“Water is money.”
A social-ecological systems approach to power and value in water management: the case of Doñana and Spanish strawberries

LUND UNIVERSITY

LUMID - Lund University Master of Science in International Development and Management

May 2018

Author: Burag Gurden
Supervisor: Axel Fredholm

Abstract

This thesis examines a water management conflict resulting from land-use change and export-oriented agricultural intensification in a geography where water is the absolute lifeline to the sustainability of a social-ecological system: the Doñana in southwestern Andalusia, in Spain. Social-ecological systems (SES) approach is the theoretical base of this research, where the Doñana SES is scrutinized with the application of Elinor Ostrom’s SES framework to the very system, as well as the DPSIR (Drivers–Pressures–State–Impacts–Responses) framework for better communication of the conflict. Both frameworks are used for understanding the system in detail and in that sense, this is an inductive study, which provides a social science angle on power relations pertinent to the long-lasting local water management struggles.

While the SES approach helps to depict the water conflict from a systematic, actor-based perspective, it exhibits the social, economic and environmental trade-offs between export-oriented water-intensive agriculture and environmental sustainability of the region. With a special focus on the local power relations and how they shape the regional development and natural resource management agenda, this study sheds light on the drivers of the water management conflict in the case of Spanish Doñana region famous for its berries, olives, oranges and wine.

Keywords:

Social-ecological systems, Doñana, water management, power, conflict, case study

2018

“Water is money.”

AUTHOR
BURAG GÜRDEN

SUPERVISOR
AXEL FREDHOLM

Acknowledgements

This thesis is the end-product of many contributors, who built and accumulated the knowledge that feeds into every single page of this work. Many more actors inspired and motivated me to collect, analyze and synthesize thoughts, ideas and information in an academic fashion to guide and serve anyone interested in such matters.

First of all, I am thankful to the Economics Department at Bogazici University, for its eye-opening teachings that made me such an economist who sees the world with all its ups and downs, and bitters and sweets… Special thanks go to my role models, Prof. Şemsa Özar, for paving my way into the field of "Development" and Prof. Begüm Özkaynak for uninterruptedly motivating me throughout the graduate study and the thesis formulation process.

Hereby I would love to express my admiration to one of the best novelists and by far the best practitioner of naturalism, Émile Zola, for his moral optimism, for always shouting out while others hushed, and the invaluable trait of speaking up for the sake of the suppressed, the underrepresented, the weak and the poor, rather in a harsh but realistic and hence in a discomforting manner. He so much changed the way I see people and my environment.

After all, this work would have never been possible without support from Johan Sandberg, planting seeds of hope into hearts of all my colleagues and me, Arvin Knoshnood for coordinating LUMID Batch 11, Axel Fredholm, for being my light-touch thesis supervisor, Alf Hornborg and Mine Islar for providing me with ideas and guiding me through the process, Beatriz Rodríguez Labajos and Rutgerd Boelens likewise, yet remotely.

I am also thankful to the 'Horse master Johanna' for providing me a place in her lovely farm in Pilas-Aznalcázar, Sevilla, where I conducted my fieldwork and got the chance to meet amazing people like Diego, Verónica, Lauren, Pete, Maria Del Mar, Natalia and notably Camille, who also got involved in the making of this thesis with her translations from Spanish into English.

I also extend my most sincere thanks to the European Environmental Bureau (EEB) in Brussels and all my colleagues, to Nick Meynen and Patrizia Heidegger in particular, that they offered me a seat among them and pulled me into several projects, including the Environmental Justice Project coordinated by the University of Barcelona, of which I am thankful to all team members including Joan Martinez-Alier, Leah Temper, Federico Demaria and Daniela Del Bene.

I so much appreciate the time devoted to my research by some organizations such as Birdlife (SEO-BirdLife), World Wildlife Fund (WWF-España), the management team of the Doñana National Park, who welcomed my interview requests and generously offered key informants.

I am also grateful to my family, friends and my partner for being an endless source of love and inspiration, and making me the person I am. Unfortunately, I feel the urge to denounce some national and international scholarship programmes, for giving to my family and me hard times by financially abandoning a non-EU student as I am, over the course of two-year master's programme with a substantial burden of financial cost.

Table of Contents

List of Abbreviations

CAP:	Common Agricultural Policy
CR:	Critical Realism
DPSIR:	Drivers–Pressures–State–Impacts–Responses
EAP:	Environment Action Programme
EEA:	European Environment Agency
ENGO:	Environmental Non-governmental Organization
IGME:	Geological and Mining Institute
IUCN:	International Union for Conservation of Nature
NRM:	Natural Resource Management
SES:	Social-Ecological System
WEF:	World Economic Forum
WFD:	Water Framework Directive
WWF:	World Wildlife Fund

List of Figures

1 Introduction

Never before have our living standards been as high as today, and so is our dependency on ecosystem services, straining the biocapacity of ecosystems. There is ample evidence that the human systems have for long crossed the planetary boundaries, and we are pushing the planet to the brink. That is why fears against 'Day Zero' in Cape Town resonated with the entire world, earlier in 2018. We have witnessed that a natural resource-runout is possible anytime and anywhere. However, why the water shortage in Cape Town made the headlines is not only the water crisis itself, but the call from the town municipality on the citizens to drop the daily water use, which was then perceived despairingly inhumane. This is only one of the many desperate 'end-of-pipe' solutions that indicates the neglect of a more prominent picture in crises of natural resource management: Production and distribution.

Fortunately, 'Day Zero' helped bring back a debate around an undermined resource into the agenda: freshwater, and groundwater in particular. Sustainability of such resources is mostly overlooked by scientific communities and politics; sometimes because it is a complex, crosscutting issue and sometimes it is overshadowed by more newsworthy, emergent global risks like climate change (Dragoni & Sukhija 2008; Acharyya 2014). The complexity and the interconnectedness of 'water' amongst various human systems, and between human- and natural systems make it both a challenge and an opportunity to today's societies.

Among all, the significance of water to two critical systems is beyond doubt: agriculture and ecosystems. In an ever-changing, shaping and developing world, one would not expect water crises to top year after year World Economic Forum (WEF)'s Global Risks Report[1] (World Economic Forum 2018). Remarkably, water crises of the modern world are by no means limited to lack of drinking water or water insecurity in post-conflict zones, but agriculture-induced water conflicts are also on the global stage now.

While putting agricultural systems under strain, extractive industries exerting pressure on ecosystems have exposed a new area of mass-extinction, where biodiversity loss is estimated to have occurred at a rate of almost 60% in the last 50 years (Ceballos *et al.* 2015; WWF 2016a).

[1] See Appendix A.

There is a wide consensus among the scientific community that the main reason for the said ecocide and environmental degradation is the human-induced landscape transformation and destruction of habitats as a result of it (Diamond 1984; WWF 2016a). Water crises, however, remain to be the largest challenge of all environmental risks according to WEF, due to its complex[2], interconnected nature as a systemic challenge rooting into several other fields (World Economic Forum 2018).

The most common argument for the complexity of water within the economic growth-nature conservation paradigm is "feeding the hungry planet" argument, which outbalances environmental concerns raised over intensive water use, also called resource overexploitation. Groundwater sources supply water to approximately 40 percent of the world's all irrigated area (Rockström *et al.* 2017; Water, Land and Ecosystems 2017). As the global food supply increases and the surface water becomes scarce and contaminated, agriculture turns its face more and more to groundwater sources. Despite some progress towards sustainable use of groundwater, water governance and water management strategies have globally fallen short in meeting sustainability targets so far, jeopardizing the resilience of communities (Lopez-Gunn *et al.* 2018).

Groundwater may not be the ideal research unit for a researcher. First, the principal hydro-cycle and storage of water occur at aquifer level that is hard to keep account of. Second, due to the wide spatial dispersion of resource users, data collection on groundwater use is a complicated task, let alone the groundwater consumption[3] of sectors or tracing the embedded groundwater resources[4] in traded goods. Third, groundwater is widely considered to be a social good, in line with the aforementioned "feeding the hungry planet" argument that makes the research sensitive to ethical concerns. Nonetheless, groundwater concurrently plays a vital role in one of the three cycles of ecosystems[5] and being the main input of an ancient human activity, agriculture, as well as of coupled human systems, renders the management of groundwater a never-ending treasure to social science.

[2] Complex systemic risks are characterized by disconnected feedback loops, unanticipated tipping points and obscure cause-and-effect relationships (International Risk Governance Council 2018).
[3] Refer to Appendix B for definitions.
[4] A.k.a. 'virtual water'
[5] The Three Cycles of Ecosystem/Nature: The three main cycles of an ecosystem are the water cycle, the carbon cycle and, the nitrogen cycle. These three cycles working in balance are responsible for carrying away waste materials and replenishing the ecosystem with the nutrients necessary to sustain life. If any of these three cycles should become unbalanced, the effects on the ecosystem can be catastrophic (Sciencing 2018).

First time in 2013, one of the most famous nature reserves in the European Union, the Doñana National Park (hereafter the Doñana NP) in southwestern Andalusia, in Spain; has been subject to discussions during the UNESCO's 37th World Heritage Summit in the Kingdom of Cambodia, over its deteriorating state of conservation. Despite the final decision of placing the Doñana NP on the list of "Heritage sites under threat" was not taken in the following summits (Badcock 2016, Neslen 2016), the Doñana NP and the surrounding area still suffer from human-induced water scarcity and water insecurity (WWF 2016b). This thesis is to examine the experience of Doñana's water management, and the existing power relations that continuously lead to the Doñana SES's water scarcity and water insecurity while exploring the potential drivers of change in Doñana's sustainability challenge.

1.1 Aim of the Study and the Research Questions

Many scholars from different angles have examined the stress on water resources. Research on groundwater sources, in particular, has gained momentum in recent years. This development is both thanks to maturation in sustainability science per se, but also due to increasing concerns about the unsustainable management of natural resources all around the world.

While each literature made a different contribution to the sustainability science, studies on groundwater rarely go beyond evaluations of natural systems at local or regional level. The innovation in this study is the approach to drivers of groundwater depletion with its linkage to local power relations and international trade, built on an investigation on the values of the producer community and elevated by the end-users' perception of the relevant supply chains and the final product. The research questions I try to answer in this study are:

1- Why does water-intensive agriculture spark water conflicts and what is the role of local power relations in water management in Spanish Doñana region?
2- How can the sustainability of the Doñana SES be promoted and who are the drivers of change?

1.2 The Roadmap

This thesis is divided into seven chapters. The **first chapter** is an introduction to the area of research, where the development of the problem and the motivation of the research are elaborated. The focus of the study, as well as the research questions can be found here. In the **second chapter**, the theoretical foundations of the research are laid, where the social-ecological systems (SES) approach is explained in detail. The **third chapter** is an introduction of the frameworks and concepts used in this research: Elinor Ostrom's (2009) SES framework and the DPSIR (Drivers–Pressures–State–Impacts–Responses) framework, including how they are to be used in a case of water resource management. The **fourth chapter** is a detailed description of the methodology, where I delve into the philosophy of research I refer in this study, followed by the research strategy, where the selection of the 'case study strategy' as the research strategy of this thesis is justified, followed by the description of the research design and the presentation of the applied methods. The **fifth chapter** serves as an operational bridge between the SES approach and the analysis of the case, including reflections of literature review and a detailed context analysis. Yet, the literature review is not concentrated in this chapter but rather dispersed over the whole thesis, just as the triangulation of the findings, as one would expect from a case study. In this chapter, the Doñana region is structured and analysed as a case of water management conflict, and the characteristics of the region are studied. This chapter informs the physical features, historical development, and the coupled natural and social systems of the Doñana SES from an ecosystem services perspective. In the **sixth chapter**, I reflect and discuss the results of the research, by interpreting the data collected via the interviews, observations and surveys over the last 8 months. Finally, in the **seventh chapter**, I summarize the findings and explain how this research tried to answer the research questions and what answers are reached as a result of this endeavour. The last chapter also includes ethical considerations of this study.

2 Social-Ecological Systems Approach

When people interact with their environment social-ecological systems are formed (Anderies *et al.* 2004). All natural resources used by humans are embedded in SESs (Anderies *et al.* 2004; Ostrom 2009: 419). In an SES, the interdependence between social systems [6] and an all-encompassing ecological system are discernible, and any separation in between is superficial (Ostrom 2009; Fabinyi *et al.* 2014; Villamor *et al.* 2014).

Berkes and Folke (1998) affiliate the emergence of such systems approach with the rise of opportunistic utilitarian views on natural resource management. They position the systems approach against the view that resources are dispersed and discrete entities in eco- and social-systems, that can be commodified and extracted from the system with no or little harm to the related ecological system (Berkes & Folke 1998: 2). Hence, SES approach is a holistic, alternative perspective to look upon systems (Fabinyi *et al.* 2014).

In hindsight, the overarching definition of an SES, referred in this thesis is:

> *the subset of social systems in which some of the interdependent relationships among humans are mediated through interacting biophysical and non-human biological units.* (Anderies *et al.* 2004: 6).

Identifying problems in complex SESs, let alone understanding these, is no easy task. On top of the complexity and wickedness[7] of some problems, scientific disciplines inherently diverge in concepts and languages they use for explaining SESs (Ostrom 2009; Ness *et al.* 2010). Ostrom (2009: 419) argues a common framework appealing to multiple disciplines can help cumulate knowledge on the sustainability of complex SESs, otherwise:

> *isolated knowledge acquired from studies of diverse resource systems in different countries by biophysical and social scientists is not likely to cumulate.*

Elinor Ostrom's (2009) multi-level framework is designed to be used in dissolving matters of unsustainability by identifying relevant variables in complex focal SESs while shedding light on the likelihood of collective action for resource management (Wilson *et al.* 2007). The

[6] Systems, where humans form or tend to form cooperative relationships and interact with each other (Anderies *et al.* 2004: 5).

[7] The term "wicked problem" is coined by Rittel and Webber (1973), for explaining problems that are perceived and understood differently by different actors, due to lack of clear problem definition, but most importantly due to diverse perspectives of stakeholders.

presumptions here are that (1) users' collective action can significantly change the outcome of the issue and (2) users behave under a bounded rationality[8] (Ostrom 1998; McGinnis & Ostrom 2014). Anderies and colleagues (2004) posit that self-organization[9] is key to robustness and resilience[10] of focal SESs, which has been undermined in the past.

Even though several terms have been attributed to desired SESs, such as "robustness" by Anderies, Janssen and Ostrom (2004) and "resilience" by Berkes and Folke (1998), "sustainability of the SES" is the principal umbrella term in this study, that is being analysed. Sustainability hereby means that the state, in which social systems levying pressure on natural resources do not exceed the tipping point of the resource system that would lead to a resource collapse, which would then bear detrimental results to the same and/or adjacent social and natural systems.

