0,015428	0,000000	0,000000
58	0,018401	0,000000	0,000000	113,138028	268,149375	0,272521	251,748252	0,011697	0,000000	0,000000
59	0,001999	0,000000	0,000000	110,708458	313,320569	0,259593	1285,714286	0,011991	0,000000	0,000000
60	0,023201	0,000669	2,881770	125,241917	146,254125	0,255296	571,428571	0,016773	0,000000	0,000000
61	0,137600	0,030361	22,064610	125,560653	112,721583	0,250841	138,728324	0,021611	0,000000	0,000000
62	0,191600	0,018088	9,440610	125,628250	101,512056	0,259786	56,916996	0,024507	0,000000	0,000000

63	0,066799	0,000000	0,000000	85,886569	147,467431	0,235848	28,436019	0,018368	1,476597	0,738299
64	0,021599	0,000000	0,000000	83,819014	173,089389	0,220438	4,873096	0,015830	1,939528	0,969764
65	0,013601	0,000000	0,000000	86,484264	132,775958	0,234191	17,870439	0,020292	1,648667	0,824333
66	0,000801	0,000000	0,000000	86,878861	151,425250	0,220450	119,205298	0,020671	1,576292	0,788146
67	0,007200	0,000000	0,000000	85,976556	175,480361	0,191136	7,814196	0,017970	1,496694	0,748347
68	0,824800	0,533234	64,650120	89,992014	79,902944	0,304925	101,123596	0,023541	2,498944	1,249472
69	0,890800	0,436321	48,980840	91,082431	71,753847	0,306251	34,782609	0,026337	2,461069	1,230535
70	0,210400	0,130131	61,849430	88,132361	98,738583	0,272366	24,291498	0,019589	2,724306	1,362153
71	0,203600	0,000000	0,000000	67,010389	132,221014	2,822091	236,842105	0,024565	35,795847	17,897924
72	0,027600	0,000000	0,000000	64,744236	149,920139	2,989164	837,209302	0,020787	36,053389	18,026694
73	0,103200	0,000000	0,000000	68,795833	117,978458	2,668248	119,601329	0,028775	35,633875	17,816937
74	0,000401	0,000000	0,000000	65,395917	147,366306	2,933388	24000,000000	0,031733	36,221514	18,110757
75	0,013601	0,000000	0,000000	75,502528	58,896194	1,785980	303,797468	0,021204	30,371306	15,185653
76	0,003201	0,000000	0,000000	76,608028	54,043569	1,864609	188,976378	0,023563	30,403194	15,201597
77	0,325600	0,019158	5,883910	78,241750	58,287875	2,892844	243,243243	0,049598	31,155708	15,577854
78	0,107600	0,005081	4,722120	75,794889	68,330833	2,778850	782,608696	0,038809	31,903750	15,951875
79	0,036799	0,003595	9,768470	72,647347	87,768944	2,596279	3600,000000	0,028605	32,587361	16,293681
80	0,007200	0,000000	0,000000	79,234944	144,633778	1,856867	363,636364	0,018993	31,080458	15,540229
81	0,003999	0,000000	0,000000	78,759736	173,341861	1,724799	1714,285714	0,016304	30,081875	15,040938
82	0,020400	0,000000	0,000000	80,666083	118,292861	1,848524	87,167070	0,023586	30,537361	15,268681
83	0,000801	0,000000	0,000000	79,689597	264,683861	1,191008	0,000000	0,014136	22,565042	11,282521
84	0,202800	0,095775	47,226430	86,864944	54,943194	1,386535	71,146245	0,019540	25,700208	12,850104
85	0,121600	0,061418	50,508550	85,762292	61,095708	1,335163	196,721311	0,017610	25,483486	12,741743
86	0,046402	0,023782	51,252530	85,025847	72,136153	1,110683	1028,571429	0,015272	25,007014	12,503507
87	0,280800	0,006372	2,269120	85,826236	71,922111	2,038678	473,684211	0,028234	27,407625	13,703813
88	0,053201	0,000748	1,405610	83,461403	94,335375	1,845018	2769,230769	0,021866	27,878306	13,939153
89	2,142400	0,177710	8,294890	88,220556	60,771014	2,053857	95,744681	0,034382	26,870319	13,435160
90	0,000401	0,000000	0,000000	82,502292	195,387653	2,064220	7200,000000	0,016120	30,852458	15,426229
91	0,001999	0,000000	0,000000	85,854792	160,344903	2,461959	137,142857	0,020023	32,829944	16,414972
92	0,688800	0,050594	7,345250	92,373208	64,123681	1,742202	22,577611	0,019686	38,096639	19,048319
93	1,060000	0,079619	7,511180	91,131111	71,020653	2,021336	53,175775	0,017412	39,216181	19,608090
94	0,327600	0,012839	3,919080	89,559542	82,246028	2,105941	256,227758	0,014910	41,000750	20,500375
95	3,373200	0,434089	12,868760	94,171792	73,106181	3,227397	42,908224	0,036143	39,938278	19,969139
96	0,495600	0,040946	8,261840	90,891125	111,526389	3,511510	610,169492	0,021709	42,226847	21,113424
97	1,650000	0,129227	7,831910	92,968778	84,774792	3,611738	139,805825	0,029348	40,074208	20,037104
98	0,245200	0,000000	0,000000	85,506139	139,810375	2,998501	39,130435	0,021447	48,290194	24,145097
99	0,084399	0,000000	0,000000	79,612569	187,677167	4,389976	376,963351	0,015825	49,696403	24,848201
100	0,359600	0,000000	0,000000	83,409111	156,297222	3,573910	81,172492	0,018928	50,154917	25,077458
101	0,001599	0,000000	0,000000	82,798889	170,559639	4,180456	521,739130	0,024051	50,514194	25,257097
102	0,006001	0,000000	0,000000	80,730694	195,064083	4,260859	642,857143	0,020206	51,354833	25,677417
103	2,044400	0,525887	25,723310	88,314875	67,174250	2,182810	71,641791	0,017280	39,959750	19,979875
104	0,657600	0,107101	16,286680	85,822347	77,019181	2,249297	369,230769	0,015108	41,912333	20,956167
105	1,319600	0,243686	18,466630	89,820389	61,740819	1,966891	32,490975	0,018984	38,739069	19,369535
106	12,947000	1,694488	13,087880	92,559847	69,229278	3,235664	42,154567	0,033301	41,022139	20,511069
107	0,864000	0,422269	48,873670	88,434236	105,700875	3,611919	837,209302	0,020948	43,543444	21,771722
108	2,869600	0,512630	17,864170	91,272306	81,869250	3,680605	178,660050	0,027116	41,036792	20,518396
109	0,027199	0,004279	15,732930	114,237889	257,878097	0,308037	210,526316	0,011396	0,000000	0,000000
110	0,164400	0,008137	4,949330	121,341917	213,633167	0,309290	44,253227	0,013247	0,000000	0,000000
111	0,321200	0,001298	0,404050	121,342056	179,182056	0,288519	15,312633	0,015525	0,000000	0,000000
112	0,023200	0,009908	42,708620	121,237653	214,136222	0,326056	105,571848	0,016620	0,000000	0,000000
113	0,037200	0,016183	43,502690	119,620639	247,129847	0,372526	180,000000	0,014217	0,000000	0,000000
114	0,047199	0,011064	23,441390	118,277972	126,121986	0,301573	436,363636	0,016111	0,000000	0,000000
115	0,200400	0,049075	24,488370	113,053056	93,197139	0,296374	133,828996	0,019555	0,000000	0,000000
116	0,262000	0,030809	11,759120	113,337861	82,213889	0,297640	50,597330	0,021927	0,000000	0,000000
117	0,293200	0,145981	49,789020	86,974806	167,770958	0,215372	3,415074	0,014603	1,962250	0,981125
118	1,607600	0,281852	17,532450	88,924153	142,028708	0,225427	15,221987	0,016622	1,346681	0,673340
119	1,631600	0,023020	1,410870	89,226944	127,430722	0,215203	6,852574	0,018168	1,486278	0,743139
120	0,046000	0,030859	67,084130	89,903750	143,250542	0,236209	42,328042	0,018618	1,427542	0,713771
121	0,222000	0,208158	93,764730	89,335403	166,420903	0,202312	4,046535	0,016479	1,645292	0,822646
122	0,428800	0,035217	8,212970	91,984403	78,193944	0,300501	78,688525	0,020124	2,452861	1,226431
123	0,356800	0,025715	7,206980	92,895931	71,138458	0,299623	30,290282	0,021888	2,405875	1,202938
124	0,052000	0,000000	0,000000	90,522319	93,854847	0,285673	18,691589	0,017561	2,699250	1,349625
125	0,045599	0,003083	6,760020	67,542444	146,155736	3,091057	818,181818	0,018516	35,662361	17,831181
126	0,156800	0,007907	5,042670	70,535750	124,215181	2,840461	185,089974	0,022070	34,638389	17,319194
127	0,451600	0,002984	0,660830	72,923194	107,795208	2,550749	63,047285	0,026049	34,122903	17,061451
128	0,002001	0,000406	20,304850	70,815222	127,330625	3,004758	705,882353	0,031656	34,665278	17,332639
129	0,002800	0,000596	21,271430	67,290653	152,884000	3,025719	2322,580645	0,024200	35,212792	17,606396
130	0,076399	0,000000	0,000000	75,968792	84,991194	2,671614	2400,000000	0,024115	31,463069	15,731535
131	0,792000	0,000279	0,035180	81,375236	58,082597	2,942018	179,104478	0,038012	29,853333	14,926667
132	0,301200	0,000333	0,110520	79,317722	66,161819	2,870699	510,638298	0,031715	30,538208	15,269104
133	0,103600	0,000497	0,479340	82,110847	133,184528	1,916168	162,528217	0,018063	29,914236	14,957118
134	0,428800	0,000015	0,003450	83,708750	113,928833	1,784033	48,714479	0,020792	28,988917	14,494458
135	0,025599	0,000247	0,966440	80,258833	167,975319	1,953019	867,469880	0,015174	30,736861	15,368431

136	0,000799	0,000471	58,936170	78,369347	253,828597	1,066983	0,000000	0,013235	21,361403	10,680701
137	0,037200	0,000000	0,000000	86,760708	89,220181	1,899987	2000,000000	0,019599	26,264875	13,132438
138	0,798000	0,000000	0,000000	90,571278	62,713083	2,094363	121,416526	0,026653	24,993153	12,496576
139	0,273600	0,000000	0,000000	88,981097	71,243625	2,059732	387,096774	0,023545	25,499931	12,749965
140	0,134800	0,000000	0,000000	77,739597	104,360500	2,356329	51,282051	0,022294	35,979611	17,989806
141	0,004800	0,000000	0,000000	70,602000	142,551708	2,904514	1636,363636	0,016875	37,824347	18,912174
142	0,026400	0,000000	0,000000	74,618181	121,992653	2,730997	206,896552	0,019270	36,894917	18,447458
143	0,456000	0,000000	0,000000	85,393056	58,372042	2,809427	125,435540	0,027858	32,273958	16,136979
144	0,033600	0,000000	0,000000	79,258986	90,473208	2,569685	3600,000000	0,019190	33,899500	16,949750
145	0,062399	0,000000	0,000000	83,562472	65,587667	2,849116	444,444444	0,024740	32,895444	16,447722
146	0,026400	0,000000	0,000000	91,981486	132,172889	2,126717	20,791221	0,021334	36,616514	18,308257
147	0,008800	0,000000	0,000000	90,892639	151,821389	2,542463	68,181818	0,018248	35,616181	17,808090
148	0,023999	0,000401	1,669240	94,433292	108,717792	3,576929	712,871287	0,018846	43,566319	21,783160
149	0,223600	0,045854	20,507290	95,417028	83,328986	3,645570	128,801431	0,024371	40,622806	20,311403
150	0,263200	0,007316	2,779520	95,943639	75,874736	3,462537	60,606061	0,027286	40,111153	20,055576
151	0,032801	0,000000	0,000000	84,764708	183,656431	4,184587	378,947368	0,014364	55,375764	27,687882
152	0,430400	0,000571	0,132670	90,493847	131,604472	2,515635	21,466905	0,019324	48,971986	24,485993
153	0,088000	0,001427	1,622050	88,106611	152,666681	3,480951	79,295154	0,016703	51,997069	25,998535
154	0,419200	0,004654	1,110090	91,919653	102,159931	3,635629	720,000000	0,018334	44,194625	22,097313
155	1,856400	0,082195	4,427660	93,037236	79,471431	3,699327	146,938776	0,022757	41,320764	20,660382
156	5,319600	0,044163	0,830190	94,065792	69,220486	3,314765	45,028143	0,026205	40,782056	20,391028
157	0,026800	0,001215	4,532840	64,954014	134,021375	0,443451	64,923354	0,029696	0,000000	0,000000
158	0,153600	0,006467	4,210550	64,057083	151,628986	0,457224	102,272727	0,026816	0,000000	0,000000
159	0,036000	0,008391	23,307220	65,347819	208,778028	0,414658	389,189189	0,021491	0,000000	0,000000
160	0,078400	0,008573	10,934440	64,113944	221,247944	0,477647	585,365854	0,025063	0,000000	0,000000
161	0,020400	0,005545	27,180390	64,987625	139,140236	0,446365	177,777778	0,038620	0,000000	0,000000
162	0,002400	0,001000	41,679170	69,472347	74,689556	0,379563	367,346939	0,037074	0,000000	0,000000
163	0,008000	0,003971	49,636250	69,841694	69,816319	0,397729	152,219873	0,040090	0,000000	0,000000
164	0,560000	0,066834	11,934710	54,152347	124,101167	0,330752	43,689320	0,029590	2,029569	1,014785
165	0,087200	0,001600	1,834750	54,343875	113,593889	0,329274	27,470431	0,032094	2,063181	1,031590
166	0,106400	0,010552	9,917200	52,934431	142,946667	0,292372	8,446739	0,026232	2,171944	1,085972
167	0,004000	0,000056	1,395000	55,371625	107,998500	0,349574	40,793201	0,039680	2,153250	1,076625
168	0,376000	0,078140	20,781890	54,412181	151,471569	0,286368	11,080332	0,028631	2,047764	1,023882
169	0,132400	0,036605	27,647210	55,113056	121,463333	0,338220	72,948328	0,034801	2,016236	1,008118
170	0,000400	0,000000	0,000000	56,946458	66,181264	0,344445	317,180617	0,037003	2,127292	1,063646
171	0,002400	0,000000	0,000000	57,468236	63,560833	0,350370	106,666667	0,038764	2,109250	1,054625
172	0,156800	0,000000	0,000000	41,691736	90,600014	5,553413	214,285714	0,047988	26,681417	13,340708
173	0,074400	0,000114	0,152820	37,564514	114,697694	6,680275	1531,914894	0,035518	27,936681	13,968340
174	0,307600	0,000697	0,226630	40,254944	99,334792	5,951889	389,189189	0,042436	27,103556	13,551778
175	0,022400	0,001100	4,911610	41,185167	97,542514	6,315236	960,000000	0,069129	27,013222	13,506611
176	0,026000	0,000301	1,156150	36,836236	124,143153	7,090103	3000,000000	0,046264	27,974292	13,987146
177	0,000400	0,000000	0,000000	47,242556	55,033542	5,463237	0,000000	0,058588	23,274042	11,637021
178	0,000400	0,000000	0,000000	48,635083	49,000347	5,682267	4000,000000	0,069415	22,737653	11,368826
179	0,002000	0,000000	0,000000	46,752139	145,198167	3,018362	12000,000000	0,026730	26,671028	13,335514
180	0,017600	0,001185	6,733520	49,981917	111,952681	3,057714	369,230769	0,033185	24,325486	12,162743
181	0,008800	0,000000	0,000000	50,758792	104,879556	3,026355	253,521127	0,035404	23,749847	11,874924
182	0,008400	0,000000	0,000000	50,796708	109,237653	3,150847	685,714286	0,049115	23,738111	11,869056
183	0,057600	0,000303	0,526220	43,859972	175,159014	3,605769	4800,000000	0,029240	26,920722	13,460361
184	0,022800	0,000000	0,000000	52,310306	124,642722	5,136253	160,000000	0,034554	30,370097	15,185049
185	0,002800	0,000000	0,000000	50,567792	147,002847	4,448838	720,000000	0,029270	30,207653	15,103826
186	0,001600	0,000000	0,000000	52,969611	112,991056	4,874086	114,285714	0,038595	30,172611	15,086306
187	0,110800	0,000800	0,721930	50,038264	103,924764	6,654344	79,734219	0,036795	41,927722	20,963861
188	0,159200	0,004263	2,677640	49,138028	115,504861	7,649809	154,506438	0,033119	44,874597	22,437299
189	0,043200	0,000000	0,000000	46,659736	142,334986	8,995502	757,894737	0,027651	50,266208	25,133104
190	0,016800	0,000356	2,120830	46,739819	145,181861	10,047446	1090,909091	0,036431	48,919444	24,459722
191	0,003200	0,000400	12,500000	48,805194	122,747625	9,531374	699,029126	0,044258	45,028111	22,514056
192	0,006000	0,005249	87,476670	55,098903	54,584833	8,065420	229,299363	0,050176	30,348167	15,174083
193	1,610000	0,216481	13,445990	103,093333	198,136847	0,356904	50,561798	0,016039	0,000000	0,000000
194	0,558000	0,125063	22,412670	102,032000	161,268167	0,322068	23,240801	0,019080	0,000000	0,000000
195	1,030400	0,062695	6,084530	107,520653	269,967167	0,291572	162,528217	0,012689	0,000000	0,000000
196	0,282800	0,024446	8,644130	106,153611	288,011292	0,313999	306,382979	0,014147	0,000000	0,000000
197	0,090800	0,001611	1,774340	102,005139	177,645986	0,355881	96,904441	0,022647	0,000000	0,000000
198	0,015999	0,000000	0,000000	103,297472	149,795708	0,300126	55,427252	0,028374	0,000000	0,000000
199	0,225600	0,001232	0,546100	106,140819	91,826194	0,289707	157,549234	0,024109	0,000000	0,000000
200	0,201600	0,010065	4,992660	106,547736	82,055500	0,287213	68,506185	0,027100	0,000000	0,000000
201	0,025200	0,000000	0,000000	104,717958	117,585750	0,270320	637,168142	0,019500	0,000000	0,000000
202	5,959600	0,911130	15,288440	80,831681	144,751278	0,229399	18,320611	0,019311	1,344792	0,672396
203	3,716000	0,504398	13,573680	78,455028	172,854597	0,201125	3,368106	0,016689	2,026389	1,013194
204	2,068000	0,239145	11,564070	81,434667	128,265403	0,214118	8,977556	0,021511	1,337069	0,668535
205	0,063602	0,001435	2,255900	83,117278	120,175403	0,261960	25,423729	0,026394	2,103264	1,051632
206	2,104400	0,733614	34,860940	79,627042	189,008028	0,215379	6,409115	0,017579	1,904361	0,952181
207	0,394400	0,077814	19,729740	82,409611	137,802861	0,242737	38,095238	0,023010	1,608139	0,804069
208	0,000801	0,000000	0,000000	83,735625	64,754931	0,197754	136,105860	0,015764	2,235889	1,117944

209	0,003199	0,000000	0,000000	82,989528	70,782569	0,165792	10,558733	0,014881	2,286625	1,143312
210	1,160400	0,017105	1,474030	85,942917	69,600972	0,304614	46,997389	0,026735	2,397875	1,198937
211	1,018400	0,012251	1,202950	85,084069	76,751931	0,296923	121,416526	0,024336	2,396958	1,198479
212	0,138800	0,001600	1,152670	83,570528	93,533014	0,280870	28,324154	0,020747	2,669181	1,334590
213	1,738400	0,042278	2,431990	65,547083	129,573972	3,282276	198,895028	0,024577	31,258028	15,629014
214	0,700400	0,020851	2,977060	62,372958	151,331958	3,555380	720,000000	0,020564	31,958000	15,979000
215	1,173200	0,038805	3,307650	68,204431	110,806722	2,955180	76,840982	0,030101	30,676625	15,338313
216	0,108000	0,015677	14,515740	67,207306	123,632750	3,483141	402,234637	0,040726	31,064528	15,532264
217	0,112000	0,002213	1,975540	61,893708	159,898042	3,690226	1263,157895	0,026803	31,954069	15,977035
218	0,037200	0,000079	0,213170	69,847500	105,502167	3,384731	230,769231	0,056546	30,537097	15,268549
219	0,014402	0,000000	0,000000	72,607333	68,193681	1,799640	1800,000000	0,018040	26,453153	13,226576
220	0,006798	0,000000	0,000000	75,776083	52,116944	2,162812	147,843943	0,024431	26,450917	13,225458
221	0,013201	0,000000	0,000000	74,285792	58,708875	2,061206	356,435644	0,021200	26,577181	13,288590
222	0,202800	0,000000	0,000000	71,278361	90,291500	3,016212	3130,434783	0,027077	28,262000	14,131000
223	0,621200	0,004606	0,741520	74,984708	66,657514	3,289624	610,169492	0,038724	27,247750	13,623875
224	1,541600	0,004739	0,307390	76,744486	58,013167	3,378537	218,844985	0,047749	26,713014	13,356507
225	0,430800	0,032402	7,521430	77,311472	137,599403	2,050464	165,137615	0,020457	27,438500	13,719250
226	0,080002	0,010097	12,620810	74,786694	170,865514	2,074330	757,894737	0,017272	28,044694	14,022347
227	0,495200	0,007490	1,512580	78,994972	118,307833	1,955884	65,934066	0,023676	26,474611	13,237306
228	0,023598	0,007894	33,453680	77,874986	134,942333	2,180167	393,442623	0,028877	27,001889	13,500944
229	0,138400	0,007971	5,759250	71,374625	208,964278	2,170767	1894,736842	0,018358	27,536208	13,768104
230	0,001201	0,000000	0,000000	79,974764	112,862278	2,179045	276,923077	0,037655	26,124681	13,062340
231	0,000400	0,000000	0,000000	83,944500	60,481986	1,479412	2482,758621	0,018151	22,106972	11,053486
232	0,944400	0,001082	0,114540	85,926236	62,642181	2,270076	152,866242	0,032420	22,865194	11,432597
233	0,292400	0,004673	1,598080	82,119042	93,076944	2,017033	1945,945946	0,022314	23,964986	11,982493
234	0,802400	0,003276	0,408330	84,526917	71,654208	2,210963	444,444444	0,028060	23,228958	11,614479
235	0,066400	0,006682	10,063400	68,383153	124,129056	3,156787	237,623762	0,022109	33,471597	16,735799
236	0,047998	0,003028	6,307970	71,618222	107,758222	2,871729	85,409253	0,025542	32,618111	16,309056
237	0,013601	0,000000	0,000000	64,519889	145,506111	3,351955	1263,157895	0,019122	34,147250	17,073625
238	0,000801	0,000000	0,000000	77,813944	53,407153	2,158921	339,622642	0,019986	28,811028	14,405514
239	0,012800	0,000000	0,000000	73,895722	65,780722	1,870810	2181,818182	0,016780	29,681028	14,840514
240	0,013201	0,000000	0,000000	76,629736	57,640097	2,053271	373,056995	0,018687	29,084986	14,542493
241	0,005602	0,000000	0,000000	74,459750	87,313931	3,029920	10285,714286	0,023153	30,249194	15,124597
242	0,003599	0,000000	0,000000	77,264625	68,687528	3,276003	1469,387755	0,028445	29,507486	14,753743
243	0,063602	0,000000	0,000000	82,873417	156,054722	2,908973	86,124402	0,020805	33,848444	16,924222
244	0,011999	0,000000	0,000000	80,644431	178,918250	2,825746	255,319149	0,018089	33,297528	16,648764
245	0,001201	0,000000	0,000000	83,729153	142,241653	2,814699	79,382580	0,023089	34,009361	17,004681
246	0,014002	0,000000	0,000000	72,611028	281,491236	1,463415	1894,736842	0,014725	28,923958	14,461979
247	0,019599	0,000000	0,000000	86,952056	69,172097	2,518187	100,278552	0,018041	36,180750	18,090375
248	0,018798	0,000000	0,000000	88,049111	60,190875	2,200489	32,185963	0,020960	34,511167	17,255583
249	0,007199	0,000000	0,000000	85,744819	79,362597	2,498699	421,052632	0,015805	38,254847	19,127424
250	0,314400	0,000000	0,000000	87,169694	108,377056	4,079089	642,857143	0,022281	41,220444	20,610222
251	1,238400	0,000001	0,000060	88,528444	80,802458	4,188238	145,161290	0,030006	37,866778	18,933389
252	1,928400	0,000816	0,042290	89,173889	70,543069	3,796868	53,019146	0,035660	37,263514	18,631757
253	1,579600	0,049224	3,116260	81,361389	130,964847	3,057585	28,962188	0,022935	46,426639	23,213319
254	2,930000	0,041891	1,429720	78,807097	153,190958	3,933566	74,303406	0,019640	49,763528	24,881764
255	1,130000	0,012815	1,134100	75,913486	182,864986	4,740273	276,923077	0,016827	52,846625	26,423313
256	0,073999	0,000666	0,899470	82,834944	117,239111	3,740065	54,836253	0,040951	44,584514	22,292257
257	0,020400	0,000795	3,895100	80,455847	149,570042	4,544307	195,652174	0,028133	48,036861	24,018431
258	0,024800	0,000000	0,000000	76,507153	188,381819	4,956971	537,313433	0,021210	52,168542	26,084271
259	0,571200	0,000000	0,000000	85,973528	55,627194	2,112738	25,387870	0,020900	34,288125	17,144063
260	0,309200	0,000000	0,000000	84,243681	64,432653	2,590021	98,495212	0,018091	35,865667	17,932833
261	0,100400	0,000000	0,000000	81,798069	73,288833	2,625629	450,000000	0,016103	37,315306	18,657653
262	0,939200	0,000000	0,000000	83,949819	99,201944	4,213483	847,058824	0,022000	40,920583	20,460292
263	5,160400	0,008507	0,164850	86,940500	66,013278	3,930560	60,759494	0,032758	37,297458	18,648729
264	3,293600	0,000518	0,015740	85,804139	76,041750	4,322507	189,973615	0,027930	38,210486	19,105243
265	0,081200	0,000000	0,000000	84,887153	255,847153	0,362002	352,941176	0,015447	0,000000	0,000000
266	0,017600	0,000000	0,000000	79,677653	181,146264	0,411189	142,574257	0,019896	0,000000	0,000000
267	0,018000	0,000000	0,000000	80,069972	168,799014	0,402354	200,000000	0,027077	0,000000	0,000000
268	0,028000	0,000000	0,000000	82,673264	258,598236	0,400391	521,739130	0,018326	0,000000	0,000000
269	0,073200	0,000000	0,000000	65,740042	135,533708	0,250898	44,887781	0,023106	1,497236	0,748618
270	0,051200	0,000000	0,000000	64,360181	152,779431	0,243260	7,384615	0,020977	1,939264	0,969632
271	0,002000	0,000000	0,000000	66,161639	121,162792	0,232045	35,982009	0,025393	1,537375	0,768687
272	0,033600	0,000000	0,000000	66,273417	158,571208	0,229869	9,057743	0,023157	1,605750	0,802875
273	0,009600	0,000000	0,000000	67,054194	132,168778	0,264611	101,838755	0,026886	1,718264	0,859132
274	0,033600	0,000000	0,000000	50,819986	117,209681	4,706498	496,551724	0,030678	27,751847	13,875924
275	0,016400	0,000000	0,000000	48,552444	131,467319	4,982009	1531,914894	0,026990	28,649486	14,324743
276	0,004000	0,000000	0,000000	53,047542	102,608153	4,437870	252,631579	0,036374	27,111069	13,555535
277	0,002800	0,000000	0,000000	49,605944	129,548958	4,970316	2400,000000	0,040507	28,003514	14,001757
278	0,002800	0,000000	0,000000	50,731667	122,584153	4,903964	1846,153846	0,044350	27,764625	13,882312
279	0,002000	0,000000	0,000000	53,174167	231,981333	1,852960	0,000000	0,019804	22,646972	11,323486
280	0,001200	0,000000	0,000000	53,264417	108,056403	4,399902	672,897196	0,028122	30,016597	15,008299
281	0,002800	0,000000	0,000000	54,650944	99,236931	4,254313	220,858896	0,030634	29,586083	14,793042