But what is "social"? Fabinyi and colleagues (2014) claim that the theories and definitions of the "social" in many SES models have fallen short so far. Among the wealth of critiques, two themes stand out: the complexity of social processes (Crane 2010; Hatt 2013), and the role of values and power (Hornborg 2009; Robards *et al.* 2011). It is the disparity in actors' interests, derived from a set of values, that turns out as different preferences and behaviours. While attributing traits to communities, one should consider the diversity in the "social". The understanding of the heterogeneity and the clash of interests within the communities can help the researchers better portray the drivers of conflicts in SESs (Fabinyi *et al.* 2014).

[8] Bounded rationality posits human mind can only work under constraints, such as (1) information is always limited and often unreliable, (2) human mind can process information only so much due to its limited capacity, and (3) time is a limiting factor in decision-making; hence any "rational" choice is bounded to constraints (Simon 1957).
[9] Authors use the word "public infrastructure" instead of "self-organization" (Anderies *et al.* 2004).
[10](1) An SES is robust if it prevents the ecological systems upon which it relies from moving into a new domain of attraction that cannot support a human population or induces a transition that causes long-term human suffering.
(2) Resilience measures the amount of change or disruption that is required to transform a system from being maintained by one set of mutually reinforcing processes and structures to a different set of processes and structures (Anderies *et al.*, 2004: 12)

3 Social-Ecological Systems Framework

Building on many frameworks for analysing SESs, Elinor's (2009) holistic framework is composed of four first-level core subsystems: Resource systems (RS), resource units (RU), users (U) and governance systems (GS), that constantly interact with each other under particular social, political and economic settings (S) as well as related ecosystems (ECO) (Figure 1). Each core subsystem is then broken down into multiple deeper, second-level variables (See Appendix C). The framework has been adapted to emerging methodological needs and slightly modified, such as the concept of resource users (RU) has been broadened (to comprise third parties that are neither direct users nor consumers of the final product) (McGinnis & Ostrom 2014). Two main functions of the framework stay the same, which are to provide a "basic vocabulary of concepts and terms" to analyze interactions and causalities in SESs and "to develop diagnostic tools …. for understanding the determinants of sustainability in complex SESs." (Ibid: 1).

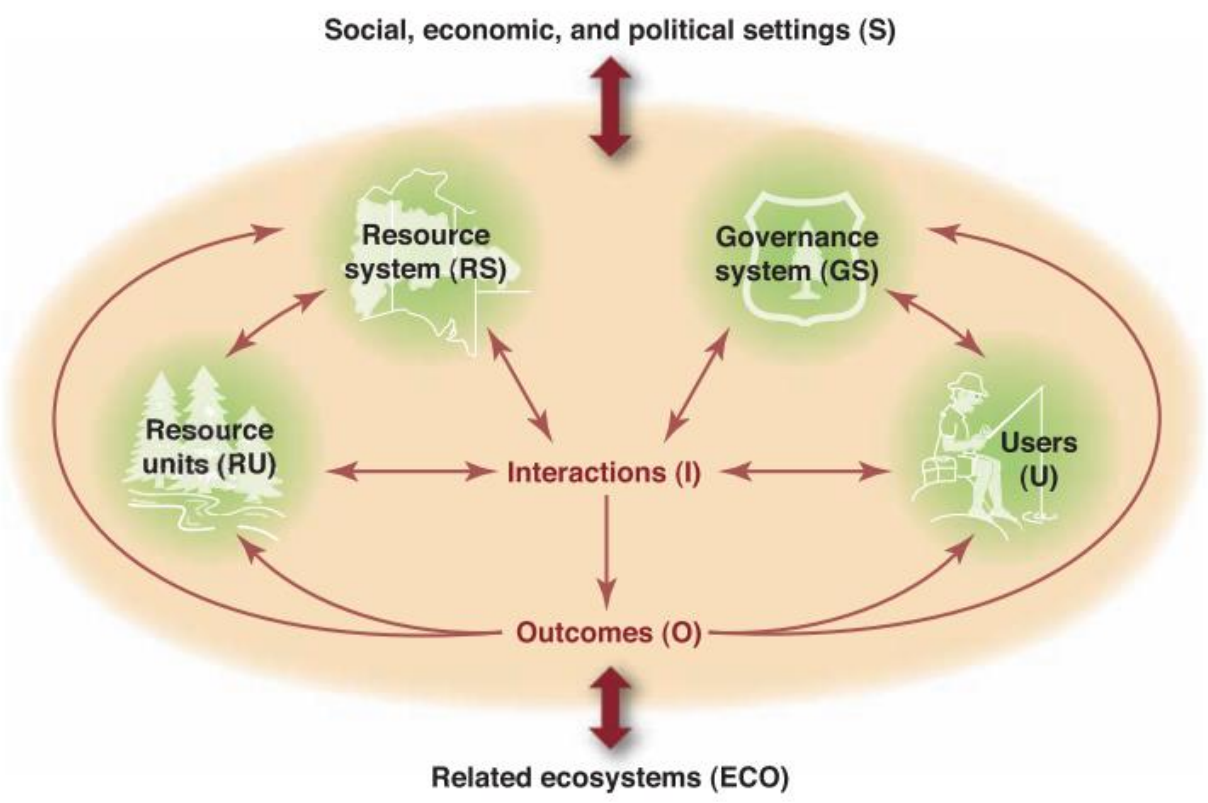


Figure 1: Social-ecological systems framework (Ostrom, 2009).

It is historically proven that in most cases, users who self-organized and took collective actions, such as building local- to regional institutions for managing a particular resource, for example, maintained the sustainability of the SES (Ostrom 2009). However, among the remaining minority of SESs, where the resource management failed, there is a multiform pattern, that is the large size of the system, state of open-access, high diversity and limited communication among users (Ostrom *et al.* 1994).

Under her framework, Ostrom (2009: 419) singles out several subsystem variables instrumental in users' engagement in collective action for achieving sustainability of SESs. Following the measures for those variables, one can have an estimative image of an SES about the likelihood of actors finding common ground on the management of a natural resource, or as Elinor Ostrom would put it, whether users self-organize (Ostrom 2009: 421). Not only that but the sheer study of subsystems, and of their interactions and outcomes, can enrich the knowledge of and on the SES itself, which would be nothing else but conceptualizations of interactions between the "social" and "biophysical" (Liu *et al.* 2007; Villamor *et al.* 2014).

After all, having a holistic framework at hand is useful in providing a potential set of themes and variables in the design of data collection methods, and also during fieldwork and data analysis concerning complex SESs. The challenge, however, lies with the diagnosis of unsustainable SESs and how they distinguish from healthy and functioning SESs, which requires clear analysis of many subsystem variables and their relationships at different spatial and temporal scales, which make a complex system (Ostrom 2009).

On the other hand, self-organization is a costly process, and for that to happen many variables need to be suitable (Ibid.). The central theoretical assumption shall also prevail that the expected benefits of self-organization for sustainable management of a natural resource outmatch all human- and financial resources invested in designing and implementing a new set of rules and norms (Ostrom 2009). This may result in loss of short-term economic gains and, coupled with several unfit variables in an SES; users may avoid coming to terms (Ostrom, Gardner & Walker 1994; Ostrom 2009: 420). Even if the actors manage to establish new rules and form institutions to enforce these, long-term sustainability of an SES would depend on the congruency of new regulations with contextual conditions, attributes of the resource system (RS); social, economic and political settings (S) at multiple levels including broader government policies, as well as coordination with

and management principles of other institutions (Ostrom 2009: 421-422). It is worth mentioning that the SES framework has been further criticised for downplaying the importance of historical and political motives (Cleaver 2000; Cleaver & Franks 2005); as well as the role of culture and meaning (Agrawal 2005; Crane 2010).

What has been left out until this point, as Villamor and colleagues (2014) claim, is the emphasis on actors' perceptions and values within an SES; as well as the external disturbances to the resource system, elaborated by Anderies and colleagues (2004: 15). Participatory methods and co-management, such as stakeholder engagement in decision-making processes, and participatory scenario building sessions became popular strategies for resource management that can reduce social conflicts (Berkes 2004; Svarstad *et al.* 2008; De Stefano *et al.* 2017). Referring to such strategies, one acknowledges differences in values, interests and ecological knowledge of different actors, while setting a platform for actors to get to know each other's values, interests and ecological knowledge, share them when common and compromise when they diverge from one another (Palomo *et al.* 2014; Villamor *et al.* 2014). For that to happen, "participation" should be inclusive and meaningful, in the sense that it identifies actors carefully and involves as many as possible while empowering them through decision-making (Palomo *et al.* 2014: 187). Otherwise, efforts to sustainable management of a natural resource fall short and the actors diverge from a desirable shared vision (Pretty 2003; Ribot *et al.* 2010; Villamor *et al.* 2014).

This also includes the ecosystem service beneficiaries, who at some stage use or value any ecosystem service (Palomo *et al.* 2014). The inclusion of ecosystem service beneficiaries (or end-users) in the decision-making mechanisms has historically given a back seat, but their inclusion in different case studies are proven to have promoted sustainability of ecosystem services, as well as the integrity[11] of related social systems (Palomo *et al.* 2012). This fact underpins thinking beyond the biophysical limits of resource systems, and empowering all actors by enabling shared learning and behavioral change (Palomo *et al.* 2014: 186-188).

This then brings us the question, how power relations affect the quality of participation and decision-making mechanisms in natural resource management?

[11] "Based on the three pillars of Transparency, Accountability, and Participation. Integrity aims for equity and sustainability. It can be promoted and enhanced to improve governance and address all major risks of corruption." (Water Integrity Network 2018).

Studies focusing on monetary valuations or biophysical assessments in SESs have undermined actors' role in decision-making, as well as their diverse preferences, power relations and socio-cultural perceptions that make actors' context-dependent, socially constructed values (Chan *et al.* 2012; Nieto-Romero *et al.* 2014). Consideration of power and values in decision-making is instrumental to the understanding of actors' motivation underlying the resource consumption- and collective action behavior (Villamor *et al.* 2014: 2).

3.1 SES Approach to Water Resource Management

Gari and colleagues claim that the interlinkages between social- and natural systems are particularly vibrant in coastal and estuarine zones, which go beyond perceived biophysical boundaries while being the most complex systems among all (Gari, Newton & Icely 2015: 63). This is both due to the social value of water and to its role for ecosystems mentioned earlier in this study. It is for the same reason why 12.7% of the terrestrial world is designated as protected areas like nature conservation sites (Note that 65% of the total 12.7% are located in Europe), where the importance of water as a regulating factor is unquestionable (UNEP-WCMC & IUCN 2016).

Protected areas have been ever since the main strategy for nature conservation and hotspots for biodiversity (Chape *et al.* 2005; Palomo *et al.* 2014). However, it is often an overlooked fact that the sustainability of ecosystems is something larger than the conservation of nature. Even though the declaration of protected areas[12] worldwide could stop the transformation of habitats within the designated areas, the impact of land-use change occurring in the surroundings of the protected areas has proven to be detrimental to nature conservation objectives in several cases (Andam *et al.* 2008). This created contrasting landscapes where land-use intensity and functions are sharply different between in- and outside of conservation areas, where sectors with higher economic returns outside of conservation sites, such as provisioning (like agriculture) and cultural services (like tourism), have undermined the importance of regulating services[13] in the surrounding landscape, jeopardizing interior properties of protected areas (Martín-López *et al.* 2011). Palomo

[12] As of 2012, protected areas cover 12.7% of the global land (Bertzky *et al.* 2012).
[13] Maintaining the quality of air and soil, providing flood and disease control, or pollinating crops are some of the 'regulating services' provided by ecosystems. They are often invisible and therefore mostly taken for granted. When they are damaged, the resulting losses can be substantial and difficult to restore. Agriculture, forestry and fisheries are influenced by and influence all types of ecosystem services (FAO 2018a).

and colleagues (2013, 2014: 181) further claim that this approach will eventually affect the provisioning and cultural services negatively over the long term:

> *the capacity of ecosystems to maintain ecosystem services and human well-being over the long term is being undermined.*

What is more, said 12.7% are projected to increase up to 29% by 2030 in the face of the massive decline in global biodiversity (Butchart *et al.* 2010; McDonald & Boucher 2011). This raises the question: If setting apart more land for environmental protection can maintain ecosystems, reverse biodiversity loss and restore the state of the environment; and what additional policies and practices should complement it?

In retrospect, systems approach asserts that spatial boundaries are trivial in natural resource management, while integration of resource systems into surrounding landscapes and wider systems can offer fruitful outcomes for the sustainability of highly valued resource systems (Figure 2).

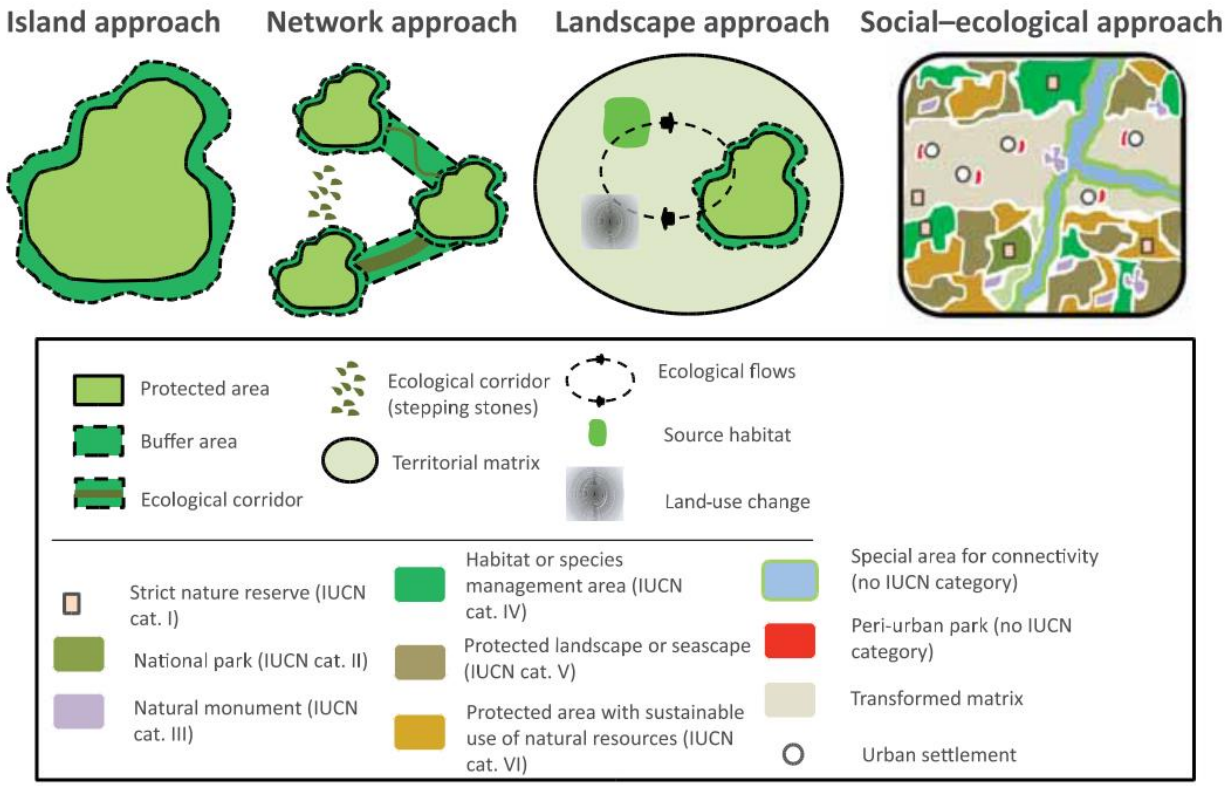


Figure 2. The evolution of the protected-area concept / from the island- to the SES approach (Palomo et al. 2014: 183).