282	0,000400	0,000000	0,000000	50,870694	122,955250	4,451039	0,000000	0,025076	30,552639	15,276319
283	0,001200	0,000000	0,000000	54,642819	103,332028	4,893964	765,957447	0,043993	29,899042	14,949521
284	0,000800	0,000000	0,000000	55,572222	96,729014	4,887320	549,618321	0,048780	29,602528	14,801264
285	0,028400	0,000000	0,000000	61,657361	133,216639	5,769693	172,661871	0,024793	46,043639	23,021819
286	0,008000	0,000000	0,000000	62,807028	115,930694	5,092658	84,606345	0,028143	42,209611	21,104806
287	0,024800	0,000000	0,000000	59,120042	164,109292	6,596427	692,307692	0,020974	50,445944	25,222972
288	0,002800	0,000000	0,000000	54,799208	219,880653	7,027133	14400,000000	0,020767	53,885444	26,942722
289	0,001600	0,000000	0,000000	62,559111	122,987194	6,368300	327,272727	0,038985	42,621750	21,310875
290	0,001200	0,000000	0,000000	63,729722	107,080167	5,915701	161,797753	0,048337	39,523486	19,761743
291	0,594400	0,000000	0,000000	107,633514	219,825347	0,344947	51,612903	0,016333	0,000000	0,000000
292	0,278400	0,000000	0,000000	108,284861	188,349708	0,313060	25,378921	0,019051	0,000000	0,000000
293	0,268800	0,000000	0,000000	99,480056	271,263264	0,329438	225,000000	0,013582	0,000000	0,000000
294	0,054802	0,000000	0,000000	108,744764	140,452597	0,283373	642,857143	0,019607	0,000000	0,000000
295	0,238800	0,014766	6,183330	109,113667	97,053042	0,301099	67,415730	0,028473	0,000000	0,000000
296	0,186400	0,011246	6,033210	108,723111	107,725250	0,290562	171,428571	0,025103	0,000000	0,000000
297	2,546400	0,008727	0,342730	70,533667	138,718292	0,261354	30,573248	0,022264	1,880986	0,940493
298	1,036800	0,000000	0,000000	68,423792	165,035903	0,266183	6,233227	0,019088	2,372167	1,186083
299	0,968800	0,000000	0,000000	70,821181	123,619194	0,262284	16,713092	0,024821	2,138806	1,069403
300	1,216400	0,155417	12,776810	74,228458	75,706014	0,304912	108,761329	0,028007	2,571653	1,285826
301	1,017600	0,112707	11,075780	75,178931	68,644514	0,312509	42,129901	0,031060	2,538972	1,269486
302	0,302800	0,015548	5,134780	72,717444	91,283042	0,293065	23,825281	0,023720	2,874667	1,437333
303	0,386000	0,000000	0,000000	54,986875	105,713417	3,468208	120,805369	0,038053	31,482292	15,741146
304	0,504400	0,000128	0,025360	52,951653	121,181181	3,815783	288,000000	0,031393	32,003986	16,001993
305	0,207200	0,000000	0,000000	50,168944	141,078347	4,233053	1161,290323	0,025853	32,788361	16,394181
306	0,018800	0,000000	0,000000	60,391931	61,052306	2,038505	1309,090909	0,022497	27,654694	13,827347
307	0,197200	0,000638	0,323430	61,743917	53,735486	2,205072	286,852590	0,025959	27,518528	13,759264
308	0,167200	0,001167	0,698090	63,485611	47,369917	2,269790	106,038292	0,030441	27,306264	13,653132
309	0,665200	0,008860	1,331960	61,863472	61,648764	3,570189	837,209302	0,048927	28,076431	14,038215
310	1,184400	0,017217	1,453610	64,409194	52,973833	3,677973	292,682927	0,062590	27,360431	13,680215
311	0,227600	0,002162	0,949740	58,602736	82,062250	3,317667	3600,000000	0,034243	28,818569	14,409285
312	0,357200	0,000000	0,000000	64,691347	112,857500	2,296724	88,019560	0,029065	27,104889	13,552444
313	0,258400	0,000000	0,000000	63,563264	127,517083	2,413435	213,649852	0,025333	27,872750	13,936375
314	0,032400	0,000000	0,000000	61,384972	157,987056	2,552105	1180,327869	0,020869	29,487403	14,743701
315	0,009999	0,000000	0,000000	70,377819	55,980528	1,669101	289,156627	0,021738	22,595569	11,297785
316	0,148000	0,003399	2,296890	72,178583	48,127153	1,698474	51,391863	0,025412	22,598569	11,299285
317	2,080000	0,024545	1,180060	71,955264	60,002764	2,589462	160,356347	0,040158	23,423611	11,711806
318	1,290400	0,013149	1,018960	70,484597	68,148847	2,529955	507,042254	0,034203	23,772014	11,886007
319	0,330800	0,001108	0,334920	68,365514	85,780986	2,310803	2250,000000	0,027311	24,323597	12,161799
320	0,030401	0,000000	0,000000	57,247694	116,798764	3,743371	300,000000	0,027067	32,650361	16,325181
321	0,030802	0,000000	0,000000	58,785278	107,662972	3,489556	160,356347	0,029601	32,025361	16,012681
322	0,001999	0,000000	0,000000	53,643153	136,801417	3,966724	7200,000000	0,023115	33,823944	16,911972
323	0,074799	0,000000	0,000000	68,727806	51,379306	3,743371	179,551122	0,044335	28,062431	14,031215
324	0,054802	0,000000	0,000000	65,639139	61,619403	3,793667	808,988764	0,035951	28,745528	14,372764
325	0,009999	0,000000	0,000000	63,235194	77,208806	3,524747	5538,461538	0,029016	29,222694	14,611347
326	0,014803	0,000000	0,000000	68,583264	189,848167	3,168317	533,333333	0,019222	29,937903	14,968951
327	0,009999	0,000000	0,000000	70,916708	155,699403	3,264714	153,191489	0,023788	31,028042	15,514021
328	0,014803	0,000000	0,000000	73,038472	123,982083	2,718931	26,239067	0,032419	32,891125	16,445562
329	0,101200	0,000000	0,000000	74,133542	77,415000	2,697336	334,883721	0,018185	35,983458	17,991729
330	0,568800	0,000702	0,123360	75,237014	66,995111	2,557908	65,040650	0,021179	33,595056	16,797528
331	1,080000	0,011058	1,023840	76,243014	59,052417	2,024348	19,769357	0,024713	31,935333	15,967667
332	0,436000	0,016867	3,868530	75,499764	103,041194	4,576950	692,307692	0,026761	37,537569	18,768785
333	2,028000	0,147248	7,260770	76,515361	80,493306	4,655072	164,009112	0,035532	35,059236	17,529618
334	4,157600	0,353297	8,497630	77,302639	71,107972	4,209788	55,598456	0,042726	34,523639	17,261819
335	1,392400	0,012797	0,919060	68,566083	147,765403	4,594474	86,227545	0,023238	45,067431	22,533715
336	1,294800	0,011578	0,894220	70,108181	129,775444	3,661141	35,242291	0,026806	42,723278	21,361639
337	0,433200	0,000560	0,129220	65,745278	181,960917	5,717008	423,529412	0,019198	46,216694	23,108347
338	0,001598	0,000000	0,000000	61,902639	241,033931	6,083136	72000,000000	0,018797	45,901458	22,950729
339	0,461600	0,011323	2,452880	72,554125	62,827125	2,841021	107,946027	0,020829	34,222903	17,111451
340	0,743200	0,047175	6,347550	74,142569	55,022986	2,385291	29,912754	0,023918	32,670097	16,335049
341	0,092402	0,005516	5,969890	70,739653	71,041111	2,917460	500,000000	0,018600	36,171556	18,085778
342	1,969600	0,192554	9,776290	72,608458	96,552458	4,728132	888,888889	0,025764	37,697861	18,848931
343	7,604400	0,673219	8,853020	74,009944	76,016458	4,806088	203,966006	0,032689	35,358500	17,679250
344	12,666000	1,105366	8,727030	75,056250	66,208764	4,421247	65,395095	0,038737	34,821139	17,410569
345	0,221200	0,000000	0,000000	116,621347	279,895319	0,260164	181,818182	0,011573	0,000000	0,000000
346	0,298800	0,000000	0,000000	118,344250	220,361986	0,293637	52,060738	0,014197	0,000000	0,000000
347	0,334800	0,000000	0,000000	117,953514	176,579931	0,284240	18,947368	0,017480	0,000000	0,000000
348	0,024400	0,000000	0,000000	115,298000	327,778694	0,272387	483,221477	0,011749	0,000000	0,000000
349	0,006001	0,000000	0,000000	111,799903	152,836778	0,280063	58,252427	0,026387	0,000000	0,000000
350	0,005199	0,000000	0,000000	113,666306	176,905097	0,295904	98,360656	0,022175	0,000000	0,000000
351	0,064400	0,000000	0,000000	114,097903	94,372653	0,296667	170,212766	0,022586	0,000000	0,000000
352	0,126400	0,000000	0,000000	114,379681	82,644667	0,304574	63,660477	0,025804	0,000000	0,000000
353	0,036799	0,000000	0,000000	113,464736	125,056125	0,253344	590,163934	0,017819	0,000000	0,000000
354	0,593600	0,000000	0,000000	83,983208	184,439139	0,206264	3,734827	0,015026	1,836014	0,918007

355	1,402000	0,000000	0,000000	87,318486	146,728861	0,215164	16,359918	0,018240	1,215750	0,607875
356	2,154800	0,000000	0,000000	87,943514	129,926097	0,210646	7,578947	0,020377	1,382750	0,691375
357	0,004399	0,000000	0,000000	89,401431	127,337944	0,251732	37,170883	0,023873	1,969931	0,984965
358	0,060400	0,000000	0,000000	83,128139	222,356278	0,359874	14,128728	0,014652	2,293375	1,146687
359	0,017600	0,000000	0,000000	88,970653	137,361222	0,230996	39,279869	0,022171	1,462292	0,731146
360	0,729200	0,000000	0,000000	92,584403	70,503292	0,294788	44,943820	0,025574	2,405597	1,202799
361	0,389200	0,000000	0,000000	91,625236	78,415681	0,292969	129,496403	0,023066	2,435903	1,217951
362	0,102800	0,000000	0,000000	89,514639	101,832139	0,275534	34,383954	0,018725	2,769694	1,384847
363	0,042399	0,000000	0,000000	67,787292	159,692583	3,150295	1090,909091	0,018513	33,101389	16,550694
364	0,265600	0,000000	0,000000	73,957403	115,069722	2,711048	83,429896	0,027694	32,026181	16,013090
365	0,111600	0,000000	0,000000	71,588333	132,502417	2,951545	220,858896	0,023018	32,479944	16,239972
366	0,004399	0,000000	0,000000	75,284278	112,082833	3,076923	315,789474	0,048757	32,031194	16,015597
367	0,001600	0,000000	0,000000	73,953694	121,050806	3,088538	566,929134	0,041529	32,253556	16,126778
368	0,438400	0,000000	0,000000	82,790458	59,766347	3,079160	240,802676	0,044835	28,010056	14,005028
369	0,092401	0,000000	0,000000	77,434167	91,544097	2,724796	2666,666667	0,025861	29,498153	14,749076
370	0,320800	0,000000	0,000030	80,870333	69,040917	2,972382	600,000000	0,036199	28,577847	14,288924
371	0,045199	0,000000	0,000000	80,599819	178,384139	1,909105	800,000000	0,015796	28,024528	14,012264
372	1,224000	0,000000	0,000000	85,047931	117,575139	1,780239	45,311517	0,022916	26,627681	13,313840
373	0,228400	0,000000	0,000000	83,199069	140,522806	1,918363	156,182213	0,019143	27,625819	13,812910
374	0,016000	0,000000	0,000000	77,130319	273,801458	1,538823	10285,714286	0,013582	19,591444	9,795722
375	0,604800	0,000000	0,000000	90,255236	73,452083	2,087622	431,137725	0,026556	23,452944	11,726472
376	1,271600	0,000000	0,000000	91,946236	63,097583	2,144133	128,113879	0,031204	23,028611	11,514306
377	0,188000	0,000000	0,000000	87,722917	97,128375	1,877787	2000,000000	0,020744	24,271875	12,135937
378	0,083600	0,000000	0,000000	78,302347	108,554528	2,470915	61,120543	0,024441	33,390236	16,695118
379	0,011200	0,000000	0,000000	74,406056	127,776056	2,823529	255,319149	0,020594	34,500125	17,250063
380	0,003600	0,000000	0,000000	70,136347	152,474667	2,898084	2322,580645	0,017456	35,172361	17,586181
381	0,003201	0,000000	0,000000	81,541750	85,629875	2,720574	10285,714286	0,022664	30,942431	15,471215
382	0,034801	0,000000	0,000000	84,366722	67,758917	2,958094	558,139535	0,028024	30,222333	15,111167
383	0,170400	0,000000	0,000000	85,943403	60,081333	2,961988	181,818182	0,031850	29,803750	14,901875
384	0,398400	0,000000	0,000000	96,361569	73,767861	3,594967	62,283737	0,033390	38,500903	19,250451
385	0,171200	0,000000	0,000000	95,669014	84,113500	3,861004	172,248804	0,028139	39,048319	19,524160
386	0,054800	0,000000	0,000000	93,938875	115,308389	3,652968	791,208791	0,020315	42,578375	21,289188
387	0,793200	0,000000	0,000000	88,530389	134,901708	2,731100	25,908600	0,021573	47,302361	23,651181
388	0,112400	0,000000	0,000000	83,070556	191,353111	4,276296	338,028169	0,015320	53,422028	26,711014
389	0,296800	0,000000	0,000000	85,825167	157,935583	3,615547	80,446927	0,018276	50,458653	25,229326
390	1,692000	0,000000	0,000000	92,739097	79,425653	3,911768	189,473684	0,026271	39,133361	19,566681
391	0,402000	0,000159	0,039500	90,704986	103,931528	3,780718	837,209302	0,020428	42,131250	21,065625
392	3,898400	0,000000	0,000000	93,913833	68,488028	3,605950	59,602649	0,030934	38,477014	19,238507
393	0,035600	0,000000	0,000000	88,959667	191,963931	0,390348	110,429448	0,018140	0,000000	0,000000
394	0,000400	0,000000	0,000000	88,693250	160,558806	0,298911	110,429448	0,020740	0,000000	0,000000
395	0,136400	0,000000	0,000000	94,000278	267,420972	0,323012	290,322581	0,014073	0,000000	0,000000
396	0,008800	0,000000	0,000000	88,832139	176,580625	0,359982	186,046512	0,024751	0,000000	0,000000
397	0,096400	0,000000	0,000000	91,224111	262,201819	0,406736	378,947368	0,017013	0,000000	0,000000
398	0,011200	0,000000	0,000000	93,301625	83,889639	0,308042	196,185286	0,027796	0,000000	0,000000
399	0,006000	0,000000	0,000000	93,390875	80,862319	0,305794	158,590308	0,028856	0,000000	0,000000
400	0,170400	0,000000	0,000000	71,207764	140,450861	0,258134	38,668099	0,021362	1,648931	0,824465
401	0,400000	0,000000	0,000000	69,168778	164,075875	0,242646	6,704535	0,018854	2,108972	1,054486
402	0,009600	0,000000	0,000000	71,797403	124,098625	0,233371	23,684211	0,023761	1,487458	0,743729
403	0,014400	0,000000	0,000000	72,705917	133,909694	0,247262	78,860898	0,025365	1,626444	0,813222
404	0,090400	0,000000	0,000000	68,584431	196,126611	0,324054	16,400911	0,018550	2,127431	1,063715
405	0,062800	0,000000	0,000000	75,248486	73,368667	0,343602	141,176471	0,026840	2,411903	1,205951
406	0,018000	0,000000	0,000000	75,761361	68,452944	0,343716	81,725312	0,028683	2,384694	1,192347
407	0,018000	0,000000	0,000000	74,043847	86,798597	0,308606	26,637070	0,023433	2,514236	1,257118
408	0,058800	0,000000	0,000000	56,692986	121,970639	4,091607	376,963351	0,028149	29,225792	14,612896
409	0,012400	0,000000	0,000000	58,977931	106,571083	3,831825	177,777778	0,033493	28,635167	14,317583
410	0,031200	0,000000	0,000000	53,773194	140,955958	4,404478	1358,490566	0,023933	30,132764	15,066382
411	0,001600	0,000000	0,000000	54,518972	141,428153	4,321729	5142,857143	0,034166	29,700986	14,850493
412	0,006400	0,000000	0,000000	57,829000	119,446542	4,280364	857,142857	0,045236	29,032181	14,516090
413	0,044000	0,000000	0,000000	65,863653	62,300694	3,983843	947,368421	0,044002	25,077556	12,538778
414	0,120400	0,000000	0,000000	67,129861	55,876861	4,100928	365,482234	0,052184	24,680681	12,340340
415	0,004000	0,000000	0,000000	63,665875	75,472069	3,771213	9000,000000	0,034538	25,767097	12,883549
416	0,008400	0,000000	0,000000	59,905319	237,639667	2,029713	36000,000000	0,018236	23,210875	11,605438
417	0,011600	0,000000	0,000000	76,340611	61,224444	2,610020	317,180617	0,035128	21,132917	10,566458
418	0,000400	0,000000	0,000000	74,367014	75,323569	2,378043	0,000000	0,028354	21,722306	10,861153
419	0,002800	0,000000	0,000000	72,578750	91,690944	2,218388	72000,000000	0,024153	22,479139	11,239569
420	0,003200	0,000000	0,000000	56,429139	132,646903	3,950617	2057,142857	0,022424	32,125111	16,062556
421	0,002800	0,000000	0,000000	57,733667	125,027500	3,884333	1058,823529	0,023595	31,827000	15,913500
422	0,001200	0,000000	0,000000	65,738847	72,494083	3,881611	72000,000000	0,028553	28,084972	14,042486
423	0,016000	0,000000	0,000000	67,705833	61,262167	4,099294	734,693878	0,033441	27,527708	13,763854
424	0,080400	0,000000	0,000000	69,205819	54,443819	4,003559	201,680672	0,038347	27,211417	13,605708
425	0,008000	0,000000	0,000000	72,608528	168,382764	3,533222	455,696203	0,028988	31,635847	15,817924
426	0,002000	0,000000	0,000000	73,312083	152,358153	3,598021	402,234637	0,033302	31,166597	15,583299
427	0,010000	0,000000	0,000000	77,289819	72,157653	5,114726	227,129338	0,035241	33,814972	16,907486

428	0,000800	0,000000	0,000000	77,421958	69,981875	5,217391	313,043478	0,036653	33,591833	16,795917
429	0,050400	0,000000	0,000000	68,084917	148,265083	5,232558	182,278481	0,021722	48,587944	24,293972
430	0,002800	0,000000	0,000000	69,740153	128,669472	4,764741	109,090909	0,024625	45,809944	22,904972
431	0,054800	0,000000	0,000000	66,035847	168,231153	5,721551	447,204969	0,019526	51,145139	25,572569
432	0,051200	0,000000	0,000000	63,785417	201,308889	6,254343	1028,571429	0,021406	52,498833	26,249417
433	0,163600	0,000000	0,000000	74,547389	69,285361	5,210595	266,666667	0,031974	33,387014	16,693507
434	0,799600	0,000000	0,000000	75,300708	62,373014	4,834811	91,254753	0,036053	32,660556	16,330278
435	0,025200	0,000000	0,000000	72,899944	89,457903	5,071137	1469,387755	0,025300	36,698014	18,349007
436	0,028400	0,000000	0,000000	89,175583	153,240403	0,331790	39,933444	0,021584	0,000000	0,000000
437	0,266000	0,000000	0,000000	88,625958	187,296167	0,391886	80,989876	0,018403	0,000000	0,000000
438	0,282800	0,000000	0,000000	92,838181	246,337972	0,352037	197,802198	0,014979	0,000000	0,000000
439	0,092800	0,000000	0,000000	93,360208	304,427875	0,347957	507,042254	0,014789	0,000000	0,000000
440	0,001200	0,000000	0,000000	89,970472	140,197167	0,313000	90,909091	0,032954	0,000000	0,000000
441	0,009600	0,000000	0,000000	89,372889	158,992153	0,344093	119,402985	0,027857	0,000000	0,000000
442	0,029600	0,000000	0,000000	91,489986	112,262625	0,308400	757,894737	0,021630	0,000000	0,000000
443	0,077600	0,003986	5,137110	93,539806	77,688222	0,319497	82,853855	0,030029	0,000000	0,000000
444	0,084000	0,000000	0,000000	93,154806	87,234653	0,313027	206,303725	0,026681	0,000000	0,000000
445	0,370800	0,000000	0,000000	99,255625	9,516653	0,153582	197,802198	0,026869	0,000000	0,000000
446	0,397200	0,000000	0,000000	98,095153	11,054514	0,131880	765,957447	0,023540	0,000000	0,000000
447	0,024000	0,000000	0,000000	99,258833	9,516806	0,152900	106,351551	0,026869	0,000000	0,000000
448	0,102400	0,000000	0,000000	71,812847	123,292903	0,234063	17,167382	0,023872	1,510611	0,755306
449	0,609200	0,001504	0,246860	71,315083	138,017542	0,236982	29,256400	0,021654	1,428236	0,714118
450	0,456800	0,000000	0,000000	69,434861	161,538625	0,240338	5,948938	0,019061	2,083694	1,041847
451	0,044800	0,000000	0,000000	71,212528	170,303778	0,230169	9,197752	0,020746	1,657014	0,828507
452	0,096000	0,000000	0,000000	73,649097	91,088194	0,302888	27,334852	0,022628	2,548944	1,274472
453	0,286800	0,000000	0,000000	75,240569	73,328306	0,343320	117,839607	0,026817	2,411889	1,205944
454	0,188800	0,000800	0,423680	75,909597	67,146958	0,343390	49,281314	0,029212	2,376556	1,188278
455	0,019200	0,000000	0,000000	90,381625	8,006333	0,227120	31,482291	0,023402	0,796208	0,398104
456	0,114800	0,000000	0,000000	90,382222	8,006292	0,228032	62,015504	0,023402	0,795847	0,397924
457	0,040800	0,000000	0,000000	89,149083	8,541792	0,223529	14,173228	0,022401	0,803917	0,401958
458	0,020400	0,000000	0,000000	53,662125	141,341792	4,388906	1531,914894	0,023840	30,163639	15,081819
459	0,054000	0,000000	0,000000	57,100486	118,926986	4,041992	309,012876	0,028996	29,100292	14,550146
460	0,077200	0,000000	0,000000	59,491542	102,847542	3,678537	114,104596	0,035161	28,498306	14,249153
461	0,000800	0,000000	0,000000	57,874500	118,563861	4,256829	2117,647059	0,045762	29,016792	14,508396
462	0,001600	0,000000	0,000000	60,729931	99,482653	4,146749	428,571429	0,065891	28,349875	14,174937
463	0,041600	0,000000	0,000000	63,075444	79,137292	3,736960	4000,000000	0,032722	25,945694	12,972847
464	0,602800	0,001517	0,251590	67,276764	55,056014	4,059311	271,698113	0,053403	24,630931	12,315465
465	0,213600	0,000000	0,000000	65,795611	62,454583	3,974387	791,208791	0,043768	25,091139	12,545569
466	0,014400	0,000000	0,000000	75,288736	14,889472	2,367487	0,000000	0,020067	16,200500	8,100250
467	0,051200	0,000000	0,000000	67,961681	133,367694	2,380874	284,584980	0,022735	25,998069	12,999035
468	0,027200	0,000000	0,000000	69,490792	117,609444	2,313030	138,996139	0,025502	25,023153	12,511576
469	0,013200	0,000000	0,000000	65,499389	161,603361	2,390518	1200,000000	0,019651	27,079431	13,539715
470	0,001600	0,000000	0,000000	69,664917	120,020917	2,440099	549,618321	0,036241	24,873222	12,436611
471	0,004800	0,000000	0,000000	70,996861	107,763486	2,448980	230,031949	0,042824	24,357708	12,178854
472	0,013200	0,000000	0,000000	73,350764	85,351611	2,326934	4500,000000	0,025488	22,182222	11,091111
473	0,068400	0,000000	0,000000	75,346667	67,762264	2,545969	600,000000	0,031344	21,415097	10,707549
474	0,084800	0,000000	0,000000	76,183708	61,891694	2,591513	269,662921	0,034622	21,157861	10,578931
475	0,002800	0,000000	0,000000	88,914597	7,167028	2,675784	585,365854	0,031164	11,900153	5,950076
476	0,005600	0,000000	0,000000	88,941694	7,167014	2,696831	1090,909091	0,031164	11,900458	5,950229
477	0,002000	0,000000	0,000000	86,404639	8,701069	2,462970	1,010101	0,026296	12,200861	6,100431
478	0,012400	0,000000	0,000000	55,167250	139,495931	4,066878	2181,818182	0,021463	32,551264	16,275632
479	0,003600	0,000000	0,000000	59,293958	116,127208	3,815985	441,717791	0,025202	31,496083	15,748042
480	0,026000	0,000000	0,000000	61,819139	99,824306	3,512024	100,139082	0,029377	30,809083	15,404542
481	0,110800	0,000000	0,000000	68,889528	55,459583	4,031129	233,009709	0,037414	27,257000	13,628500
482	0,034800	0,000000	0,000000	67,517611	62,154028	4,109824	757,894737	0,032895	27,577833	13,788917
483	0,010400	0,000000	0,000000	65,183361	76,785764	3,821453	4800,000000	0,027184	28,321958	14,160979
484	0,006800	0,000000	0,000000	67,661792	194,970125	2,882190	900,000000	0,018163	31,927722	15,963861
485	0,002000	0,000000	0,000000	76,170597	94,804611	4,938949	2117,647059	0,026423	37,535639	18,767819
486	0,000400	0,000000	0,000000	77,303222	70,225681	5,331359	533,333333	0,036423	33,600069	16,800035
487	0,004000	0,000000	0,000000	76,886889	77,361153	5,135521	441,717791	0,032360	34,471250	17,235625
488	0,001200	0,000000	0,000000	87,512861	6,773333	4,427227	261,818182	0,038077	15,517236	7,758618
489	0,005600	0,000000	0,000000	86,308778	7,413542	4,274773	1756,097561	0,034430	15,897292	7,948646
490	0,018000	0,000000	0,000000	87,619417	6,773333	4,536576	387,096774	0,038077	15,517236	7,758618
491	0,097600	0,000000	0,000000	70,238389	121,111194	4,079551	49,586777	0,026039	44,771097	22,385549
492	0,172000	0,000000	0,000000	68,551028	142,493806	4,958678	122,241087	0,022452	47,816236	23,908118
493	0,151600	0,000000	0,000000	65,805194	169,968111	5,742543	423,529412	0,019349	51,374208	25,687104
494	0,071200	0,000000	0,000000	64,027111	197,925403	6,228374	900,000000	0,021752	52,272389	26,136194
495	0,001600	0,000000	0,000000	69,105903	142,761667	5,700713	444,444444	0,031383	46,782333	23,391167
496	0,631200	0,000000	0,000000	74,472486	69,788458	5,168330	240,802676	0,031684	33,424667	16,712333
497	0,150800	0,000000	0,000000	72,832708	90,119750	5,048734	1263,157895	0,025124	36,829958	18,414979
498	1,354000	0,000000	0,000000	75,268389	62,355889	4,778655	85,409253	0,036004	32,622597	16,311299
499	0,018400	0,000000	0,000000	87,272611	6,596389	4,479841	167,832168	0,033961	15,698417	7,849208
500	0,020400	0,000000	0,000000	87,272778	6,596389	4,479841	387,096774	0,033961	15,698417	7,849208