An adaptive SES approach that portrays landscapes with the intrinsic value of relevant ecosystems coupled with the instrumental value of the system can best help the researchers understand the historical evolution of complex SESs, analyze drivers of unsustainable practices and trace systemic responses to policy interventions (Balvanera *et al.* 2017). By so doing, different cases of conflict settlements in SESs can broaden researchers' view on sustainability transformations (Ibid.).

3.2 DPSIR Framework

The Drivers–Pressures–State–Impacts–Responses framework (DPSIR) is an interdisciplinary functional analysis tool designed to conceptualize systems and create models to communicate knowledge on the state and key causal factors concerning environmental issues (EEA 1999; Svarstad *et al.* 2008). The tool is developed through the joint efforts of the Organization of Economic Cooperation and Development (OECD) and the European Environment Agency (EEA) for the adaptive management of SESs (OECD 1993; Stanners & Bourdeau 1995).

DPSIR is a preferred conceptual framework in policy-relevant research on environmental conflicts since it unravels complex relationships between social factors and nature (Ibid.). It embodies a systems perspective, and it is widely utilized for structuring case studies on natural resource management, especially on issues of natural resource conflicts driven by excess human intervention in natural systems (Svarstad *et al.* 2008: 2).

DPSIR have been applied to various cases: Gari and colleagues (2015) made an inventory of different cases where DPSIR has been deployed. While Borja (2006) applied it to elaborate on management and protection of water resources within the frames of the European Water Framework Directive (WFD), Lin (2007) used it in the impact assessment of development activities over a coastal environment. With similar intentions, Nobre (2009), Bell (2012) and Newton and Weichselgartner (2014) applied it to the deterioration of coastal zones and lagoons with an emphasis on coastal vulnerability. It has also been widely used beyond the aquatic environment that Gari and colleagues (2015) listed intricately. Remarkably, Pinto and colleagues (2013) used the framework in a similar context to the case of this study, where they used the framework for tracing human-induced structural and functional changes in transitional wetlands of the Mondego estuary in Portugal while analyzing socio-ecological consequences of such anthropogenic influence. As Gari and colleagues claim (2015: 67-68), the research of Pinto and

colleagues (2013) later informed policymaking by deciphering "the competing water uses of estuarine resources and their ecological functions", which fed into the mitigation strategies aimed at preventing estuarine deterioration in line with the targets of WFD. It turns out that DPSIR is an effective model to communicate the concepts and different stages of the evolution of environmental conflicts and to reflect on associated decision-making mechanisms.

In its basics, the framework consists of five nodes (Table 1): Driving forces (D) are social, economic and demographic developments and corresponding changes in lifestyles, production and consumption patterns that exercise Pressures (P) on the environment. The accumulated pressure then changes the State (S) of the environment. The State of the environment is the overall condition of the physical, chemical and biological components of a particular ecosystem. Changes in S are mostly deemed negative, damaging the ecosystem. Arguably, changes in the State of the environment create Impacts (I) on the societal level affecting the welfare and wellbeing of the agents in a specific area. Reciprocally, there builds a response (R) at the societal or political level against the impacts in different forms and at different stages of DPSIR taxonomy. The response may be preventive, mitigative or adaptive and it can address one or more of the three nodes: Drivers, Pressures and State.

Term	**Explanation**
Driving forces (D)	refers to the driving forces of changes caused by human activities; they put pressure on systems indirectly and can be of demographic, economic, social, political, scientific or technological nature (e.g., the demand for energy, economic growth, the demand for food and housing, population growth).
Pressures (P)	refers to pressures and stress points that impact systems and manifest themselves as changed environmental conditions (e.g., greenhouse gas emissions, contaminated sites, noise).
State of the environment (S)	refers to the quantitative and qualitative condition of a system (e.g., lake water quality, average global temperature, number of species in a forest).
Impacts (I)	refers to the specific effect of a pressure on ecosystems' functioning and thus also on humans and their quality of life (e.g., health problems, species extinction, eutrophication).
Responses (R)	refers to political and societal reactions (e.g., taxes, laws, migration) that reduce the driving forces and the pressures or make adaptation to the changed condition and its impact possible.

Table 1. Components of the DPSIR framework (Ecologic Institute and SERI 2010).

In hindsight, there exist some critics towards DPSIR framework that it oversimplifies complex relationships (Svarstad *et al.* 2008); creates linear relations between multi-layered phenomena and categorizes themes in clear-cut nodes ignoring the fact that factors may act under different nodes (D-P-S-I-R) (Klijn 2004). Other critics involve impossibility of defining discrete boundaries to the cases and externalizing factors which are hard to observe or measure, if not immensurable (Kates *et al.* 2001).

4 Methodology

In the following section the philosophical stance of this study, the selection of research strategy, the research design, the applied methods and data analysis principles are described.

4.1 Philosophy of Research

The philosophical stance and the meta-theoretical position of this research is critical realism (CR), which I believe is the best fit for the purpose, as an account of social science, that can inform the data collected during the fieldwork (Archer 1982; Vandenberghe 2013). Principal to critical realism is the ontological *stratification* of the social and natural world; unlike conventional distinctions like natural and social, or macro and micro, which acknowledges that the *social* is "an emergent reality with its own specific powers and properties." (Gorski 2013: 659).

Note that, CR does not claim these *stratas* to be easily-identifiable or axiomatic. On the contrary, since social structures bear numerous contextual drivers (e.g., social networks or culture) and causal effects, CR presumes social structures deserve a case-based, thorough analysis by social scientists (Ibid.).

The importance of philosophy of science in a good research is very well explained by Gorski (2013). He draws clear-cut lines between positivism, interpretivism, and social constructivism, all of which are based on distinct social ontologies, which has been broadly discussed by many scholars before (Hempel 1958; Winch 1958; Popper 1959; Geertz 2003). Nevertheless, it is self-evident that neither positivists nor the interpretivists are perfect in explaining the social world and natural life:

> *"Natural life may be governed by laws, they counter, but social life is governed by meanings. Thus, they conclude, the aims and methods of the social sciences are radically different from those of the natural sciences. The social sciences pursue idiographic knowledge by hermeneutic means. They do not attempt to explain what happens in the social world, only to render it comprehensible by reconstructing meaning and intention."* (Gorski 2013: 661).

This also means that *meaning and intention* shall never be natural laws, considering each social structure builds on particular social circumstances, like locality, time, culture and corresponding human activities that cannot be fit into physical frames. This also implies that human interaction

and behavior cannot be experimented within closed systems since the human societies are by default communicative, creative and resistant unlike units in physical science (Gorski 2013). Therefore, the essence of social science, namely, to interpret and explain the causality through social structures, is better equipped to approach the social world (Ibid.).

In retrospect, CR, according to Baskhar (1998, 2005), is a mediator between natural and social science insofar as it denies the traditional sharp division between the two. It is also critical in the sense that it stands against the reduction of social phenomena to natural facts since social reality is a living entity within the frames of social structures and bound to the limits of the human mind.

It is worth to mention five principles of critical realism hereby, as Gorski (2013) claims, (1) Causality is not a constant conjunction between events, but rather a derivation from power structures. (2) Social structure transcends and dominates the intentions of individual agents. (3) In order to explain something, one shall identify and elaborate the initiative and determinant *structures and powers.* (4) Scientific knowledge embodies not only factual and phenomenal propositions but also power-related and structural descriptions. (5) Social science intuitively and indirectly sets principles of social values and individual virtues.

4.2 Research Strategy

Research in social science can be done pursuing many different research strategies. When the researcher poses "how" and "why" questions, case studies are commonly selected research strategies (Yin 2003). A case study is an appropriate approach, particularly when the events are out of researcher's control and the researcher is after examination of a contemporary phenomenon with real-life data, and within a certain context (Ibid.).

Case studies are characterized by three primary functions: (1) Explanatory case studies, (2) Exploratory case studies and (3) Descriptive case studies. However, most prominent studies are proven to be pluralistic case studies, incorporating more than two functionalities of case study strategy (Ibid.). The "how" and "why" questions implicitly necessitate a certain level of explanatoriness, yet it doesn't prevent case studies to be pluralistic.

Two important tools of a researcher deploying a case study strategy are *direct observation and systematic interviewing.* This is the comparative advantage of case studies, that research can absorb

a massive variety of evidence; including a diverse set of documents, interviews, and observations (Ibid.).

It is no wonder that an extensive literature review is widely accepted to be the backbone of case studies (Flyvbjerg 2006). Unlike the general perception of literature review being an inventory of previous research on the selected issue, in case study strategy, literature review plays an iterative role, pushing the researcher further to develop and sharpen the theories at work and also to come up with more precise and daring research questions (Ibid.).

Case study strategy is often criticized for researcher bias and fairness issues. However, these are not unique to case studies. Regardless of the research strategy, bias in interpretation of data or bias in questionnaire design has been previously encountered in other research strategies too (Ibid.).

Another common criticism against the case study strategy is the issue of scientific generalizability. Yin (2003: 10) retaliates in this matter by asking the very same question with regards to empirical science: "How can you generalize from a single experiment?" and "What would be the scientific basis that can justify generalization from a single case?", and adds:

> *"In fact, scientific facts are rarely based on single experiments; they are usually based on a multiple set of experiments, which have replicated the same phenomenon under different conditions. Case studies, like experiments, are generalizable to theoretical propositions and not to populations or universes. In this sense, the case study, like the experiment, does not represent a "sample," and the investigator's goal is to expand and generalize theories ("analytic generalization") and not to enumerate frequencies (statistical generalization)."*

In the core of case studies are decisions, that the researcher investigates and tracks the drivers of. Furthermore, illustrating the implementation and implications of decisions, and projecting their future impacts make a case study complete. The wording is important here because no decision comes on its own, but it is designed, agreed upon and implemented by agents. Hence the individuals, organizations, institutions, processes, programmes, etc. make up the whole body of case study research (Creswell 2012).

In short, case studies can be identified as empirical inquiries that "investigate a contemporary phenomenon within its real-life context" and in particular when "the boundaries between phenomenon and context are not clearly evident" (Yin 2003: 13). In hindsight, one can assume that case studies are designed to uncover particular, if not unique, contextual conditions that

believed to have high logical relevance to the phenomena studied. In that sense, phenomena in case studies are preconditioned to many factors, unlike several other research strategies that progress by deliberately isolating only one or few variables from their context, or sometimes within a constrained and limited understanding of the context, in pursuit of simplification of complex phenomena which are rooted into multitudinous determinants. Case study strategy avoids the distinction of phenomena from context, and vice versa, which are assumed to be nested inside each other (Yin 2003). Yin (2003) and Stoker (1991) further advocate for case study strategy, as it relies on multiple sources of evidence by employing all-encompassing methods, and its flexible method design that enables data collection and analysis develop iteratively adhering to theoretical propositions.

4.3 Research Design

The research design is the blueprint of the research and the logic hinging the collected data to research questions, and later to final conclusions (Yin 2003). For this research, both quantitative and qualitative data have been collected, albeit disproportionately, at different stages of the study; both being simultaneously of explanatory and of exploratory nature. In that sense, this study can qualify as a mixed methods research while a larger share is given to the qualitative analysis, with the quantitative analysis offering follow-up findings to the results derived from the qualitative analysis. Qualitative data collection was made to reflect actors' perspectives on phenomena like drivers and impacts of land-use change, economic growth-nature conservation paradigm, water scarcity, water insecurity, local governance and regional development; while quantitative data is to test the validity of a statement emerged during the fieldwork and it is limited to univariate analysis, which can be a good starting point for future research.

This research is designed, as Creswell (2013: 101) suggests, in an order starting with the introduction of the problem, aim of the study, research questions, theoretical base of the study, introduction of contextual analysis tools such as DPSIR and SES framework, properties of the selected case including the application of aforementioned frameworks, lessons learned, and finally the conclusion including ethical considerations.

In analytical terms, the making of this thesis followed the roadmap by Kvale (1996): thematize, design the study to address RQs, conduct interviews, transcribe, analyze, and report. In that

respect, SES approach and Ostrom's SES framework are used for elaboration on the particular context of the research case, including complex socio-cultural, environmental and economic relations within the system. Later, DPSIR framework is applied to the SES in order the communicate main stages of water management conflict in the Doñana SES.

4.4 Applied Methods

For this study, I use multiple forms of data: field notes and observations, photographs, interviews, conversations in the natural setting of the problem of study, and surveys. Nonetheless, major methods used in this study are systematic interviews, direct observations and surveys, which Yin (2003) posits, are prominent data collection methods of case studies. Direct observations primarily involve field observations on the way to, in and around the site of research, visits to greenhouses, farms, agricultural cooperatives and the nearest towns in the vicinity. While field observations help with illuminating the context of the case, systematic interviewing helps build themes around the phenomenon of sustainable water management. Surveys, on the other hand, are to explore the quality of the relationship between end-users of ecosystem services and service providers (Creswell 2013).

After assuming boundaries of the case study, I identified the actors that are connected to the problem at different levels and scales. They are farmers, residents, environmental civil society organizations (ENGOs), National Park management, representatives of the tourism sector in the Doñana region (hereafter Doñana). Purposeful sampling, maximum variation method in particular, is the main sampling logic of the data collection, that can integrate the most of different perspectives to the research (Scheyvens & Storey 2003; Creswell 2013).

To that purpose, I have reached out to a farm in September 2017, where a volunteer position[14] was open to a person who could help the farm to develop. There I stayed for two months, on the border of the Doñana Natural Park. My physical presence facilitated multiple data collection opportunities; including field visits, observations and on-the-spot interviews (also spontaneous interviews). On top of that, it helped me to initiate an off-the-record dialog with the actors, which

[14] Via the volunteering platform: workaway.info.

translated into a better understanding of the context and opened up otherwise unlikely perspectives on the area of research.