Appendix 4. On the tables below we have the representation of the highest and the lowest values of each Ecosystem Service in the different HRUs. From the 500 HRUs the five most high and relevant values of each ES were selected, and the same exercise was done to the lowest values of Ecosystem Services.

Table 1 - Highest values of each Ecosystem Service, per HRU, according to the values of each analysed outputs.

Ecosystem Services	Highest Values					
	HRU ID	**Water Quantity (mm)**	**HRU ID**	**Water Timing (mm)**	**HRU ID**	**Water Quality (N kg/ha. yr)**
Water Supply	**9**	126,370875	**348**	327,778694	**190**	10,047446
	7	126,353792	**59**	313,320569	**191**	9,531374
	8	126,039431	**439**	304,427875	**189**	8,995502
	4	125,707958	**196**	288,011292	**192**	8,065420
	62	125,628250	**246**	281,491236	**188**	7,649809
	HRU ID	**Soil Erosion Control(t/ha. yr)**	**HRU ID**	**Flood Regulation (mm)**		
Water damage mitigation	**338**	72000	**178**	0,069415		
	422	72000	**175**	0,069129		
	419	72000	**462**	0,065891		
	416	36000	**310**	0,062590		
	74	24000	**177**	0,058588		
	HRU ID	**Biomass (t/ha. yr)**				
Biomass Production	**151**	55,375764				
	288	53,885444				
	388	53,422028				
	255	52,846625				
	432	52,498833				
	HRU ID	**Carbon Storage (tC/ha.yr)**				
Climate Regulation	**151**	27,687882				
	288	26,942722				
	388	26,711014				
	255	26,423313				
	432	26,249417				

Table 2: Lowest values of each Ecosystem Service, per HRU, according to the values of each analysed outputs.

Ecosystem Services	Lowest Values					
	HRU ID	**Water Quantity (mm)**	**HRU ID**	**Water Timing (mm)**	**HRU ID**	**Water Quality (N kg/ha. yr)**
Water Supply	**176**	36,836236	**499**	6,596389	**446**	0,131880
	173	37,564514	**500**	6,596389	**5**	0,145718
	174	40,254944	**488**	6,773333	**447**	0,152900
	175	41,185167	**490**	6,773333	**445**	0,153582
	172	41,691736	**476**	7,167014	**6**	0,162169
	HRU ID	**Soil Erosion Control (t/ha. yr)**	**HRU ID**	**Flood Regulation (mm)**		
Water damage mitigation	**477**	1,010101	**109**	0,011396		
	203	3,368106	**345**	0,011573		
	117	3,415074	**58**	0,011697		
	354	3,734827	**348**	0,011749		
	121	4,046535	**59**	0,011991		
	HRU ID	**Biomass (t/ha. yr)**				
Biomass Production	**456**	0,795847				
	455	0,796208				
	457	0,803917				
	355	1,215750				
	204	1,337069				
	HRU ID	**Carbon Storage (tC/ha.yr)**				
Climate Regulation	**456**	0,397924				
	455	0,398104				
	457	0,401958				
	355	0,607875				
	204	0,668535				

Appendix 5. Table with information on the Ecosystem Services present in each of the 500 HRUs. The gaps refer to inexistence of the service in the HRU and the symbol "✔" refers to the presence of that service in the HRU.

HRU ID	HRU area (Km2)	HNVf area (%)	Water Supply			Water damage mitigation		Biomass Production	Climate Regulation
			Water Quantity	Water Timing	Water Quality	Soil Erosion Control	Flood Regulation	Biomass	Carbon Storage
1	0,004401	0,000	✔	✔	✔	✔	✔	✔	✔
2	0,002803	0,000	✔	✔	✔	✔	✔	✔	✔
3	0,025599	0,000	✔	✔	✔	✔	✔	✔	✔
4	0,000401	0,000	✔	✔	✔	✔	✔	✔	✔
5	0,000803	0,000	✔	✔	✔	✔	✔	✔	✔
6	0,004000	0,000	✔	✔	✔	✔	✔	✔	✔
7	0,167200	17,286	✔	✔	✔	✔	✔	✔	✔
8	0,033198	22,193	✔	✔	✔	✔	✔	✔	✔
9	0,340400	6,295	✔	✔	✔	✔	✔	✔	✔
10	0,021599	0,000	✔	✔	✔	✔	✔	✔	✔
11	0,119200	0,000	✔	✔	✔	✔	✔	✔	✔
12	0,018000	0,000	✔	✔	✔	✔	✔	✔	✔
13	0,038797	0,000	✔	✔	✔	✔	✔	✔	✔
14	0,018402	0,000	✔	✔	✔	✔	✔	✔	✔
15	0,053600	0,000	✔	✔	✔	✔	✔	✔	✔
16	0,261600	13,454	✔	✔	✔	✔	✔	✔	✔
17	0,313200	7,404	✔	✔	✔	✔	✔	✔	✔
18	0,058402	27,057	✔	✔	✔	✔	✔	✔	✔
19	1,586000	19,621	✔	✔	✔	✔	✔	✔	✔
20	0,414800	22,018	✔	✔	✔	✔	✔	✔	✔
21	3,147200	15,678	✔	✔	✔	✔	✔	✔	✔
22	0,002401	0,000	✔	✔	✔	✔	✔	✔	✔
23	0,003197	0,000	✔	✔	✔	✔	✔	✔	✔
24	0,002000	0,000	✔	✔	✔	✔	✔	✔	✔
25	0,000803	0,000	✔	✔	✔	✔	✔	✔	✔
26	0,069600	0,939	✔	✔	✔	✔	✔	✔	✔
27	0,063600	0,000	✔	✔	✔	✔	✔	✔	✔
28	0,236400	4,099	✔	✔	✔	✔	✔	✔	✔
29	0,659200	3,282	✔	✔	✔	✔	✔	✔	✔
30	1,758000	1,431	✔	✔	✔	✔	✔	✔	✔
31	0,003197	0,000	✔	✔	✔	✔	✔	✔	✔
32	0,026402	0,000	✔	✔	✔	✔	✔	✔	✔
33	0,067600	21,565	✔	✔	✔	✔	✔	✔	✔
34	0,574400	0,000	✔	✔	✔	✔	✔	✔	✔
35	0,168800	1,983	✔	✔	✔	✔	✔	✔	✔
36	0,293600	8,848	✔	✔	✔	✔	✔	✔	✔
37	3,896000	1,070	✔	✔	✔	✔	✔	✔	✔
38	0,868000	3,504	✔	✔	✔	✔	✔	✔	✔
39	0,016402	0,000	✔	✔	✔	✔	✔	✔	✔
40	0,082002	2,240	✔	✔	✔	✔	✔	✔	✔
41	0,000401	0,000	✔	✔	✔		✔	✔	✔
42	0,482800	0,382	✔	✔	✔	✔	✔	✔	✔