4.4.1 Interviews

I systematically reached out to the interviewees. Residents, farmers and agricultural cooperatives were selected for convenience reasons, which became an opportune option during my stay in the field, where I got to know residents and farmers. I personally contacted some widely-recognized civil society organizations and a manager of Doñana NP before the filed visit and arranged the interviews. On the other hand, due to the tight and irregular schedule of tourism agencies, I got to interview one tour guide and five tourists spontaneously (The interviews with tourists were rather brief and did not provide as much data as other in-depth interviews), which worked out since I had the interview form readily stored in a platform called "kobotoolbox"[15], created by Harvard Humanitarian Initiative (HHI) for the benefit of field researchers.

I prepared in-depth semi-structured interviews in a multiform fashion (See Appendix D) because the interviewees are from diverse backgrounds, representing a particular group of actors. With in-depth interviews, it is intended to collect different understandings of the central phenomenon (Creswell 2013; Bryman 2016). The interviewees are also asked to state whenever their personal view diverges from the group he or she is assumed to belong. By so doing, the researcher captures the most of interviewees' contribution, while not missing the main perspective of the larger group. I interviewed two farmers, five residents, one tour guide, five tourists, four ENGO officers; and one of the coordinating managers of the Doñana NP (A total of 18 interviews) has provided data for my research (Table 2).

[15] http://www.kobotoolbox.org, the researcher can prepare and store surveys, questionnaires and interviews on the platform. One can access, edit, distribute or fill in the forms both online and offline. If offline, the platform still stores the changes in the forms or newly entered data in its offline database and transfers these to researcher's account as soon as there is an internet connection.

Category	Interviewee Profile	Code
Farmers (Agriculture)	Two farmers, a *traditional* and a *new* farmer.	F
Residents (Local community)	Five residents, living in the border towns of Doñana.	R
Tour facilitators and tourists (Tourism)	One tour guide of the Doñana NP and five tourists in the vicinity of the Doñana NP.	T
ENGO Officers (Civil Society)	Four ENGO Officers working on biodiversity conservation in Doñana.	E
Doñana NP management (Administration)	One manager from the Doñana NP administration.	M

Table 2. Categorization of interviewees

4.4.2 Surveys

Surveys here are designed to explore end-users' (service-beneficiaries') awareness on relevant supply chains and their past and potential reaction towards supply-side disturbances. The need for this method emerged as a result of the qualitative data analysis; when most interviewees stressed an issue, which has never been investigated in the case of Doñana before. In fact, the information collected via digital surveys complement the initial data collection method of interviews because the end-users of the ecosystem service focal to this study are physically remote from the very SES, where they are also counted as actors according to the SES thinking.

For that purpose, I again referred to kobotoolbox and created a survey (See Appendix E), which I later digitally distributed via personal social media accounts. Snowball sampling method was used to spread the survey around. It has a brief introduction containing information about the researcher himself and the purpose of the research as well as an acknowledgement section where the participants are asked to ensure they are suitable for taking the survey. Considering the meagre personal network of the researcher, the first section is followed by personal questions such as age

and occupation to specify the audience. The following questions are with respect to purchasing and consumption behaviour, awareness on conditions of production and supply chain, behavioural change in case of information provision; and the final question is about the potential action of activism in case of problem confrontation. The survey could reach to 37 respondents, of which only 24 are valid, and the results are elaborated in the "lessons learned" section.

4.5 Methodological Considerations

Before conducting a case study, one should acknowledge the major challenges and misunderstandings about case study research. Flyvbjerg (2006) claims, by so doing one can better justify the need for a case study. One misunderstanding is about the context dependency of case studies, which is downplayed by the scientific communities, thinking that the practical knowledge generated from context-dependent cases is no match to general, theoretical knowledge. However, in social sciences one cannot reach to general predictive theories, nor should it be aimed, since social systems are context-dependent, and they are not regulated by general laws. Another issue is the generalizability of the findings. Yet again, case studies do not aim for statistical generalizations but analytic generalizations, and they are designed to build patterns around certain themes and phenomena. The third misconception is about the verification of the case study research. Case studies are considered to have "a tendency to confirm the researcher's preconceived notions" (Flyvbjerg 2006: 221). But this is an individual problem rather than a wider problem of case studies. There is no evidence to show that case studies embody more "researcher's bias" than any other research strategy (Ibid.). In hindsight, case study strategy is a useful tool to accumulate social scientific knowledge.

4.6 Ethical Considerations

According to Creswell (2013), the researcher may be collecting sensitive or personal data from the participants and she should always keep ethical considerations in mind. During the time in the field, I categorically informed the interviewees before and after the interview about the reasons for my presence in the field, as well as the purpose of the research. I asked the interviewees for consent regarding the data collection/use and voice recording. Interviewees were selected and interviewed on a voluntary basis and the personal information of interviewees was kept confidential. The collected data was stored offline in an external USB storage for data protection.

As Moss and colleagues (1999) state, positionality and reflexivity and are two major ethical considerations which researchers should take into account during the research. Since I have already had a pre-set position towards environmental protection, multiple times I had to put in extra effort in understanding different perspectives that I otherwise would disdain.

The investigator can face challenges when the research takes place in a cultural circumstance unfamiliar to that of researcher's own culture (Murray & Overton 2003). I reckon that I was not only a visitor but a researcher in the eyes of the interviewees. Living in Doñana did not make me a person with whom the interviews can be open and genuine now; however, it helped me to learn the language of the countryside, or as locals would say, *the language of "Campo",* with a particular way of life it bears, and this eradicated my state of being an outsider. I was lucky to be in a friendly environment and well-received by the people in my residence area and by the interviewees.

5 The Case Study – Doñana's Sustainability Challenge

Water stress in Doñana is a complex issue with a history of regional water conflicts and changing-restructuring institutions of water resource management. This makes Doñana a suitable candidate for a case study, as Yin (2003) claim, case studies are to cover contextual circumstances salient and pertinent to phenomena of study.

McGinnis and Ostrom (2014) recommend a three-step process, when the SES framework is to be applied to particular cases: (1) Selection of the focal level of analysis, including an analysis of interactions and outcomes related to the resource system, (2) selection of variables and evaluation of relevant indicators, (3) communication of the results.

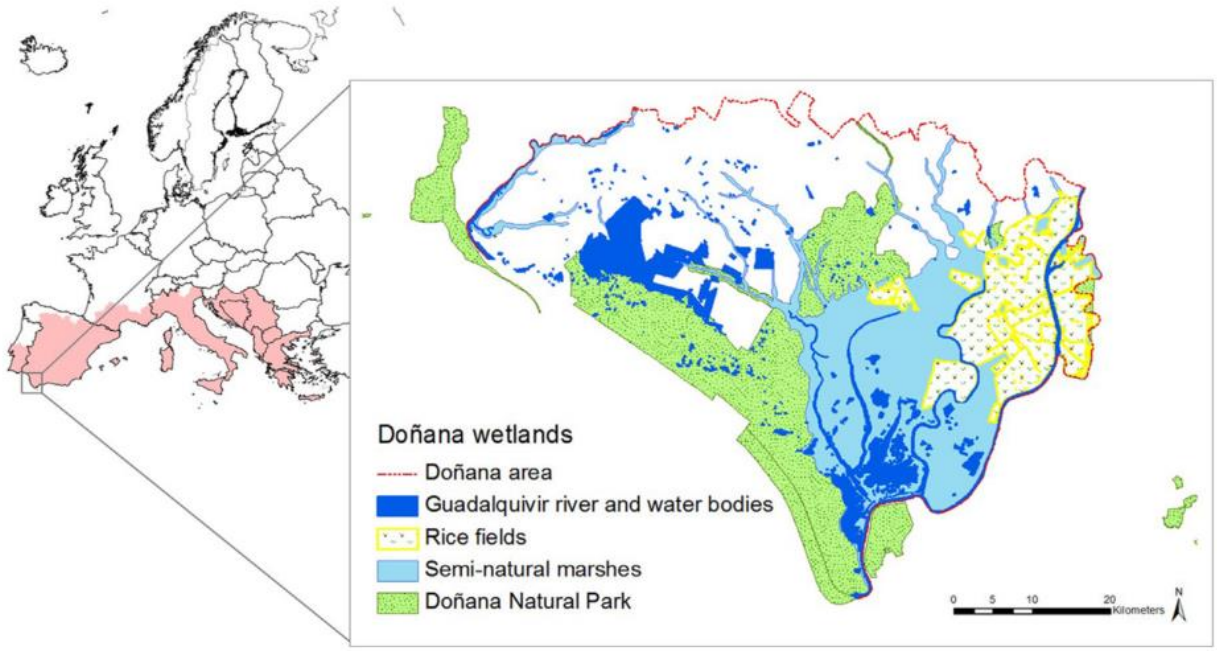
The analysis will be at the groundwater level which extensively concerns agriculture and biodiversity conservation. The interactions and outcomes related to the water management are analysed from an actor-based sectoral perspective and also elaborated under the DPSIR framework at societal and policy level with regards to the results of interviews. The application of DPSIR framework to the SES further helps to simplify conceptualization and communication of the conflict more dynamically. In the following sections, the physical characteristics and historical development of Doñana are elaborated, which are succeeded by an explicit SES analysis.

5.1 Physical and Spatial Characteristics

Doñana is located on the southwestern coast of Andalusia in Spain (Map 1). Central to the region is the famous Doñana NP, surrounded by four natural parks and four larger municipalities[16] including a few coastal towns that are bordering the parks. The Doñana NP (54,300 ha) is a vast wetland and the ecological system of Doñana is characterized by four eco-districts: marshes (In Spanish: Las marismas), coast, aeolian sheets[17] and the Guadalquivir estuary (Palomo *et al.* 2011). The Doñana NP is strictly protected by the so-called "fortress conservation" strategy, where no more than a few traditional-cultural activities are allowed within the Doñana NP, while the natural

[16] Of those four larger municipalities, 16 lower municipalities are administratively operating with a total population of nearly 213,839 inhabitants (involving a low population density: 0.65 inhabitants ha−1).
[17] A.k.a. sand sheets.

parks are open to some traditional practices under rigid control of park management (e.g., free cattle ranching, hunting, controlled forestry and limited agriculture).



Map 1: Location of the case study in the Mediterranean (De Stefano et al. 2017: 3).

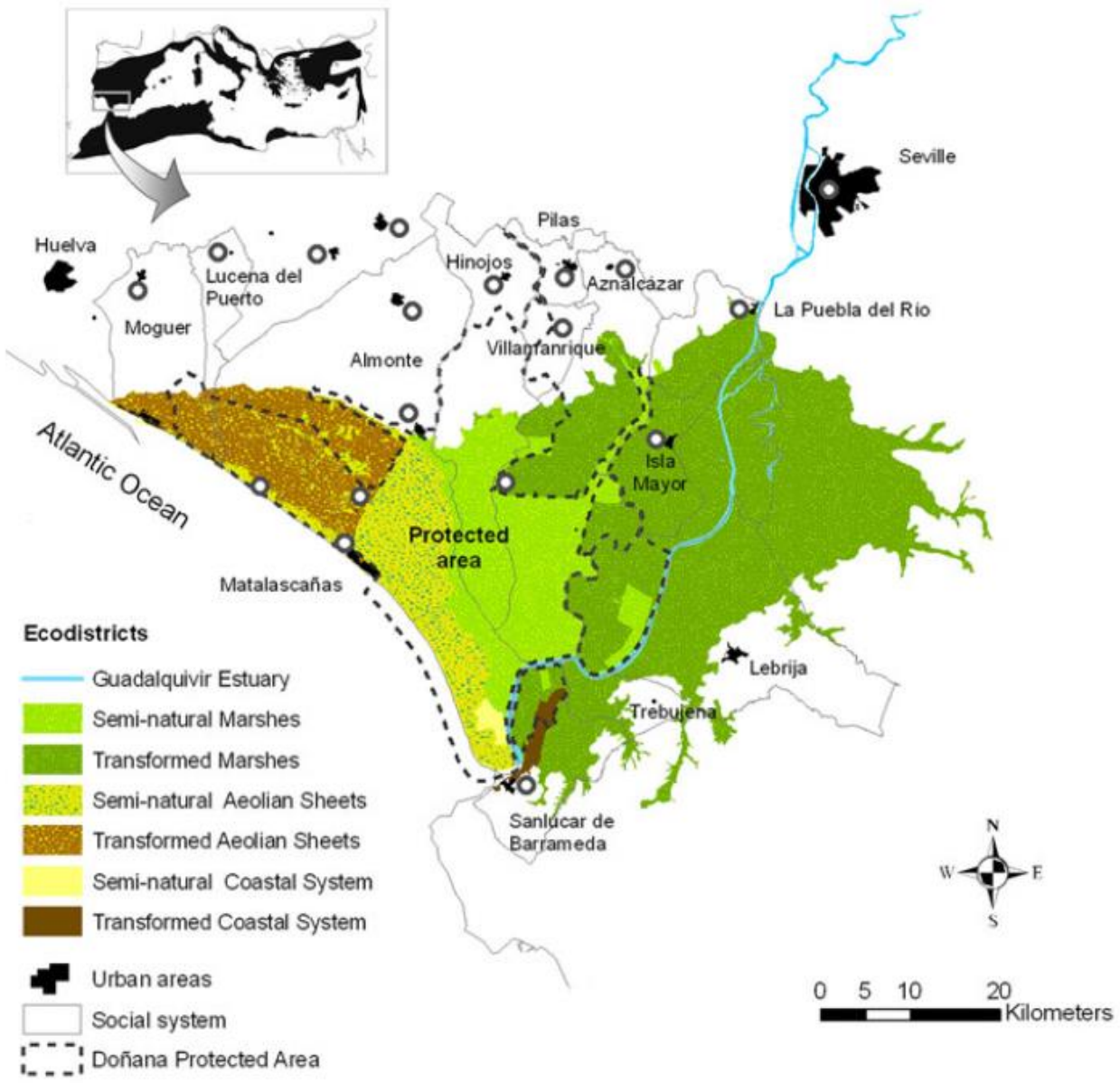
The total conservation zone is a stepping-stone for birds[18] migrating between Europe and Africa, and it offers food and shelter to over 300 different species of birds (See Appendix F). Except for ornithology, Doñana is famous for a couple of charismatic endangered animal species, such as the Iberian lynx (Lynx pardinus) and the Spanish imperial eagle (Aquila adalberti) which became the symbol of nature conservation over the last decades. Despite increased conflicts; rainwater, groundwater and the Guadalquivir River constantly feed Doñana and give life to the richest nature reserve in terms of biodiversity in Europe. After all, Doñana is one of the most renown wetlands in Europe (Martín-López *et al.* 2011).

5.2 Historical Development of Doñana

Life in Doñana has been shaped by different uses of terrestrial- and wetlands throughout the history (Ojeda, cited in Gómez-Baggethun *et al.* 2010). Agriculture, forestry and cattle herding were the

[18] 75 per cent of all European bird species can be found in Doñana (WWF 2016b).

main human activities in the region and it is described as a cultural landscape "where nature and society have co-evolved over centuries" (Gómez-Baggethun *et al.* 2010). Doñana is associated with "a continuous process of human landscape transformation", where agriculture was a baseline to local livelihood. This continued until the 1940s, by then the economy of Doñana was portrayed as a slow and closed system, which only relied on the local provisioning services (Ojeda, cited in Martín-López *et al.* 2011).