43	1,814800	0,944	✔	✔	✔	✔	✔	✔	✔
44	2,898000	1,380	✔	✔	✔	✔	✔	✔	✔
45	0,786800	14,070	✔	✔	✔	✔	✔	✔	✔
46	2,908000	7,900	✔	✔	✔	✔	✔	✔	✔
47	5,091200	3,735	✔	✔	✔	✔	✔	✔	✔
48	0,009599	0,000	✔	✔	✔	✔	✔	✔	✔
49	0,010000	0,000	✔	✔	✔	✔	✔	✔	✔
50	0,382800	13,597	✔	✔	✔	✔	✔	✔	✔
51	3,919600	8,969	✔	✔	✔	✔	✔	✔	✔
52	1,709600	11,365	✔	✔	✔	✔	✔	✔	✔
53	3,742800	40,036	✔	✔	✔	✔	✔	✔	✔
54	9,563200	31,259	✔	✔	✔	✔	✔	✔	✔
55	14,955000	10,279	✔	✔	✔	✔	✔	✔	✔
56	0,027600	0,000	✔	✔	✔	✔	✔		
57	0,002400	0,000	✔	✔	✔	✔	✔		
58	0,018401	0,000	✔	✔	✔	✔	✔		
59	0,001999	0,000	✔	✔	✔	✔	✔		
60	0,023201	2,882	✔	✔	✔	✔	✔		
61	0,137600	22,065	✔	✔	✔	✔	✔		
62	0,191600	9,441	✔	✔	✔	✔	✔		
63	0,066799	0,000	✔	✔	✔	✔	✔	✔	✔
64	0,021599	0,000	✔	✔	✔	✔	✔	✔	✔
65	0,013601	0,000	✔	✔	✔	✔	✔	✔	✔
66	0,000801	0,000	✔	✔	✔	✔	✔	✔	✔
67	0,007200	0,000	✔	✔	✔	✔	✔	✔	✔
68	0,824800	64,650	✔	✔	✔	✔	✔	✔	✔
69	0,890800	48,981	✔	✔	✔	✔	✔	✔	✔
70	0,210400	61,849	✔	✔	✔	✔	✔	✔	✔
71	0,203600	0,000	✔	✔	✔	✔	✔	✔	✔
72	0,027600	0,000	✔	✔	✔	✔	✔	✔	✔
73	0,103200	0,000	✔	✔	✔	✔	✔	✔	✔
74	0,000401	0,000	✔	✔	✔	✔	✔	✔	✔
75	0,013601	0,000	✔	✔	✔	✔	✔	✔	✔
76	0,003201	0,000	✔	✔	✔	✔	✔	✔	✔
77	0,325600	5,884	✔	✔	✔	✔	✔	✔	✔
78	0,107600	4,722	✔	✔	✔	✔	✔	✔	✔
79	0,036799	9,768	✔	✔	✔	✔	✔	✔	✔
80	0,007200	0,000	✔	✔	✔	✔	✔	✔	✔
81	0,003999	0,000	✔	✔	✔	✔	✔	✔	✔
82	0,020400	0,000	✔	✔	✔	✔	✔	✔	✔
83	0,000801	0,000	✔	✔	✔		✔	✔	✔
84	0,202800	47,226	✔	✔	✔	✔	✔	✔	✔
85	0,121600	50,509	✔	✔	✔	✔	✔	✔	✔
86	0,046402	51,253	✔	✔	✔	✔	✔	✔	✔
87	0,280800	2,269	✔	✔	✔	✔	✔	✔	✔
88	0,053201	1,406	✔	✔	✔	✔	✔	✔	✔
89	2,142400	8,295	✔	✔	✔	✔	✔	✔	✔
90	0,000401	0,000	✔	✔	✔	✔	✔	✔	✔
91	0,001999	0,000	✔	✔	✔	✔	✔	✔	✔
92	0,688800	7,345	✔	✔	✔	✔	✔	✔	✔

93	1,060000	7,511	✔	✔	✔	✔	✔	✔	✔
94	0,327600	3,919	✔	✔	✔	✔	✔	✔	✔
95	3,373200	12,869	✔	✔	✔	✔	✔	✔	✔
96	0,495600	8,262	✔	✔	✔	✔	✔	✔	✔
97	1,650000	7,832	✔	✔	✔	✔	✔	✔	✔
98	0,245200	0,000	✔	✔	✔	✔	✔	✔	✔
99	0,084399	0,000	✔	✔	✔	✔	✔	✔	✔
100	0,359600	0,000	✔	✔	✔	✔	✔	✔	✔
101	0,001599	0,000	✔	✔	✔	✔	✔	✔	✔
102	0,006001	0,000	✔	✔	✔	✔	✔	✔	✔
103	2,044400	25,723	✔	✔	✔	✔	✔	✔	✔
104	0,657600	16,287	✔	✔	✔	✔	✔	✔	✔
105	1,319600	18,467	✔	✔	✔	✔	✔	✔	✔
106	12,947000	13,088	✔	✔	✔	✔	✔	✔	✔
107	0,864000	48,874	✔	✔	✔	✔	✔	✔	✔
108	2,869600	17,864	✔	✔	✔	✔	✔	✔	✔
109	0,027199	15,733	✔	✔	✔	✔	✔		
110	0,164400	4,949	✔	✔	✔	✔	✔		
111	0,321200	0,404	✔	✔	✔	✔	✔		
112	0,023200	42,709	✔	✔	✔	✔	✔		
113	0,037200	43,503	✔	✔	✔	✔	✔		
114	0,047199	23,441	✔	✔	✔	✔	✔		
115	0,200400	24,488	✔	✔	✔	✔	✔		
116	0,262000	11,759	✔	✔	✔	✔	✔		
117	0,293200	49,789	✔	✔	✔	✔	✔	✔	✔
118	1,607600	17,532	✔	✔	✔	✔	✔	✔	✔
119	1,631600	1,411	✔	✔	✔	✔	✔	✔	✔
120	0,046000	67,084	✔	✔	✔	✔	✔	✔	✔
121	0,222000	93,765	✔	✔	✔	✔	✔	✔	✔
122	0,428800	8,213	✔	✔	✔	✔	✔	✔	✔
123	0,356800	7,207	✔	✔	✔	✔	✔	✔	✔
124	0,052000	0,000	✔	✔	✔	✔	✔	✔	✔
125	0,045599	6,760	✔	✔	✔	✔	✔	✔	✔
126	0,156800	5,043	✔	✔	✔	✔	✔	✔	✔
127	0,451600	0,661	✔	✔	✔	✔	✔	✔	✔
128	0,002001	20,305	✔	✔	✔	✔	✔	✔	✔
129	0,002800	21,271	✔	✔	✔	✔	✔	✔	✔
130	0,076399	0,000	✔	✔	✔	✔	✔	✔	✔
131	0,792000	0,035	✔	✔	✔	✔	✔	✔	✔
132	0,301200	0,111	✔	✔	✔	✔	✔	✔	✔
133	0,103600	0,479	✔	✔	✔	✔	✔	✔	✔
134	0,428800	0,003	✔	✔	✔	✔	✔	✔	✔
135	0,025599	0,966	✔	✔	✔	✔	✔	✔	✔
136	0,000799	58,936	✔	✔	✔		✔	✔	✔
137	0,037200	0,000	✔	✔	✔	✔	✔	✔	✔
138	0,798000	0,000	✔	✔	✔	✔	✔	✔	✔
139	0,273600	0,000	✔	✔	✔	✔	✔	✔	✔
140	0,134800	0,000	✔	✔	✔	✔	✔	✔	✔
141	0,004800	0,000	✔	✔	✔	✔	✔	✔	✔
142	0,026400	0,000	✔	✔	✔	✔	✔	✔	✔

143	0,456000	0,000	✔	✔	✔	✔	✔	✔	✔
144	0,033600	0,000	✔	✔	✔	✔	✔	✔	✔
145	0,062399	0,000	✔	✔	✔	✔	✔	✔	✔
146	0,026400	0,000	✔	✔	✔	✔	✔	✔	✔
147	0,008800	0,000	✔	✔	✔	✔	✔	✔	✔
148	0,023999	1,669	✔	✔	✔	✔	✔	✔	✔
149	0,223600	20,507	✔	✔	✔	✔	✔	✔	✔
150	0,263200	2,780	✔	✔	✔	✔	✔	✔	✔
151	0,032801	0,000	✔	✔	✔	✔	✔	✔	✔
152	0,430400	0,133	✔	✔	✔	✔	✔	✔	✔
153	0,088000	1,622	✔	✔	✔	✔	✔	✔	✔
154	0,419200	1,110	✔	✔	✔	✔	✔	✔	✔
155	1,856400	4,428	✔	✔	✔	✔	✔	✔	✔
156	5,319600	0,830	✔	✔	✔	✔	✔	✔	✔
157	0,026800	4,533	✔	✔	✔	✔	✔		
158	0,153600	4,211	✔	✔	✔	✔	✔		
159	0,036000	23,307	✔	✔	✔	✔	✔		
160	0,078400	10,934	✔	✔	✔	✔	✔		
161	0,020400	27,180	✔	✔	✔	✔	✔		
162	0,002400	41,679	✔	✔	✔	✔	✔		
163	0,008000	49,636	✔	✔	✔	✔	✔	✔	✔
164	0,560000	11,935	✔	✔	✔	✔	✔	✔	✔
165	0,087200	1,835	✔	✔	✔	✔	✔	✔	✔
166	0,106400	9,917	✔	✔	✔	✔	✔	✔	✔
167	0,004000	1,395	✔	✔	✔	✔	✔	✔	✔
168	0,376000	20,782	✔	✔	✔	✔	✔	✔	✔
169	0,132400	27,647	✔	✔	✔	✔	✔	✔	✔
170	0,000400	0,000	✔	✔	✔	✔	✔	✔	✔
171	0,002400	0,000	✔	✔	✔	✔	✔	✔	✔
172	0,156800	0,000	✔	✔	✔	✔	✔	✔	✔
173	0,074400	0,153	✔	✔	✔	✔	✔	✔	✔
174	0,307600	0,227	✔	✔	✔	✔	✔	✔	✔
175	0,022400	4,912	✔	✔	✔	✔	✔	✔	✔
176	0,026000	1,156	✔	✔	✔	✔	✔	✔	✔
177	0,000400	0,000	✔	✔	✔		✔	✔	✔
178	0,000400	0,000	✔	✔	✔	✔	✔	✔	✔
179	0,002000	0,000	✔	✔	✔	✔	✔	✔	✔
180	0,017600	6,734	✔	✔	✔	✔	✔	✔	✔
181	0,008800	0,000	✔	✔	✔	✔	✔	✔	✔
182	0,008400	0,000	✔	✔	✔	✔	✔	✔	✔
183	0,057600	0,526	✔	✔	✔	✔	✔	✔	✔
184	0,022800	0,000	✔	✔	✔	✔	✔	✔	✔
185	0,002800	0,000	✔	✔	✔	✔	✔	✔	✔
186	0,001600	0,000	✔	✔	✔	✔	✔	✔	✔
187	0,110800	0,722	✔	✔	✔	✔	✔	✔	✔
188	0,159200	2,678	✔	✔	✔	✔	✔	✔	✔
189	0,043200	0,000	✔	✔	✔	✔	✔	✔	✔
190	0,016800	2,121	✔	✔	✔	✔	✔	✔	✔
191	0,003200	12,500	✔	✔	✔	✔	✔	✔	✔
192	0,006000	87,477	✔	✔	✔	✔	✔	✔	✔

193	1,610000	13,446	✔	✔	✔	✔	✔	✔	✔
194	0,558000	22,413	✔	✔	✔	✔	✔	✔	✔
195	1,030400	6,085	✔	✔	✔	✔	✔	✔	✔
196	0,282800	8,644	✔	✔	✔	✔	✔	✔	✔
197	0,090800	1,774	✔	✔	✔	✔	✔	✔	✔
198	0,015999	0,000	✔	✔	✔	✔	✔	✔	✔
199	0,225600	0,546	✔	✔	✔	✔	✔	✔	✔
200	0,201600	4,993	✔	✔	✔	✔	✔	✔	✔
201	0,025200	0,000	✔	✔	✔	✔	✔	✔	✔
202	5,959600	15,288	✔	✔	✔	✔	✔	✔	✔
203	3,716000	13,574	✔	✔	✔	✔	✔	✔	✔
204	2,068000	11,564	✔	✔	✔	✔	✔	✔	✔
205	0,063602	2,256	✔	✔	✔	✔	✔	✔	✔
206	2,104400	34,861	✔	✔	✔	✔	✔	✔	✔
207	0,394400	19,730	✔	✔	✔	✔	✔	✔	✔
208	0,000801	0,000	✔	✔	✔	✔	✔	✔	✔
209	0,003199	0,000	✔	✔	✔	✔	✔	✔	✔
210	1,160400	1,474	✔	✔	✔	✔	✔	✔	✔
211	1,018400	1,203	✔	✔	✔	✔	✔	✔	✔
212	0,138800	1,153	✔	✔	✔	✔	✔	✔	✔
213	1,738400	2,432	✔	✔	✔	✔	✔	✔	✔
214	0,700400	2,977	✔	✔	✔	✔	✔	✔	✔
215	1,173200	3,308	✔	✔	✔	✔	✔	✔	✔
216	0,108000	14,516	✔	✔	✔	✔	✔	✔	✔
217	0,112000	1,976	✔	✔	✔	✔	✔	✔	✔
218	0,037200	0,213	✔	✔	✔	✔	✔	✔	✔
219	0,014402	0,000	✔	✔	✔	✔	✔	✔	✔
220	0,006798	0,000	✔	✔	✔	✔	✔	✔	✔
221	0,013201	0,000	✔	✔	✔	✔	✔	✔	✔
222	0,202800	0,000	✔	✔	✔	✔	✔	✔	✔
223	0,621200	0,742	✔	✔	✔	✔	✔	✔	✔
224	1,541600	0,307	✔	✔	✔	✔	✔	✔	✔
225	0,430800	7,521	✔	✔	✔	✔	✔	✔	✔
226	0,080002	12,621	✔	✔	✔	✔	✔	✔	✔
227	0,495200	1,513	✔	✔	✔	✔	✔	✔	✔
228	0,023598	33,454	✔	✔	✔	✔	✔	✔	✔
229	0,138400	5,759	✔	✔	✔	✔	✔	✔	✔
230	0,001201	0,000	✔	✔	✔	✔	✔	✔	✔
231	0,000400	0,000	✔	✔	✔	✔	✔	✔	✔
232	0,944400	0,115	✔	✔	✔	✔	✔	✔	✔
233	0,292400	1,598	✔	✔	✔	✔	✔	✔	✔
234	0,802400	0,408	✔	✔	✔	✔	✔	✔	✔
235	0,066400	10,063	✔	✔	✔	✔	✔	✔	✔
236	0,047998	6,308	✔	✔	✔	✔	✔	✔	✔
237	0,013601	0,000	✔	✔	✔	✔	✔	✔	✔
238	0,000801	0,000	✔	✔	✔	✔	✔	✔	✔
239	0,012800	0,000	✔	✔	✔	✔	✔	✔	✔
240	0,013201	0,000	✔	✔	✔	✔	✔	✔	✔
241	0,005602	0,000	✔	✔	✔	✔	✔	✔	✔
242	0,003599	0,000	✔	✔	✔	✔	✔	✔	✔