Map 2. Map of the Doñana SES and land-use transformation (Palomo et al. 2011).

As Martín-López and colleagues (2011) explain, economic activities and the landscape of Doñana have been transformed by different policies in different time periods (Map 2). In 1941, a large forestry district in western Doñana was turned into a commercial forestry area of fast-growing monocultures; in 1960 more than 70,000 ha of marshes located in eastern Doñana (Left bank of the Guadalquivir River) transformed into croplands[19] (Ibid.). In 1968, the coastal town of Matalascañas in southern Doñana has been declared a national tourism centre, proliferating beach tourism activities. And in 1971, Almonte-Marshes irrigation project was brought to life in western Doñana (Right bank of the Guadalquivir River), which transformed 46,000 ha into irrigated lands.

On the other side, the Spanish Government declared a large part of wetlands and related morphological systems a National Park in 1969 through substantial efforts of the World Wildlife Fund (WWF). An additional declaration of the surrounding area as natural parks followed this decision in 1989, to serve as a buffer zone between the pristine National Park and surrounding local settlements, this time by the Andalusian Government. Together with the National Park, more than 29% of Doñana is under conservation status as of today. The natural value of Doñana has been recognized by multiple parties, as such it has been nominated to several designations by the International Biosphere Reserve, the Ramsar Convention, and UNESCO; in 1980, 1982, and 1995 respectively.

Tracing the land transformation back to early 20th century, Zorrilla-Miras and colleagues (2014) record that more than 70% of Doñana's marshes were transformed into croplands (mostly converted to intensive agriculture), and the remaining untransformed 30% of lands correspond to the marshes within Doñana's protected areas. The picture is more dramatic when one compares the land transformation in- and outside of protected areas. While only 30% of the protected areas in Doñana were transformed from 1956 until 2010, this figure tops to 93% when it comes to the surrounding areas (Martín-López *et al*. 2011).

After all, being exposed to policies of intensive agricultural transformation has changed Doñana's ecosystems accordingly during the last decades. Conflicts started to took place more often and conflicting parties became more vocal in their concerns and claims regarding the development of Doñana. These parties are on one side the conservationists advocating for more eco-friendly

[19] Irrigation Area of the Lower Guadalquivir Project.

industries such as nature tourism, environmental education and ecological farming, and on the other side advocates of expansionist economic development of the region with limited environmental concern, such as beach tourism and export-oriented water-intensive agriculture (Ibid.: 1482).

5.3 Doñana as a Social-Ecological System

This thesis is not the first attempt to study Doñana from an SES perspective. The literature is rather rich in fact. From conservation effectiveness to land-use change Doñana as an SES has been scrutinized before (Martín-López *et al.* 2011). However, very few of these studies focused on the power relations within the system and external drivers of disturbance, such as international trade.

The SES of Doñana offers several ecosystem services. It is the "water" factor that distinguishes which sectors and actors are to be included in this study. This is not to say water does not play a role for the ecosystem services not included in this study, but the state of change in water does not affect all sectors equally (e.g., forestry) and to some (e.g., agriculture and conservation-tourism) it poses a social conflict coupled with a sustainability challenge. Hence, only those social systems of serious water conflict are lengthily elaborated here, while those of less significance are only briefly introduced.

Palomo and colleagues (2011) point out in their research that water and biodiversity are the two most important aspects of the Doñana SES; these are followed by land-use change, nature conservation and agriculture. In this manner, the Doñana SES is dependent on the sustainable management of freshwater to maintain the natural and social systems that live on the Doñana's services. This makes the whole SES vulnerable to climate- and human-induced disturbances, as De Stefano and colleagues (2017) claim, water conflicts in Doñana will further continue considering the degrading groundwater tables and exacerbating impacts of climate change.

5.4 Ecosystem Services

Martín-López and colleagues (2011) have previously identified the actors in the Doñana SES from an ecosystem services approach (Table 3). During the time in the field, I did not identify additional ecosystem services at the level of the resource system.

Ecosystem Service Type	Ecosystem Service
Provisioning	**Agriculture** Fishing (Estuary and marshes) Cattle Coastal shell-fishing Crayfish
Regulating	**Hydrological regulation** Erosion control Water quality Micro-climatic regulation
Cultural	Biodiversity conservation and nature tourism Beach tourism Religious tourism Research Environmental education Moral satisfaction for conserving biodiversity

Table 3. Main ecosystem services received from the Doñana SES (Martín-López et al. 2011).

5.5 Provisioning Services

5.5.1 Agriculture

Agriculture is the economic engine of Doñana. Agricultural areas have significantly increased throughout the last century, with the majority of the local population employed in the agriculture sector. It is the largest contributor to the regional economy in terms of income generation (Martín-López *et al.* 2011).

There is a sharp divide between different agricultural practices in Doñana. Traditional agriculture such as olive groves and vineyards has been gradually replaced by more profitable cash-crops such as berry greenhouses, orange yards and rice paddies (hereafter "New agriculture"[20]). While table olive, olive oil and wine are mostly marketed locally, harvest from the new agriculture is largely exported, especially berries (the majority being strawberries). This transformation is perceived disparately among the local population; hence they are analysed separately in the following part.

[20] I prefer the term "New agriculture" instead of more progressive words like "modern agriculture" or "smart agriculture", because the agriculture transformation in Doñana is limited to a land conversion to intensive agriculture, rather than a technological transformation, green revolution alike.

It is worth mentioning that although agriculture has been constantly intensifying over the last decades, ecological agriculture practices have only made less than one percent of the total production in Doñana (Atienza Serna *et al.*, cited in Palomo *et al.* 2011).

5.5.1.1 New Agriculture

Doñana is the top region worldwide for strawberry production. Around 97% of all Spanish strawberries (Fragaria ananassa Duch.) are produced in Huelva and around 60% to 70% are produced in the area between Huelva and the Doñana NP (Bickford *et al.* 2016). The total production of strawberries (Figure 3) in Spain, according to Food and Agriculture Organization (FAO), was almost 300,000 metric tonnes in 2014 (FAO 2018b). Out of all production, more than 90% are exported, importing countries being Germany, UK, France and Scandinavia (Morillo *et al.* 2015).

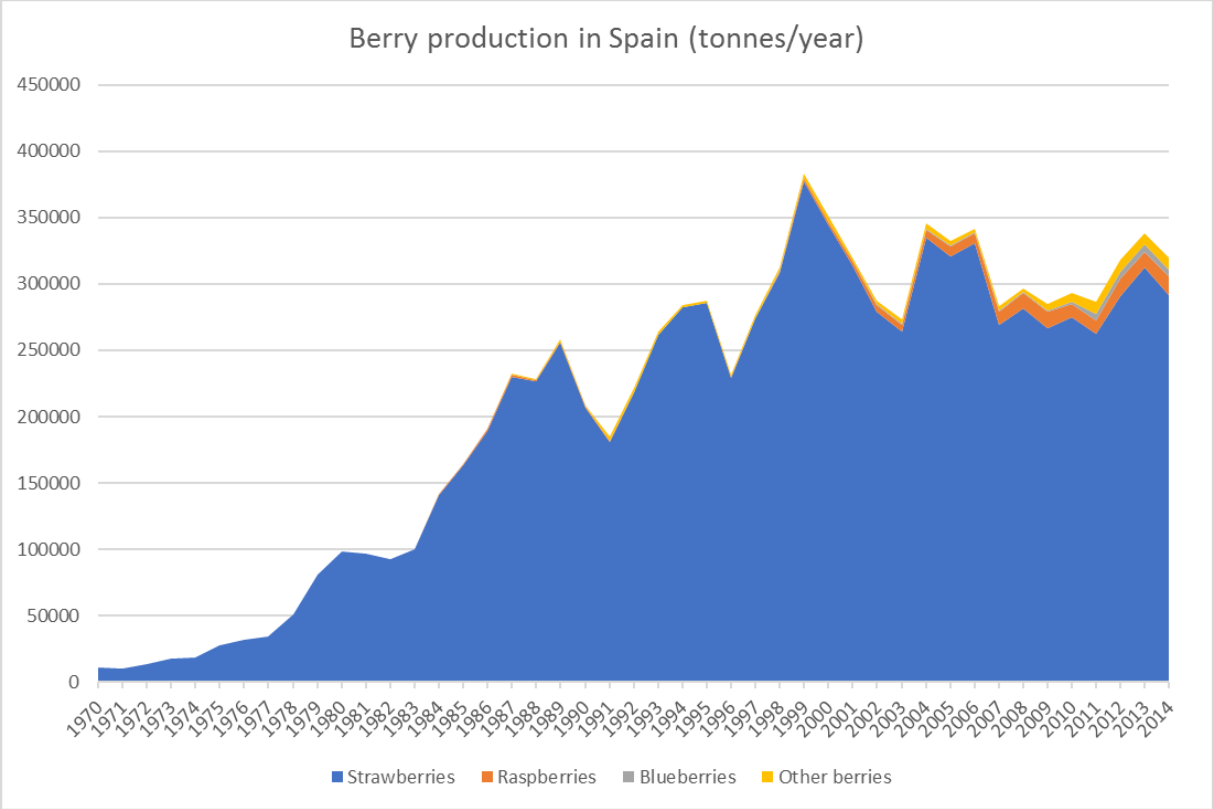


Figure 3. Historical development of berry production in Spain (FAO 2018b).

De Stefano and colleagues (2017) note that rice and fruit sectors locally support the livelihood of more than 200,000 people. Berry (Strawberry, blackberry, blueberry and raspberry) production

became an important mono-culture cash-crop of Doñana (Bickford *et al.* 2016). The agricultural policy of intensification and expansion[21] (Figure 4) is further supported by the increasing demand for red fruits from the EU countries (Ibid.).

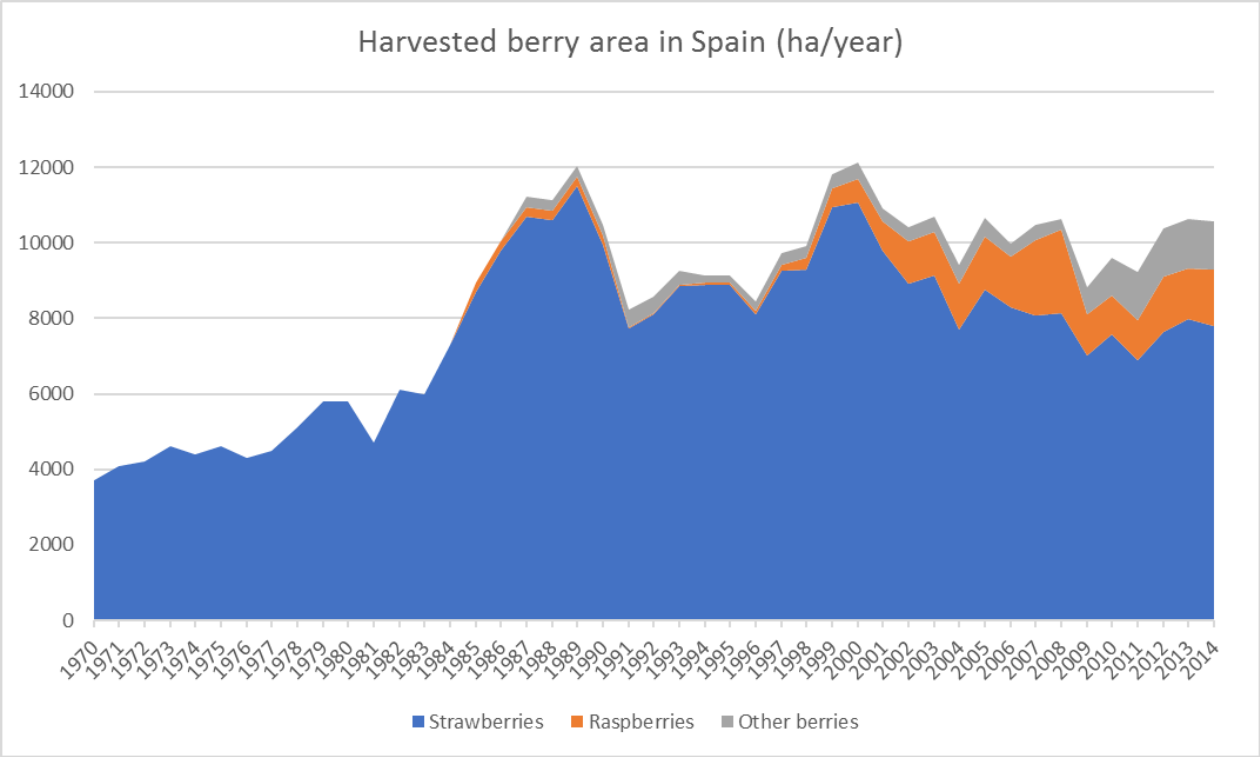


Figure 4. Historical development of harvested berry area in Spain (FAO 2018b).

5.5.1.2 Traditional Agriculture

Vineyards and olive farms make up the traditional agriculture in Doñana. In contrast to the growth pattern in red fruit production, vineyards have suffered a dramatic drop in total harvested area. Market competitiveness is the main reason for the decline since the price for grapes has been too low, while the profitability of "New agriculture" was on peak. This trend was further encouraged by multiple policies at different levels and scales. For example, the subsidies received from the EU Common Agricultural Policy (CAP) has gradually decreased over the last decades, while the

[21] While total harvested area of all other berries increased in Doñana, the strawberry harvested area has declined over the last decade. Nonetheless, the productivity and total berry produce have increased in the same period. (Bickford *et al.* 2016). Note that Huelva is almost the only berry producing region in Spain (Except for strawberries all other berries are only produced in Huelva.).

same programme offered incentives to farmers for abandoning their traditional, "uncompetitive" vineyards[22]. The implications of CAP were also complemented at the regional level with the introduction of new crops, such as plums, oranges, almonds, but especially berries. These policies accelerated the land-use change to intensive berry production (Martín-López *et al.* 2011). The fact that most vineyards are smallholders[23] who continue to run the traditional family farm with little, if any, commercial purpose added up to the vulnerability of the smallholders against price distortions and unfriendly agricultural policies towards traditional farming. It is also noted that both traditional grape- and olive farmers increased their engagement in agricultural cooperatives in response to detrimental agricultural policies (Plieninger & Bieling 2013).

5.5.2 Other Provisioning Services

Additional provisioning services received from Doñana, albeit insignificant compared to the size of agriculture, are livestock, fishing, coastal shell-fishing and crayfish catching. While cattle farming was an important source of income in the past, this has been substituted by the cultural value[24] of it (Fernández-Delgado 2017). Fishing activities have the same faith as cattle ranching. The estuary and marshes in Doñana, as well as the Guadalquivir River, have suffered large drops in sea-animal populations (Sobrino *et al.* 2005). Some reasons for the population decline were recorded as pollution and droughts, resulting in a reduction of 95% of total captures (Ibid.). In terms of forestry, an important portion (67,608 ha) of natural parks and surrounding areas in the Doñana SES are covered with forests. Therefore; timber, pine cones and honey are the products harvested from Doñana's forests[25], yet to a limited extent.