243	0,063602	0,000	✔	✔	✔	✔	✔	✔	✔
244	0,011999	0,000	✔	✔	✔	✔	✔	✔	✔
245	0,001201	0,000	✔	✔	✔	✔	✔	✔	✔
246	0,014002	0,000	✔	✔	✔	✔	✔	✔	✔
247	0,019599	0,000	✔	✔	✔	✔	✔	✔	✔
248	0,018798	0,000	✔	✔	✔	✔	✔	✔	✔
249	0,007199	0,000	✔	✔	✔	✔	✔	✔	✔
250	0,314400	0,000	✔	✔	✔	✔	✔	✔	✔
251	1,238400	0,000	✔	✔	✔	✔	✔	✔	✔
252	1,928400	0,042	✔	✔	✔	✔	✔	✔	✔
253	1,579600	3,116	✔	✔	✔	✔	✔	✔	✔
254	2,930000	1,430	✔	✔	✔	✔	✔	✔	✔
255	1,130000	1,134	✔	✔	✔	✔	✔	✔	✔
256	0,073999	0,899	✔	✔	✔	✔	✔	✔	✔
257	0,020400	3,895	✔	✔	✔	✔	✔	✔	✔
258	0,024800	0,000	✔	✔	✔	✔	✔	✔	✔
259	0,571200	0,000	✔	✔	✔	✔	✔	✔	✔
260	0,309200	0,000	✔	✔	✔	✔	✔	✔	✔
261	0,100400	0,000	✔	✔	✔	✔	✔	✔	✔
262	0,939200	0,000	✔	✔	✔	✔	✔	✔	✔
263	5,160400	0,165	✔	✔	✔	✔	✔	✔	✔
264	3,293600	0,016	✔	✔	✔	✔	✔	✔	✔
265	0,081200	0,000	✔	✔	✔	✔	✔		
266	0,017600	0,000	✔	✔	✔	✔	✔		
267	0,018000	0,000	✔	✔	✔	✔	✔		
268	0,028000	0,000	✔	✔	✔	✔	✔	✔	x
269	0,073200	0,000	✔	✔	✔	✔	✔	✔	x
270	0,051200	0,000	✔	✔	✔	✔	✔	✔	x
271	0,002000	0,000	✔	✔	✔	✔	✔	✔	x
272	0,033600	0,000	✔	✔	✔	✔	✔	✔	x
273	0,009600	0,000	✔	✔	✔	✔	✔	✔	x
274	0,033600	0,000	✔	✔	✔	✔	✔	✔	x
275	0,016400	0,000	✔	✔	✔	✔	✔	✔	x
276	0,004000	0,000	✔	✔	✔	✔	✔	✔	x
277	0,002800	0,000	✔	✔	✔	✔	✔	✔	x
278	0,002800	0,000	✔	✔	✔	✔	✔	✔	x
279	0,002000	0,000	✔	✔	✔		✔	✔	x
280	0,001200	0,000	✔	✔	✔	✔	✔	✔	x
281	0,002800	0,000	✔	✔	✔	✔	✔	✔	x
282	0,000400	0,000	✔	✔	✔		✔	✔	x
283	0,001200	0,000	✔	✔	✔	✔	✔	✔	x
284	0,000800	0,000	✔	✔	✔	✔	✔	✔	x
285	0,028400	0,000	✔	✔	✔	✔	✔	✔	x
286	0,008000	0,000	✔	✔	✔	✔	✔	✔	x
287	0,024800	0,000	✔	✔	✔	✔	✔	✔	x
288	0,002800	0,000	✔	✔	✔	✔	✔	✔	x
289	0,001600	0,000	✔	✔	✔	✔	✔	✔	x
290	0,001200	0,000	✔	✔	✔	✔	✔	✔	x
291	0,594400	0,000	✔	✔	✔	✔	✔		
292	0,278400	0,000	✔	✔	✔	✔	✔		

293	0,268800	0,000	✔	✔	✔	✔	✔		
294	0,054802	0,000	✔	✔	✔	✔	✔		
295	0,238800	6,183	✔	✔	✔	✔	✔		✔
296	0,186400	6,033	✔	✔	✔	✔	✔	✔	✔
297	2,546400	0,343	✔	✔	✔	✔	✔	✔	✔
298	1,036800	0,000	✔	✔	✔	✔	✔	✔	✔
299	0,968800	0,000	✔	✔	✔	✔	✔	✔	✔
300	1,216400	12,777	✔	✔	✔	✔	✔	✔	✔
301	1,017600	11,076	✔	✔	✔	✔	✔	✔	✔
302	0,302800	5,135	✔	✔	✔	✔	✔	✔	✔
303	0,386000	0,000	✔	✔	✔	✔	✔	✔	✔
304	0,504400	0,025	✔	✔	✔	✔	✔	✔	✔
305	0,207200	0,000	✔	✔	✔	✔	✔	✔	✔
306	0,018800	0,000	✔	✔	✔	✔	✔	✔	✔
307	0,197200	0,323	✔	✔	✔	✔	✔	✔	✔
308	0,167200	0,698	✔	✔	✔	✔	✔	✔	✔
309	0,665200	1,332	✔	✔	✔	✔	✔	✔	✔
310	1,184400	1,454	✔	✔	✔	✔	✔	✔	✔
311	0,227600	0,950	✔	✔	✔	✔	✔	✔	✔
312	0,357200	0,000	✔	✔	✔	✔	✔	✔	✔
313	0,258400	0,000	✔	✔	✔	✔	✔	✔	✔
314	0,032400	0,000	✔	✔	✔	✔	✔	✔	✔
315	0,009999	0,000	✔	✔	✔	✔	✔	✔	✔
316	0,148000	2,297	✔	✔	✔	✔	✔	✔	✔
317	2,080000	1,180	✔	✔	✔	✔	✔	✔	✔
318	1,290400	1,019	✔	✔	✔	✔	✔	✔	✔
319	0,330800	0,335	✔	✔	✔	✔	✔	✔	✔
320	0,030401	0,000	✔	✔	✔	✔	✔	✔	✔
321	0,030802	0,000	✔	✔	✔	✔	✔	✔	✔
322	0,001999	0,000	✔	✔	✔	✔	✔	✔	✔
323	0,074799	0,000	✔	✔	✔	✔	✔	✔	✔
324	0,054802	0,000	✔	✔	✔	✔	✔	✔	✔
325	0,009999	0,000	✔	✔	✔	✔	✔	✔	✔
326	0,014803	0,000	✔	✔	✔	✔	✔	✔	✔
327	0,009999	0,000	✔	✔	✔	✔	✔	✔	✔
328	0,014803	0,000	✔	✔	✔	✔	✔	✔	✔
329	0,101200	0,000	✔	✔	✔	✔	✔	✔	✔
330	0,568800	0,123	✔	✔	✔	✔	✔	✔	✔
331	1,080000	1,024	✔	✔	✔	✔	✔	✔	✔
332	0,436000	3,869	✔	✔	✔	✔	✔	✔	✔
333	2,028000	7,261	✔	✔	✔	✔	✔	✔	✔
334	4,157600	8,498	✔	✔	✔	✔	✔	✔	✔
335	1,392400	0,919	✔	✔	✔	✔	✔	✔	✔
336	1,294800	0,894	✔	✔	✔	✔	✔	✔	✔
337	0,433200	0,129	✔	✔	✔	✔	✔	✔	✔
338	0,001598	0,000	✔	✔	✔	✔	✔	✔	✔
339	0,461600	2,453	✔	✔	✔	✔	✔	✔	✔
340	0,743200	6,348	✔	✔	✔	✔	✔	✔	✔
341	0,092402	5,970	✔	✔	✔	✔	✔	✔	✔
342	1,969600	9,776	✔	✔	✔	✔	✔	✔	✔

343	7,604400	8,853	✔	✔	✔	✔	✔	✔	✔
344	12,666000	8,727	✔	✔	✔	✔	✔	✔	✔
345	0,221200	0,000	✔	✔	✔	✔	✔		
346	0,298800	0,000	✔	✔	✔	✔	✔		
347	0,334800	0,000	✔	✔	✔	✔	✔		
348	0,024400	0,000	✔	✔	✔	✔	✔		
349	0,006001	0,000	✔	✔	✔	✔	✔		
350	0,005199	0,000	✔	✔	✔	✔	✔		
351	0,064400	0,000	✔	✔	✔	✔	✔		
352	0,126400	0,000	✔	✔	✔	✔	✔		
353	0,036799	0,000	✔	✔	✔	✔	✔		
354	0,593600	0,000	✔	✔	✔	✔	✔	✔	✔
355	1,402000	0,000	✔	✔	✔	✔	✔	✔	✔
356	2,154800	0,000	✔	✔	✔	✔	✔	✔	✔
357	0,004399	0,000	✔	✔	✔	✔	✔	✔	✔
358	0,060400	0,000	✔	✔	✔	✔	✔	✔	✔
359	0,017600	0,000	✔	✔	✔	✔	✔	✔	✔
360	0,729200	0,000	✔	✔	✔	✔	✔	✔	✔
361	0,389200	0,000	✔	✔	✔	✔	✔	✔	✔
362	0,102800	0,000	✔	✔	✔	✔	✔	✔	✔
363	0,042399	0,000	✔	✔	✔	✔	✔	✔	✔
364	0,265600	0,000	✔	✔	✔	✔	✔	✔	✔
365	0,111600	0,000	✔	✔	✔	✔	✔	✔	✔
366	0,004399	0,000	✔	✔	✔	✔	✔	✔	✔
367	0,001600	0,000	✔	✔	✔	✔	✔	✔	✔
368	0,438400	0,000	✔	✔	✔	✔	✔	✔	✔
369	0,092401	0,000	✔	✔	✔	✔	✔	✔	✔
370	0,320800	0,000	✔	✔	✔	✔	✔	✔	✔
371	0,045199	0,000	✔	✔	✔	✔	✔	✔	✔
372	1,224000	0,000	✔	✔	✔	✔	✔	✔	✔
373	0,228400	0,000	✔	✔	✔	✔	✔	✔	✔
374	0,016000	0,000	✔	✔	✔	✔	✔	✔	✔
375	0,604800	0,000	✔	✔	✔	✔	✔	✔	✔
376	1,271600	0,000	✔	✔	✔	✔	✔	✔	✔
377	0,188000	0,000	✔	✔	✔	✔	✔	✔	✔
378	0,083600	0,000	✔	✔	✔	✔	✔	✔	✔
379	0,011200	0,000	✔	✔	✔	✔	✔	✔	✔
380	0,003600	0,000	✔	✔	✔	✔	✔	✔	✔
381	0,003201	0,000	✔	✔	✔	✔	✔	✔	✔
382	0,034801	0,000	✔	✔	✔	✔	✔	✔	✔
383	0,170400	0,000	✔	✔	✔	✔	✔	✔	✔
384	0,398400	0,000	✔	✔	✔	✔	✔	✔	✔
385	0,171200	0,000	✔	✔	✔	✔	✔	✔	✔
386	0,054800	0,000	✔	✔	✔	✔	✔	✔	✔
387	0,793200	0,000	✔	✔	✔	✔	✔	✔	✔
388	0,112400	0,000	✔	✔	✔	✔	✔	✔	✔
389	0,296800	0,000	✔	✔	✔	✔	✔	✔	✔
390	1,692000	0,000	✔	✔	✔	✔	✔	✔	✔
391	0,402000	0,040	✔	✔	✔	✔	✔	✔	✔
392	3,898400	0,000	✔	✔	✔	✔	✔	✔	✔