A remarkable distinction between agriculture and other provisioning services is that, while agricultural produce is mostly exported, other provisioning services are either not marketized and consumed locally or only a small part of it is supplied to international markets. This creates a

[22] CAP Policy: Regulation EC/479/ 2008 & Regional policy: Andalusian Royal Decree 1244/2008 (Real Decreto 1244/2008)
[23] This figure does not only account for vineyard fields. It is recorded that 95% of all farmers are smallholder in Doñana, while almost 70% of the fields are less than 2 ha (Martín-López *et al*. 2011).
[24] For example, "the Mares' Roundup" is a half-millennium-old tradition in Doñana, where local horses are herded together within the Doñana NP every year in June and then taken to the border towns of El Rocio and Almonte. Here horses get trimmed and the foals sold.
[25] Forestry is managed according to conservation principles by the Department of Environment of the Andalusian Government.

great disparity between the total market value of exported- and of locally consumed agricultural goods.

5.6 Regulating Services

The Doñana SES is home to multiple ecosystems, and these are highly dependent on the aquifers beneath Doñana (Gómez-Baggethun *et al.* 2010). Water is what gives life to many natural and social systems here: from pristine conservation areas to beach resorts and from lush forests to vast strawberry fields. Among others, the ecosystems of Doñana provide four principal regulating services: Hydrological regulation, erosion control, water quality and micro-climatic regulation that sustains the SES (Martín-López *et al.* 2011). While climate change is perceived as a critical future challenge to Doñana, the hydrological regulation and the existing water stress is respectively the most valued and most problematic regulating ecosystem services (Ibid.).

5.6.1 Water Use, Water Consumption and Virtual Water

Resource-intensive agricultural production can sometimes disrupt the material cycles, like water energy and nutrients within an ecosystem (Tomich *et al.* 2011). It is therefore important to scrutinize the application practice of water in agriculture (Map 3). Two points are critical here, what type of water is used in agriculture and how does it affect the hydrological-cycle. The endemic crops in Doñana, grapevines and olive trees are crops with high drought-resistance and low water-requirement. Berries and rice, on the other hand, are water-intensive crops with low drought resistance. Due to the low water demand of traditional crops, grape- and olive-farmers historically relied on rainwater. The practice has very little changed[26] within the olive groves and vineyards, while the abandoned and transformed lands of new *rice* and *strawberry fields* turned their face to irrigation systems.

[26] A majority of traditional farms still refrain from irrigation systems. (CMA, cited in Martín-López *et al.* 2009).

Map 3. Water withdrawal for agricultural use % of total water withdrawal in Spain / Average 1990 – 2010 (FAO 2018b)

It would be technically incorrect to classify both agricultural subsystems under the same irrigation scheme from an environmental perspective since the irrigation per se may not disrupt the hydrological regulation of a system. It is the scale and the cycle that makes the picture whole. Rice paddies in Doñana are irrigated via the water distributors of the famous Guadalquivir River and the water use[27] of rice paddies are within the allowed limits of the Environment and Water Agency of Andalusia[28]. After long disputes over the environmental impact of irrigated rice fields, a consensus has built in the region about the hydrological sustainability of existing rice production (Fernández *et al.* 2010).

Berry production, on the other hand, heavily relies on underground resources, which is far beyond the carrying capacity of Doñana's aquifer systems. Most prominent reasons are the long distance from the Guadalquivir River, lack of water-supply infrastructure and spatial dispersion of strawberry fields in the region, while factors like easy and free access to groundwater, weak water governance and ill-planning due to rapid transformation also motivate the bad practice.

On top of that, intensive berry production poses a hidden hydrological threat to Doñana. While almost the complete strawberry produce is exported, it entails a significant water consumption in

[27] Refer to Appendix B for definitions.
[28] The regional government institution responsible for regional water management.

the form of "virtual water", rather than water use. Considering the total amount of yearly berry exports, the water abstraction from the Doñana's hydrological system is the total water embedded in more than 90% of 300,000[29] metric tonnes of berries, that does not return to their initial ecosystem, nor to their hydrological cycle. Hoekstra (2006) notes that most EU countries "have a high virtual water import dependency" (Ecologic Institute and SERI 2010).

5.6.2 Underground Resources and Desiccation of Wetlands

Underground water is a renewable natural resource as long as water withdrawals do not exceed the replacement rate. If groundwater tables are overexploited, the impact can be observed at the state of ecosystems, which groundwater tables are feeding, and consequently at the related ecosystem services (Kreamer *et al.* 2015; Rosegrant *et al.* 2009). Eventually, overexploitation may cause "the collapse of aquifers" (Ecologic Institute and SERI 2010: 39).

According to a report by WWF (2007), Doñana's aquifer system has suffered around 50% depletion over 30 years, and continue to deplete (WWF 2016b). This resulted in another 50% reduction of the average recorded flows into the marshes in Doñana, according to the Geological and Mining Institute (IGME) (Morillo *et al.*, 2015: 44). One basic sign of rapid groundwater depletion is the disappearance of lagoons (Sousa & Garcia-Murillo 2009), and the vegetation loss due to drops in soil humidity. In a similar vein, marshlands in Doñana shrunk as much as 82% from 1991 to 2009 (Haberl *et al.* 2009: 1815)

5.7 Cultural Services

Cultural services received from the Doñana SES are diverse and popular. Palomo and colleagues (2011) come up with a high figure of 97% representing the percentage of people in the Doñana SES who use one or more of the cultural ecosystem services. Besides the income generating cultural ecosystem services such as nature tourism, beach tourism and religious tourism (faith tourism); research, environmental education and various cultural-traditional activities take place in Doñana. The exact numbers and figures for Doñana being unknown, tourists from the UK, France, Germany and Scandinavia make the top list of visitors to Andalusia (Martín-López *et al.* 2014).

[29] Note that this is a rough estimate and only represents the total amount of physically embedded water in is exported berries. This figure multiplies exponentially if the water consumption of berry farming is added up on top.

As mentioned earlier, Matalascañas in southern Doñana offers all-inclusive “sun and beach” type of tourism on sandy beaches. While the population of the town is less than 2,000, in summers this figure increases up to a temporary half a million people (Fernández-Delgado 2017). A very similar pattern of tourist influx occurs because of the religious tourism when particular events; such as the pilgrimage of El Rocío takes place. The town of El Rocío, having a population of 700 residents, receives around 1 million tourists for the frantic celebration of the Virgin of el Rocío. On the other side, national and natural parks receive visitors year-round. While the nature reserves in Doñana are used for recreational purposes by the locals, ornithology in the Doñana NP charms thousands of bird-lovers into bird-watching in Doñana.

Environmental education and scientific knowledge services are two non-income generating pillars of cultural ecosystem services in Doñana. The capacity of these services includes breeding centres for endangered charismatic species, the Doñana Biological Station[30] (Estación Biológica de Doñana), ecological education in schools and in municipal education centres.

[30] A public research institute carrying out multidisciplinary research on the ecology of Doñana.

6 Lessons Learned

The relevant literature review, direct observations in the field and the analysis of the Doñana SES from an ecosystem services perspective have helped with the large part of the application of DPSIR framework to the case of the Doñana SES. In line with the similar literature on the water stress in Doñana (Haberl *et al.* 2009), historical and ongoing intensification of water-intensive agriculture is identified as a driving force. Going one step back to the motivation of the change in Doñana's agricultural system, it is the increasing demand and high price for the end-products (berries) that motivated the transformation. The direct effect of the intensification of water-intensive agriculture is the increased groundwater withdrawal and aquifer overexploitation (P), that results in the depletion of Doñana's aquifer system, drops in soil humidity and desiccation of wetlands, which are the main morphological feature of the Doñana (S). While the immediate impact of the change in Doñana's state of the environment is observed as habitat fragmentation, biodiversity loss and landscape change (I); it can translate into a larger problem of water scarcity and more frequent droughts in the long term if the trend continues.

The political and societal reactions (R) to Doñana's long-lasting water management struggle, however, are perceived rather unsatisfactory among the local population. Note that responses may be destined to address Drivers, Pressures or State, and they can be of preventive, mitigative or adaptive nature[31]. Also, responses may arise at different levels, such as at community, industry, market or policy level. During the long years of water conflict in Doñana, policy-makers have arguably missed the sustainability targets.

[31] Drivers (D) may be re-organised, pressures (P) may be altered, or the state of environment (S) may be restored or adapted to reduce its sensitivity.

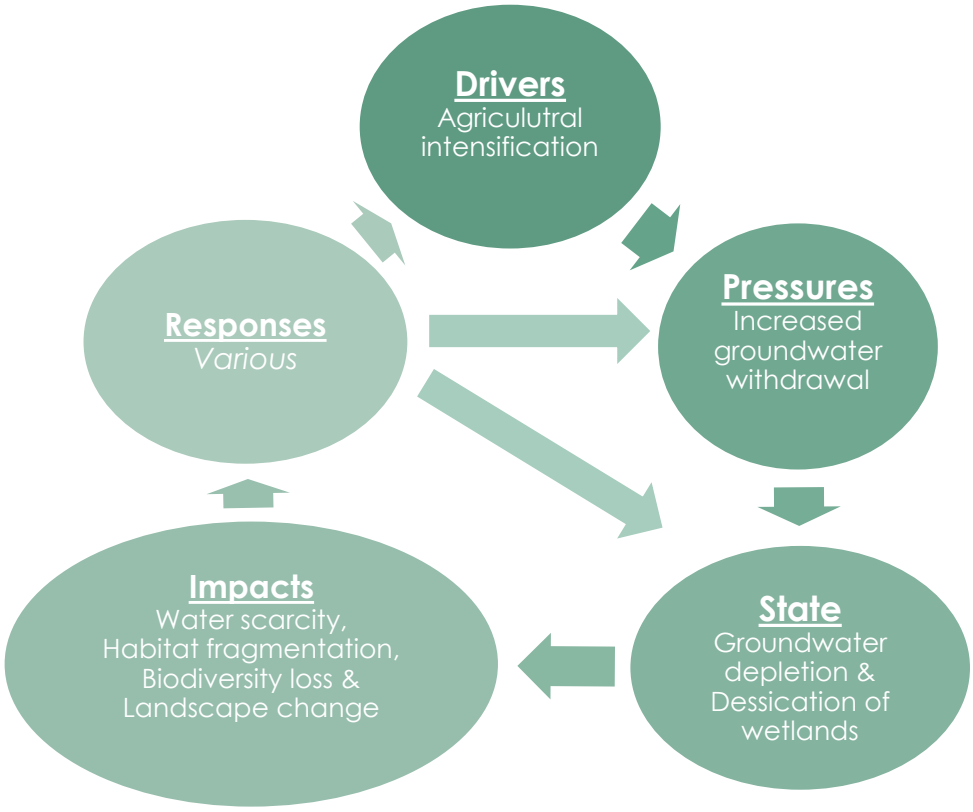


Figure 5. DPSIR framework applied to the Doñana SES (Researcher's own construct)

6.1 Responses at the Policy Level

There are two main regulatory frameworks at the European Union (EU) level that directly and indirectly emphasize sustainable management of water resources: respectively, the 7th Environment Action Programme (EAP) and the European Water Framework Directive (WFD).

The 7th EAP has a clear mission statement inherited from the 6th EAP formulated back in 2005:

> *"ensuring that the consumption of resources and their associated impacts do not exceed the carrying capacity of the environment and breaking the linkages between economic growth and resource use"* (European Commission 2005).

WFD, on the other side, is a very operational and explicit framework for sustainable use of surface- and groundwater with the final goal of "reaching good ecological quality status" for all related water resources (Borja *et al.* 2006: 84).

However, the water management in Doñana has not been able to keep pace with the developments in EU-wide environmental regulations so far, let alone reaching a good ecological status. The most recent development in this matter is the Special Plan for the Regulation of Irrigation in the Northern Part of Doñana (PECN)[32], where the progress made in the implementation of the plan as of early 2018 is far from satisfactory. Despite the plan was first published in 2010 and updated constantly, the achievements are meagre due to the lack of common ground between the actors (Rodríguez & Stefano 2012: 277)

6.2 Responses at the Market, Industry and Community Level

Other reactions to the sustainability challenge of Doñana were created by different actors at various levels and scales. For example, in 2016 a consortium of supermarkets and food companies[33] has urged the regional government of Andalusia to implement an environmental-friendly land-use plan, including the strengthening of environmental regulations and shutting down thousands of illegal wells in Doñana (Bryce 2016). Another reaction to the water-intensity of berry production is "precision irrigation" and technological applications of "smart agriculture" (Morillo *et al.* 2015). This response is however only perceived as partially effective since the response is highly mitigative and not necessarily promise a sustainable solution to the groundwater depletion (van Ittersum *et al.* 2008: 150; Morillo *et al.* 2015). During the time in the field, responses at the community level are found rather weak, which will be thoroughly analysed in the following section.

6.3 State of Collective Action

This study has covered the social, economic and political settings (S), as well as the state of related ecosystems (ECO) so far. However, little has been said concerning the quality of four core subsystems in Doñana: Resource system, resource unit, governance systems and users[34] and how these interact (Ostrom 2009). The following section is to analyse the attributes of and interactions

[32] The 57 million Euros plan for Doñana, that spans over 12-year, including actions like strict regulations to groundwater abstraction, recreation of ecological corridors within Doñana, and relocation of many strawberry plantations (Rodriguez & De Stefano, 2012).
[33] SAI Platform: http://www.saiplatform.org
[34] Or "actors".

between these subsystems and explore the role of power and value in the creation of collection action.

6.3.1 Resource System

The resource system of Doñana (e.g., large agricultural areas combined with the extent of groundwater tables) is extensive and poses a challenge of sustainable management. This is further elevated by the ambiguity of system boundaries, what practises and which farms are notorious for the sustainability of resource system or what is the overall carrying capacity of it. The existing agricultural system is widely known to deteriorate the sustainability challenge.

> *"You don't go to a dessert to cultivate something that needs water to thrive. Doñana is the same, we do not have water. This is not a new problem. It was obvious back in time when agriculture was transformed from endemic species to water-intensive crops, and the water issue was ignored. Now it reached a state that no one can ignore anymore."* (E)

While the productivity of agriculture is increasing (more produce/ha each year), groundwater overexploitation continues. This means increased uncertainty about the future of the groundwater resources and the social systems (incl. agriculture) relying largely on groundwater. However, Doñana's water scarcity did not influence water supply to agriculture, except for minor water withdrawal restrictions.

> *"I think we need to consider the amount of water we have first, the amount of water intake into the region is not increasing, and it won't increase. Strawberry is not a crop, that the water level of this region can carry. So strawberry farming will never be sustainable .... Even the irrigation systems are efficient and smart, this region can only carry the capacity for local cultivars. Otherwise, we will never have an ecological balance."* (T)

6.3.2 Resource Unit

As a result of field observations and of interviews, it is concluded that the nature of groundwater resource makes it harder to manage direct resource withdrawals. The number of illegal wells is beyond control (WWF 2016b), and the connection between droughts and groundwater depletion is inconclusive in the eyes of the public. However, the interviews point to an increased frequency and severity of droughts in Doñana.

> *"There is a big impact on the marshes. It is all dry .... even in the good raining seasons the park* is drier in general compared to historical and biologic data. This is because the water level underground is dropping really fast. During the last 10 years, in some areas of the marshes the water level dropped up to 8 meters .... this year we are having a severe drought, not only in the park but overall in the region. And they are becoming extreme."* (T)

Unless supplied from the Guadalquivir River (which is not the case of berry fields), the agriculture sector in western Doñana has free access to groundwater. So, the economic cost of the resource unit is almost zero[35]. Yet the monetary value it creates, as well as the opportunity cost of groundwater withdrawal to other water-dependent social and natural systems are rather high.

> *"After experiencing how profitable berry business is, it is so hard to bring change to the agriculture sector. Water is money here."* (T)

6.3.3 Governance Systems

Among all the subsystems, water governance is the most problematic variable in the Doñana SES. All the actors interviewed have raised concerns about transparency, accountability and participatory management regarding natural resource management. The perception of corruption is high and decision-making mechanisms are known as politically motivated.

> *"The local government is turning the eyes away and doesn't face the water problem, because if they face the problem, and close the illegal wells, the local population won't be happy."* (T)

The impact of high corruption is not limited to higher level decision-making, but it also influences the general public negatively.

> *"Corruption from high top to very low level that makes everyone sort of passive. There is a corruption culture and it demotivates young people."* (R)

The very same pattern is also witnessed when it comes to the management of Doñana NP.

> *"If the local government regulates the water use and manages it in a way favourable to nature conservation principles, farmers won't vote the same party again, the National Park is a club for political parties[36]."* (E)

---

[35] There is a cost of water withdrawal, such as the cost of the pump and of the construction of a well.
[36] The interviewee does not mean the political parties at national level, but actors who has influence over the regional politics.
* Doñana NP.

According to the interviews with key informants on nature conservation, the administration of Doñana NP is appointed by the regional government of Andalusia. Every 6 months, managerial Board of Doñana gathers up for the meeting. There is a total of 50 to 60 representatives in the Board of Doñana. These are from the national government, regional government, municipalities in Doñana, farmers' associations, hunters' associations, NGOs and religious communities. More than 60% of them are representatives from the government bodies. This creates a space for the actors in Doñana to influence the government bodies and turn the decision-making in their favour.

> *"When the board is voting for a decision, the administration always wins. So, the question here is what does administration want? Which party is stronger over the other. The biggest problem is the water in Doñana and for water, there is no cooperation. Both the agriculture and conservationists want more water."* (F)

Compared to all different lobbies, conservationists have the least powerful voice in decision-making, while the agriculture is the dominating figure. Hence the quality of participation is mostly questioned by the actors who do not share common goals with the agriculture sector. This fuels the economic growth–nature conservation paradigm.

> *"Agriculture is everything here because people are employed in farms, they make the money, and they make the decisions."* (F)

Another issue concerning good governance is the budget cuts in regional government spending as a result of nationwide financial instability, which affects the budget allocated to nature protection incommensurately. Interviewees associated the budget cuts with the low prioritization of environment and weak green politics. In that matter, the regulations and frameworks of the EU are considered as driving forces towards more environmental-friendly economies. In relation to Doñana's water conflict, the EU urged the Central Government of Spain to transform the agriculture in Doñana to ecological agriculture. However, both the national and regional government bodies have been reluctant to take action.

> *"The EU regulations only apply within the area. Outside of the park the rules and regulations lose their validity because it is the regional governments' sovereign area and the regional government puts profit over nature."* (E)

After all, the flagship of the EU in the matters of environmental protection is contradictory to the earlier policies of agricultural intensification in Doñana.

> *"EU helped transform the agriculture here in Doñana, that caused a complex environmental problem: water scarcity. Agriculture here was environmental-friendly before the 1980s, after the transformation of agriculture to water-demanding crops, the hydro-balance of the region was disturbed." (*M)

Civil society in Doñana is very active in cultural and religious activities, but advocacy for environmental protection is only provided by a couple of international NGOs and some smaller environmental organizations. One such ENGO is the WWF, working extensively on the water management struggle in Doñana. They played a crucial role in achieving two milestones for sustainable water resource management. WWF ran a campaign, calling on the EU and the major supermarkets, who procure berries from Doñana, to demand a sustainability transformation from the producers in Doñana. Both campaigns succeeded, where the EU Commission's Environment Directorate started a case against the Spanish Government to investigate the water management in Doñana, while some supermarkets started to enforce sustainability standards in their procurement. Yet, the outcome is not satisfactory, says one of the ENGO Officers: "Change comes very slow with such indirect methods".

A setback against the removal of illegal wells in Doñana is considered the system of property rights. Despite the construction of new wells are not allowed in some regions of Doñana with high water-stress, permits of the existing wells stay unchecked. This does not exclusively apply to water wells, because the progress made in property rights are still insufficient in Doñana.

> *"In the countryside, there are shortages because most structures, lands and water-wells are built without a permit. Power supply, for example, is not large enough as the demand, so there are often power cuts."* (R)

On top, the overall quality of environmental regulations concerning agriculture is considered sluggish by most of the key experts interviewed.

> *"At the moment, the biggest threat to the environment is the agriculture sector in Doñana. They consume all the water Doñana needs. The principles of agriculture and environmental regulations for agriculture is insufficient."* (E)

6.3.4 Resource Users and Actors

The number of resource users at the level of resource system is very high since groundwater facilitates multiple ecosystem services mentioned earlier in the thesis. This complicates the communication and cooperation between the resource users. On the hand, this number increases if

non-local service-beneficiaries are also included in the evaluation. It is necessary to widen the scope of resource users to service beneficiaries because the services like agriculture and tourism are dependent on non-local (national and international) demand.

While most interviewees see the service-beneficiaries as potential agents of change, there is wide consensus that the water problem is unknown to the end-users of agricultural services (unlike tourists, since they visit Doñana and get to know the local conflicts).

> *"I think an average European still lacks updated information on Doñana. Huelva strawberries are known to be ecological, organic, premium, fair etc., even though there are no such labels on the product. When berries arrive in Northern Europe, it is marketed with the brand of Doñana: the paradise of conservation in Europe. If people have the truthful information that the Huelva berries' production is destroying the environment, it would change many things."* (E)

Yet, there exists some vulnerability about the potential reaction from consumers, in particular, fears against a boycott against Huelva berries. Regardless of the direction of pressure, be it transformational (sectoral development towards environment-friendly practices) or detrimental (decrease in berry demand) to the agricultural services in Doñana, the power of consumers is undisputed by the most interviewees.

> *"You lose a lot if you tell people how environmentally damaging production of these strawberries is. The farmers follow the law on quality of the product, so the product is legal. But no law regulates the environmental impact of the strawberry production. If you buy a wooden box of strawberries, you never know the circumstances that box of strawberry is produced."* (T)

To test the knowledge gap and inform the potential reaction of consumers, I conducted surveys with residents in Sweden, who do their grocery shopping here. I asked the participants to reflect their knowledge of the berry production and supply chains, as well as their potential reaction when informed about the environmental impact of the product (See Appendix G). The results confirm the interviewees' perception of consumer's power and actions, as well as of the lack of general knowledge on the production conditions of Spanish berries. While only 2 out of 24 respondents say that they are knowledgeable about the social and environmental conditions that berries are produced in Spain, 20 respondents are missing updated information about the issue. Further, 19 out of 24 respondents show mistrust in the berry production and supply chains, stating that they do not believe berries are produced according to any of ecological, organic or fair business

principles. However, a majority of respondents are eager to take either personal or political measures when informed about the poor social and environmental conditions of berry production, the European Union and supermarkets being the principal choice of most respondents to urge for action.

Other findings of the study are related to the social norms/social capital, users' knowledge of the SES and the importance of the resource to users. Environmental protection in the area is highly related to the history of Doñana.

> *"For centuries Doñana was a hunting reserve, it is called "Coto de Doñana", do you know what it means? A "Coto" is a place where people hunt. It was a hunting reserve for royal families, dukes, nobles etc., and locals were never allowed in Doñana. So, it never belonged to the people, and it still does not belong to the people."* (E)

This finding confirms one of the earlier studies on the ownership of Doñana, where Palomo and colleagues (2011) found that only 3% of the locals identify themselves as "Doñaneros"[37].

> *"In fact, the strict conservation rules replaced earlier park the fact that it belonged to royal families. The people do not have the sense of ownership. Before it was Franco, now it is the park management, it has always been disconnected from people and still it is .... people have to embrace the park, but they still consider it as a private property, not a public park, but an "El Coto", a hunting place."* (E)

Even though the vast majority of the local population is actively engaged in social and cultural activities in Doñana, findings point out that Doñana's nature is not internalized by locals. Other findings expose additional reasons for this situation, as such Doñana's wealth of biodiversity (mainly for ornithology) is not utilized by locals, but tourists; marshes of Doñana are associated with illness and misery for good reasons, and environmental restrictions within the protected areas of Doñana are conflicting some cultural traditions and externalize local from their own environment.

Thanks to the high engagement of some active ENGOs in Doñana, the water conflict is well-known among the general public. Nonetheless, the general awareness of environmental issues and the situation of environmental education among locals are insufficient.

[37] "Doñaneros" is the Spanish word for what people from Doñana might be called.

> *"There is a great lack of knowledge on environment and of education. Schools do not have such education system here. When I meet teenagers and kids I ask about environmental in schools, they first time hear that from me. Most of them say they have never heard of it. At home, there is no value about the environment, we do not care about the environment, there are no such values unless money is concerned. Nature and environment are ignored here."* (R)

Besides acknowledging the problem, some key informants interpret the trend rather positively.

> *"There is no practical environmental education in schools. The environment is not a principal issue right now. It is obviously better than compared to 50 years ago. We need to improve that."* (E)

This being said, the importance of water to all sectors is widely recognized by the general public. "I cannot imagine Doñana without agriculture." says one of the ENGO Officers during the interview.

> *"Doñana has a great potential to facilitate more productive agriculture and fruitful tourism. It is unique in Europe. It can be a hotspot for the green economy, but it is a challenge at the same time because not all of us want to protect and maintain Doñana, but some want to increase the wealth of the region with little consideration of limited resources. In fact, we could develop both the agriculture and tourism."* (T)

90% of the locals in Doñana are employed in the agricultural sector, posing a threat of economic dependency at the same time. The said dependency concerns both the continuation of the demand from the market, as well as the continuation of resource flows, such as of water. A tourist guide says, "This is not sustainable farming".

> *"Water has a huge social aspect here, and that is, agriculture is the principal economic activity in the area, changing something that can affect the most powerful sector here is not easy. Agriculture employs people, and here we have high unemployment rate and widespread poverty."* (E)

And the path dependency of water-intensive agriculture is asserted by many actors.

> *"Extending and intensifying agricultural sector eased the unemployment problem but created water conflicts between agriculture and the wider ecosystem. Vineyards were not profitable, so the EU planned the change to strawberries, as more a profitable crop. Now it is huge."* (M)

Residents, in particular, who were interviewed in this study, have several times mentioned agriculture and berry production as the economic engine of the region.

> *"Here people predominantly work in agriculture. We kept growing olive for a long time, but now subsidies from the EU are cut, particularly for olives and vineyards. Farmers do not even pick olives from the trees and let it rot. Those who started berry production make a lot of money."* (R)

There is also no consensus about the contribution of new technologies to the resolution of water conflict in Doñana. While farmers are convinced that integration of technology-based agriculture techniques (smart agriculture) will solve the water-scarcity and oppose further restrictions on water withdrawals,

> *"New systems save so much water. Modern technologies help reduce excess resource consumption, from water to fertilizers and pesticides. Especially machines that can regulate the humidity of greenhouses that can bring resource efficiency."* (M)

Advocates of environmental protection are sceptical about it.

> *"Most greenhouses already have drip irrigation, that is a must for mass production. Water efficiency is not an issue, but excess water demand. You need really smart techniques for resource efficiency. You can be legal, you can be efficient, but it does not mean you are sustainable, it does not mean you are ecological for water."* (E)

7 Conclusion

Today, after decades of fierce water conflicts, Doñana SES is going through maybe the hardest times ever in its history for the survival of its nested social and natural systems. The ignorance of the interconnection and interdependence between Doñana's social and natural systems (coupled systems) resulted in a scenario, where the future of the entire system is associated with more uncertainty and higher risks. This appears to have happened due to the emergence of a regional economic model that disregards the biocapacity of Doñana's ecosystems. The identified responses to Doñana's water conflict are also found ineffective in restoring the hydro-cycle in the region and the results confirm Gupta and colleagues (2013: 573) statement that sustainable water management is under threat of a 'crisis of governance'.

In this thesis, I tried to answer

1- Why does water-intensive agriculture spark water conflicts and what is the role of local power relations in water management in Spanish Doñana region?
2- How can the sustainability of the Doñana SES be promoted and who are the drivers of change?

I found several attributes of the Doñana SES that play a role as determinants of collective action at different levels: Ambiguity of system boundaries, uncertainty about the sustainability of resource system (water insecurity), path dependency of the agricultural sector, weak transparency-accountability-participation (TAP) in natural resource management, high socio-cultural engagement of locals in Doñana, low sense of belonging, weak system of private property rights, intensive lobbying in decision-making mechanisms and high public influence on local governance, low prioritization of environmental values at both household and political level, great importance of water to agricultural systems and of agriculture to local livelihoods, weak environmental regulations for agriculture sector, high dependency on external demand for particular (water-intensive) agricultural goods, differentiated sense of appreciation of nature; and finally, low awareness on related production and supply chains on the consumer side.

Moreover, power relations in Doñana are found to be abused in favour of short-term economic gains and at the expense of ongoing environmental degradation and of future water scarcity. Meaningful participation and integrity at some governance levels are found to be undermined and

it is concluded that not only the agriculture is dependent on water resources, but the region largely relies on the development of agriculture. High dependence on global markets also creates a local-level path dependence for water-intensive agriculture in Doñana, which damages its natural capital.

Several actors at various levels are found to be powerful for bringing change to Doñana's sustainability challenge, yet at different capacities. While the producer community considers the consumers at the end of the supply chain powerful as agents of change, this study showed that there is a significant lack of information on the consumer side. Overall, this study provided a critical understanding of power relations, values and opportunities in Doñana, by bringing diverse perspectives on water management from different interest groups in the Doñana SES.