393	0,035600	0,000	✔	✔	✔	✔	✔	✔	
394	0,000400	0,000	✔	✔	✔	✔	✔	✔	
395	0,136400	0,000	✔	✔	✔	✔	✔	✔	
396	0,008800	0,000	✔	✔	✔	✔	✔	✔	
397	0,096400	0,000	✔	✔	✔	✔	✔	✔	
398	0,011200	0,000	✔	✔	✔	✔	✔	✔	
399	0,006000	0,000	✔	✔	✔	✔	✔	✔	
400	0,170400	0,000	✔	✔	✔	✔	✔	✔	✔
401	0,400000	0,000	✔	✔	✔	✔	✔	✔	✔
402	0,009600	0,000	✔	✔	✔	✔	✔	✔	✔
403	0,014400	0,000	✔	✔	✔	✔	✔	✔	✔
404	0,090400	0,000	✔	✔	✔	✔	✔	✔	✔
405	0,062800	0,000	✔	✔	✔	✔	✔	✔	✔
406	0,018000	0,000	✔	✔	✔	✔	✔	✔	✔
407	0,018000	0,000	✔	✔	✔	✔	✔	✔	✔
408	0,058800	0,000	✔	✔	✔	✔	✔	✔	✔
409	0,012400	0,000	✔	✔	✔	✔	✔	✔	✔
410	0,031200	0,000	✔	✔	✔	✔	✔	✔	✔
411	0,001600	0,000	✔	✔	✔	✔	✔	✔	✔
412	0,006400	0,000	✔	✔	✔	✔	✔	✔	✔
413	0,044000	0,000	✔	✔	✔	✔	✔	✔	✔
414	0,120400	0,000	✔	✔	✔	✔	✔	✔	✔
415	0,004000	0,000	✔	✔	✔	✔	✔	✔	✔
416	0,008400	0,000	✔	✔	✔	✔	✔	✔	✔
417	0,011600	0,000	✔	✔	✔	✔	✔	✔	✔
418	0,000400	0,000	✔	✔	✔		✔	✔	✔
419	0,002800	0,000	✔	✔	✔	✔	✔	✔	✔
420	0,003200	0,000	✔	✔	✔	✔	✔	✔	✔
421	0,002800	0,000	✔	✔	✔	✔	✔	✔	✔
422	0,001200	0,000	✔	✔	✔	✔	✔	✔	✔
423	0,016000	0,000	✔	✔	✔	✔	✔	✔	✔
424	0,080400	0,000	✔	✔	✔	✔	✔	✔	✔
425	0,008000	0,000	✔	✔	✔	✔	✔	✔	✔
426	0,002000	0,000	✔	✔	✔	✔	✔	✔	✔
427	0,010000	0,000	✔	✔	✔	✔	✔	✔	✔
428	0,000800	0,000	✔	✔	✔	✔	✔	✔	✔
429	0,050400	0,000	✔	✔	✔	✔	✔	✔	✔
430	0,002800	0,000	✔	✔	✔	✔	✔	✔	✔
431	0,054800	0,000	✔	✔	✔	✔	✔	✔	✔
432	0,051200	0,000	✔	✔	✔	✔	✔	✔	✔
433	0,163600	0,000	✔	✔	✔	✔	✔	✔	✔
434	0,799600	0,000	✔	✔	✔	✔	✔	✔	✔
435	0,025200	0,000	✔	✔	✔	✔	✔	✔	✔
436	0,028400	0,000	✔	✔	✔	✔	✔		
437	0,266000	0,000	✔	✔	✔	✔	✔		
438	0,282800	0,000	✔	✔	✔	✔	✔		
439	0,092800	0,000	✔	✔	✔	✔	✔		
440	0,001200	0,000	✔	✔	✔	✔	✔		
441	0,009600	0,000	✔	✔	✔	✔	✔		
442	0,029600	0,000	✔	✔	✔	✔	✔		

443	0,077600	5,137	✓	✓	✓	✓	✓		
444	0,084000	0,000	✓	✓	✓	✓	✓		
445	0,370800	0,000	✓	✓	✓	✓	✓		
446	0,397200	0,000	✓	✓	✓	✓	✓		
447	0,024000	0,000	✓	✓	✓	✓	✓		
448	0,102400	0,000	✓	✓	✓	✓	✓	✓	✓
449	0,609200	0,247	✓	✓	✓	✓	✓	✓	✓
450	0,456800	0,000	✓	✓	✓	✓	✓	✓	✓
451	0,044800	0,000	✓	✓	✓	✓	✓	✓	✓
452	0,096000	0,000	✓	✓	✓	✓	✓	✓	✓
453	0,286800	0,000	✓	✓	✓	✓	✓	✓	✓
454	0,188800	0,424	✓	✓	✓	✓	✓	✓	✓
455	0,019200	0,000	✓	✓	✓	✓	✓	✓	✓
456	0,114800	0,000	✓	✓	✓	✓	✓	✓	✓
457	0,040800	0,000	✓	✓	✓	✓	✓	✓	✓
458	0,020400	0,000	✓	✓	✓	✓	✓	✓	✓
459	0,054000	0,000	✓	✓	✓	✓	✓	✓	✓
460	0,077200	0,000	✓	✓	✓	✓	✓	✓	✓
461	0,000800	0,000	✓	✓	✓	✓	✓	✓	✓
462	0,001600	0,000	✓	✓	✓	✓	✓	✓	✓
463	0,041600	0,000	✓	✓	✓	✓	✓	✓	✓
464	0,602800	0,252	✓	✓	✓	✓	✓	✓	✓
465	0,213600	0,000	✓	✓	✓	✓	✓	✓	✓
466	0,014400	0,000	✓	✓	✓		✓	✓	✓
467	0,051200	0,000	✓	✓	✓	✓	✓	✓	✓
468	0,027200	0,000	✓	✓	✓	✓	✓	✓	✓
469	0,013200	0,000	✓	✓	✓	✓	✓	✓	✓
470	0,001600	0,000	✓	✓	✓	✓	✓	✓	✓
471	0,004800	0,000	✓	✓	✓	✓	✓	✓	✓
472	0,013200	0,000	✓	✓	✓	✓	✓	✓	✓
473	0,068400	0,000	✓	✓	✓	✓	✓	✓	✓
474	0,084800	0,000	✓	✓	✓	✓	✓	✓	✓
475	0,002800	0,000	✓	✓	✓	✓	✓	✓	✓
476	0,005600	0,000	✓	✓	✓	✓	✓	✓	✓
477	0,002000	0,000	✓	✓	✓	✓	✓	✓	✓
478	0,012400	0,000	✓	✓	✓	✓	✓	✓	✓
479	0,003600	0,000	✓	✓	✓	✓	✓	✓	✓
480	0,026000	0,000	✓	✓	✓	✓	✓	✓	✓
481	0,110800	0,000	✓	✓	✓	✓	✓	✓	✓
482	0,034800	0,000	✓	✓	✓	✓	✓	✓	✓
483	0,010400	0,000	✓	✓	✓	✓	✓	✓	✓
484	0,006800	0,000	✓	✓	✓	✓	✓	✓	✓
485	0,002000	0,000	✓	✓	✓	✓	✓	✓	✓
486	0,000400	0,000	✓	✓	✓	✓	✓	✓	✓
487	0,004000	0,000	✓	✓	✓	✓	✓	✓	✓
488	0,001200	0,000	✓	✓	✓	✓	✓	✓	✓
489	0,005600	0,000	✓	✓	✓	✓	✓	✓	✓
490	0,018000	0,000	✓	✓	✓	✓	✓	✓	✓
491	0,097600	0,000	✓	✓	✓	✓	✓	✓	✓
492	0,172000	0,000	✓	✓	✓	✓	✓	✓	✓

493	0,151600	0,000	✔	✔	✔	✔	✔	✔	✔
494	0,071200	0,000	✔	✔	✔	✔	✔	✔	✔
495	0,001600	0,000	✔	✔	✔	✔	✔	✔	✔
496	0,631200	0,000	✔	✔	✔	✔	✔	✔	✔
497	0,150800	0,000	✔	✔	✔	✔	✔	✔	✔
498	1,354000	0,000	✔	✔	✔	✔	✔	✔	✔
499	0,018400	0,000	✔	✔	✔	✔	✔	✔	✔
500	0,020400	0,000	✔	✔	✔	✔	✔	✔	✔

Appendix 6. Highest values of Ecosystem Services achieved for Vez watershed HRUs

Ecosystem Services	**Water supply**			**Water damage mitigation**		**Biomass**	**Climate Regulation**
HRU ID	**Water Quantity (mm)**	**Water Timing (mm)**	**Water Quality (N kg/ha. yr)**	**Soil Erosion Control (t/ha. yr)**	**Flood Regulation (mm)**	**Biomass (t/ha. yr)**	**Carbon Storage (tC/ha. yr)**
4	125,707958						
7	126,353792						
8	126,039431						
9	126,370875						
59		313,320569					
62	125,628250						
74				24000			
151						55,375764	27,687882
175					0,069129		
177					0,058588		
178					0,069415		
188			7,649809				
189			8,995502				
190			10,047446				
191			9,531374				
192			8,065420				
196		288,011292					
246		281,491236					
255						52,846625	26,423313
288						53,885444	26,942722
310					0,062590		
338				72000			
348		327,778694					
388						53,422028	26,711014
416				36000			
419				72000			
422				72000			
432						52,498833	26,249417
439		304,427875					
462					0,065891		

Appendix 7. Detailed information used to determine the occurrence of different targeted Ecosystem Services within each HRU.

HRU ID	HRU area (Km2)	HNVf area (%)	Water Supply			Water damage mitigation		Biomass Production	Climate Regulation
			Water Quantity	Water Timing	Water Quality	Soil Erosion Control	Flood Regulation	Biomass	Carbon Storage
41	0,000401	0,000	✔	✔	✔		✔	✔	✔
56	0,027600	0,000	✔	✔	✔	✔	✔		
57	0,002400	0,000	✔	✔	✔	✔	✔		
58	0,018401	0,000	✔	✔	✔	✔	✔		
59	0,001999	0,000	✔	✔	✔	✔	✔		
60	0,023201	2,882	✔	✔	✔	✔	✔		
61	0,137600	22,065	✔	✔	✔	✔	✔		
62	0,191600	9,441	✔	✔	✔	✔	✔		
83	0,000801	0,000	✔	✔	✔		✔	✔	✔
109	0,027199	15,733	✔	✔	✔	✔	✔		
110	0,164400	4,949	✔	✔	✔	✔	✔		
111	0,321200	0,404	✔	✔	✔	✔	✔		
112	0,023200	42,709	✔	✔	✔	✔	✔		
113	0,037200	43,503	✔	✔	✔	✔	✔		
114	0,047199	23,441	✔	✔	✔	✔	✔		
115	0,200400	24,488	✔	✔	✔	✔	✔		
116	0,262000	11,759	✔	✔	✔	✔	✔		
157	0,026800	4,533	✔	✔	✔	✔	✔		
158	0,153600	4,211	✔	✔	✔	✔	✔		
159	0,036000	23,307	✔	✔	✔	✔	✔		
160	0,078400	10,934	✔	✔	✔	✔	✔		
161	0,020400	27,180	✔	✔	✔	✔	✔		
162	0,002400	41,679	✔	✔	✔	✔	✔		
177	0,000400	0,000	✔	✔	✔		✔	✔	✔
265	0,081200	0,000	✔	✔	✔	✔	✔		
266	0,017600	0,000	✔	✔	✔	✔	✔		
267	0,018000	0,000	✔	✔	✔	✔	✔		
279	0,002000	0,000	✔	✔	✔		✔	✔	✔
282	0,000400	0,000	✔	✔	✔		✔	✔	✔
291	0,594400	0,000	✔	✔	✔	✔	✔		
292	0,278400	0,000	✔	✔	✔	✔	✔		
293	0,268800	0,000	✔	✔	✔	✔	✔		
294	0,054802	0,000	✔	✔	✔	✔	✔		
295	0,238800	6,183	✔	✔	✔	✔	✔		✔
345	0,221200	0,000	✔	✔	✔	✔	✔		
346	0,298800	0,000	✔	✔	✔	✔	✔		
347	0,334800	0,000	✔	✔	✔	✔	✔		

348	0,024400	0,000	✔	✔	✔	✔	✔		
349	0,006001	0,000	✔	✔	✔	✔	✔		
350	0,005199	0,000	✔	✔	✔	✔	✔		
351	0,064400	0,000	✔	✔	✔	✔	✔		
352	0,126400	0,000	✔	✔	✔	✔	✔		
353	0,036799	0,000	✔	✔	✔	✔	✔		
393	0,035600	0,000	✔	✔	✔	✔	✔	✔	
394	0,000400	0,000	✔	✔	✔	✔	✔	✔	
395	0,136400	0,000	✔	✔	✔	✔	✔	✔	
396	0,008800	0,000	✔	✔	✔	✔	✔	✔	
397	0,096400	0,000	✔	✔	✔	✔	✔	✔	
398	0,011200	0,000	✔	✔	✔	✔	✔	✔	
399	0,006000	0,000	✔	✔	✔	✔	✔	✔	
418	0,000400	0,000	✔	✔	✔		✔	✔	✔
436	0,028400	0,000	✔	✔	✔	✔	✔		
437	0,266000	0,000	✔	✔	✔	✔	✔		
438	0,282800	0,000	✔	✔	✔	✔	✔		
439	0,092800	0,000	✔	✔	✔	✔	✔		
440	0,001200	0,000	✔	✔	✔	✔	✔		
441	0,009600	0,000	✔	✔	✔	✔	✔		
442	0,029600	0,000	✔	✔	✔	✔	✔		
443	0,077600	5,137	✔	✔	✔	✔	✔		
444	0,084000	0,000	✔	✔	✔	✔	✔		
445	0,370800	0,000	✔	✔	✔	✔	✔		
446	0,397200	0,000	✔	✔	✔	✔	✔		
447	0,024000	0,000	✔	✔	✔	✔	✔		
466	0,014400	0,000	✔	✔	✔		✔	✔	✔