Bibliography

Acharyya, A. (2014). Groundwater, Climate Change and Sustainable Well Being of the Poor: Policy Options for South Asia, China and Africa. *Procedia - Social and Behavioral Sciences*, 157, pp.226–235. Available at: http://linkinghub.elsevier.com/retrieve/pii/S1877042814058455.

Agrawal, A. (2005). Environmentality: Community, intimate government, and the making of environmental subjects in Kumaon, India. *Current Anthropology*, 46(2), pp.161–190.

Andam, K.S., Ferraro, P.J., Pfaff, A., Sanchez-Azofeifa, GA., Robalino JA. (2008). Measuring the effectiveness of protected area networks in reducing deforestation. *Proceedings of the National Academy of Sciences*, 105(42), pp.16089–16094. Available at: http://www.pnas.org/cgi/doi/10.1073/pnas.0800437105.

Anderies, J.M., Janssen, M.A. and Ostrom, E. (2004). A Framework to Analyze the Robustness of Social-ecological Systems from an Institutional Perspective. *Ecology and Society*, 9(1), p.art18. Available at: http://www.ecologyandsociety.org/vol9/iss1/art18/.

Archer, M.S. (1982). Morphogenesis ver structuration: On combining structure and Action. *British Journal of Sociology*, 33(4), pp.455–483.

Balvanera, P.; Calderón-Contreras, R.; Castro, A.J.; Felipe-Lucia, M.R.; Geijzendorffer, I.R.; Jacobs, S.; Martín-López, B.; Arbieu, U.; Ifejika Speranza, C.; Locatelli, B.; Pérez-Harguindeguy, N.; Ruiz-Mercado, I.; Spierenburg, M.J. ; Vallet, A.; Lynes, L.; Gillson, L. (2017). Interconnected place-based social-ecological research can inform global sustainability. *Current Opinion in Environmental Sustainability*, (December).

Bell, S. (2012). DPSIR = A Problem Structuring Method? An exploration from the “imagine” approach. *European Journal of Operational Research*, 222(2), pp.350–360.

Berkes, F. (2004). Rethinking community-based conservation. *Conservation Biology*, 18(3), pp.621–630.

Berkes, F. and Folke, C. (1998). Linking social and ecological systems for resilience and sustainability. In *Linking Social and Ecological Systems*. pp. 13–20.

Bertzky, B. Corrigan, C., Kemsey, J., Kenney, S., Ravilious, C., Besançon, C. and Burgess, N (2012) *Protected Planet Report 2012: Tracking progress towards global targets for protected areas.* IUCN, Gland, Switzerland and UNEP-WCMC, Cambridge, UK.

Bhaskar, R., (1998). Philosophy and Scientific Realism. *Critical Realism: Essential Readings*, pp.16–47.

Bhaskar, R., (2005). *The Possibility of Naturalism, A Philosophical Critique of the Contemporary Human Sciences*, Available at: http://doi.wiley.com/10.1111/j.1468-0149.1981.tb02719.x.

Bickford, R., Valverde, C. & Specialist, A., (2016). Spain Spanish soft fruit production increases and consolidates as an alternative to strawberry. , pp.1–3.

Borja, Á., Galparsoro, I., Solaun, O., Muxika, I., Tello, EM., Uriarte, A., Valencia, V. (2006). The European Water Framework Directive and the DPSIR, a methodological approach to assess the risk of failing to achieve good ecological status. *Estuarine, Coastal and Shelf Science*, 66(1–2), pp.84–96.

Bryce, J. (2016). *Stop Spain's strawberry growers sucking key wetland dry, say supermarkets.* [online] Available at: https://www.theguardian.com/environment/2016/mar/15/stop-spains-strawberry-growers-sucking-key-wetland-dry-say-supermarkets [Accessed 1 May 2018].

Bryman, A. (2016). *Social research methods*, Oxford: Oxford University Press.

Butchart, SH., Walpole, M., Collen, B., van Strien, A., Scharlemann, JP., Almond, RE., Baillie, JE., Bomhard, B., Brown, C., Bruno, J., Carpenter, KE., Carr, GM., Chanson, J., Chenery, AM., Csirke, J., Davidson, NC., Dentener, F., Foster, M., Galli, A., Galloway, JN., Genovesi, P., Gregory, RD., Hockings, M., Kapos, V., Lamarque, JF., Leverington, F., Loh, J., McGeoch, MA., McRae, L., Minasyan, A., Hernández Morcillo, M., Oldfield, TE., Pauly, D., Quader, S., Revenga, C., Sauer, JR., Skolnik, B., Spear, D., Stanwell-Smith, D., Stuart, SN., Symes, A., Tierney, M., Tyrrell, TD., Vié, JC., Watson, R (2010). Global biodiversity: Indicators of recent declines. *Science*, 328(5982), pp.1164–1168.

Ceballos, G. *et al.* (2015). Accelerated modern human-induced species losses: Entering the sixth mass extinction. *Science Advances*, 1(5), pp.e1400253–e1400253. Available at: http://advances.sciencemag.org/cgi/doi/10.1126/sciadv.1400253.

Chan, K.M.A., Satterfield, T. & Goldstein, J. (2012). Rethinking ecosystem services to better address and navigate cultural values. *Ecological Economics*, 74, pp.8–18.

Chape, S. *et al.* (2005). Measuring the extent and effectiveness of protected areas as an indicator for meeting global biodiversity targets. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 360(1454), pp.443–455. Available at: http://rstb.royalsocietypublishing.org/cgi/doi/10.1098/rstb.2004.1592.

Cleaver, F. (2000). Moral Ecological Rationality, Institutions and the Management of Common Property Resources. *Development and Change*, 31(2), pp.361–383. Available at: http://doi.wiley.com/10.1111/1467-7660.00158.

Cleaver, F. & Franks, T. (2005). How institutions elude design: river basin management and sustainable livelihoods. *BCID Research Paper No.12*.

Crane, T.A. (2010). Of models and meanings: Cultural resilience in social-ecological systems. *Ecology and Society*, 15(4).

Creswell, J.W. (2013). Qualitative inquiry and research design: choosing among five approaches. *Qualitative Inquiry and Research Design*, p.448. Available at: https://books.google.com.my/books?id=Ykruxor10cYC.

Diamond, J.M. (1984). Normal extinctions of isolated populations. In *Extinctions*. pp. 191–246.

Dragoni, W. & Sukhija, B.S. (2008). Climate change and groundwater: a short review. *Geological Society, London, Special Publications*, 288(1), pp.1–12.

Ecologic Institute and SERI (2010). *Establishing Environmental Sustainability Thresholds and Indicators. Final report to the European Commission's DG Environment*, Available at: http://ec.europa.eu/environment/enveco/waste/pdf/thresholds_final_report.pdf.

EEA (1999). Environmental indicators : Typology and overview. *European Environment Agency*, 25(25), p.19.

European Commission (2005). *Thematic Strategy on the Sustainable Use of Natural Resources*. COM (2005) 670 final, European Commission, Brussels.

Fabinyi, M., Evans, L. & Foale, S.J., (2014). Social-ecological systems , social diversity , and power : insights from anthropology and political ecology. , 19(4).

Fernández-Delgado, C. (2017). Doñana Natural Space: The Uncertain Future of a Crown Jewel in

Europe's Protected Areas. *Case Studies in the Environment*, (October). Available at: http://cse.ucpress.edu/content/early/2017/10/23/cse.2017.000570.abstract.

Fernández, N., Paruelo, J.M. & Delibes, M. (2010). Ecosystem functioning of protected and altered Mediterranean environments: A remote sensing classification in Doñana, Spain. *Remote Sensing of Environment*, 114(1), pp.211–220. Available at: http://dx.doi.org/10.1016/j.rse.2009.09.001.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry*, 12(2), pp.219–245.

Foley, J. A., N. Ramankutty, K. A. Brauman, E. S. Cassidy, J. S. Gerber, M. Johnston, N. D. Mueller, C. O'Connell, D. K. Ray, P. C. West, C. Balzer, E. M. Bennett, S. R. Carpenter, J. Hill, C. Monfreda, S. Polasky, J. Rockstrom, J. Sheehan, S. Siebert, D. Tilman and D. P. M. Zaks (2011). Solutions for a cultivated planet. *Nature*, 478(7369), pp.337–342. Available at: http://www.nature.com/doifinder/10.1038/nature10452.

Food and Agriculture Organization of the United Nations (FAO). (2018a). *Regulating services.* [online] Available at: http://www.fao.org/ecosystem-services-biodiversity/background/regulating-services/en/ [Accessed 24 Apr. 2018]

Food and Agriculture Organization of the United Nations (FAO). (2018b). FAOSTAT. [online] Available at: http://www.fao.org/faostat/en/#data/QC [Accessed 1 May 2018].

Funder, M. (2005). Bias, Intimacy and Power in Qualitative Fieldwork Strategies. *The Journal of Transdisciplinary Environmental Studies*, 4(1), pp.1–9. Available at: http://www.journal-tes.dk/vol 4 no 1/no_3_L.pdf?id=00029.

Gari, S.R., Newton, A. & Icely, J.D., (2015). A review of the application and evolution of the DPSIR framework with an emphasis on coastal social-ecological systems. *Ocean and Coastal Management*, 103(December), pp.63–77. Available at: http://dx.doi.org/10.1016/j.ocecoaman.2014.11.013.

Geertz, C. (2003). *The Interpretation of Cultures*, New York: Basic Books.

Gómez-Baggethun, E., Mingorría, S., Reyes-García, V., Calvet, L., Montes, C. (2010). Traditional ecological knowledge trends in the transition to a market economy: empirical study in the Doñana natural areas. *Conservation biology : the journal of the Society for Conservation Biology*, 24(3), pp.721–9. Available at: http://www.ncbi.nlm.nih.gov/pubmed/20067484.

Gomm, R., Hammersley, M. & Foster, P. (2009). Case Study and Generalization. In *Case Study Method*. pp. 98–115.

Gorski, P.S. (2013). What is Critical Realism? And Why Should You Care? *Contemporary Sociology: A Journal of Reviews*, 42(5), pp.658–670. Available at: http://csx.sagepub.com/cgi/doi/10.1177/0094306113499533.

Gupta, J., Pahl-Wostl, C. and Zondervan, R. (2013). *'Glocal' water governance: a multi-level challenge in the anthropocene.* Current Opinion in Environmental Sustainability, 5(6), pp. 573-580.

Haberl, H., Gaube, V., Díaz-Delgado, R., Krauze, K., Neuner, A., Peterseil, J., Plutzar, C., Singh, SJ., Vadineanu, A. (2009). Towards an integrated model of socioeconomic biodiversity drivers, pressures and impacts. A feasibility study based on three European long-term socio-ecological research platforms. *Ecological Economics*, 68(6), pp.1797–1812.

Hatt, K. (2013). Social Attractors: A Proposal to Enhance "Resilience Thinking" about the Social. *Society and Natural Resources*, 26(1), pp.30–43.

Hempel, C.G. (1958). The Theoretician's Dilemma: A Study in the Logic of Theory Construction. *Concepts, Theories, and the Mind-Body Problem*, 2, pp.37–98.

Hoekstra, A. (2006). The global dimension of water governance: Nine reasons for global arrangements in order to cope with local water problems. *Value of Water Research Report Series*, (20), pp.1–33. Available at: http://doc.utwente.nl/58371/.

Hornborg, A. (2009). Zero-Sum world: Challenges in conceptualizing environmental load displacement and ecologically unequal exchange in the world-system. *International Journal of Comparative Sociology*, 50(3–4), pp.237–262.

International Risk Governance Council (2018). *Guidelines for Dealing with Systemic Risks in the Context of Transitions*, Lausanne, Switzerland: IRGC.

Badcock, J. (2016). *Spain's Doñana coastal wetlands risk being added to Unesco danger list.* [online] The Telegraph. Available at: https://www.telegraph.co.uk/news/2016/09/15/spains-doana-coastal-wetlands-risk-being-added-to-unesco-danger/ [Accessed 9 May 2018].

van Ittersum, M.K., Ewert, F., Heckelei, T., Wery, J., Alkan Olsson, J., Andersen, E., Bezlepkina, I., Brouwer, F., Donatelli, M., Flichman, G., Olsson, L., E. Rizzoli, A., van der Wal, T., Wien., JE and Wolf, J. (2008). Integrated assessment of agricultural systems - A component-based framework for the European Union (SEAMLESS). *Agricultural Systems*, 96(1–3), pp.150–165.

Kates, R.W., Clark, WC., Corell, R., Hall, JM., Jaeger, CC., Lowe, I., McCarthy, JJ., Schellnhuber, HJ., Bolin, B., Dickson, NM., Faucheux, S., Gallopin, GC., Grübler, A., Huntley, B., Jäger, J., Jodha, NS., Kasperson, RE., Mabogunje, A., Matson, P., Mooney, H., Moore, B. O'Riordan, T., Svedlin, U. (2001). Sustainability Science. *Science Magazine*, 292(5517), pp.641–642.

Klijn, J.A. (2004). Driving forces behind landscape transformation in Europe, from a conceptual approach to policy options. *Volume 4 - The New Dimension of the European Landscapes*, pp.201–218.

Kreamer, D.K., Stevens, L.E. & Ledbetter, J.D. (2015). Groundwater Dependent Ecosystems – Science, Challenges, and Policy Directions. In *Groundwater*. pp. 206–230.

Kvale, S. (1996). *An introduction to qualitative research interviewing*. Thousand Oaks, CA: Sage.

Lin, T., Xue, X.Z. & Lu, C.Y. (2007). Analysis of coastal wetland changes using the DPSIR model: A case study in Xiamen, China. *Coastal Management*, 35(2–3), pp.289–303.

Liu, J., Dietz, T., Carpenter, SR., Alberti, M., Folke, C., Moran, E., Pell, AN., Deadman, P., Kratz, T., Lubchenco, J., Ostrom, E., Ouyang, Z., Provencher, W., Redman, CL., Schneider, SH., Taylor, WW. (2007). Complexity of Coupled Human and Natural Systems. *Ambio*, 36(8), pp.639–649.

Lopez-Gunn, E. (2018). *Advances in Groundwater Governance*, London: CRC Press.

Martín-López, B., García-Llorente, M., Palomo, I. and Montes, C. (2011). The conservation against development paradigm in protected areas: Valuation of ecosystem services in the Do??ana social-ecological system (southwestern Spain). *Ecological Economics*, 70(8), pp.1481–1491. Available at: http://dx.doi.org/10.1016/j.ecolecon.2011.03.009.

Martín-López, B., Gómez-Baggethun, E., García-Llorente, M. and Montes, C (2014). Trade-offs across value-domains in ecosystem services assessment. *Ecological Indicators*, 37(PART A), pp.220–228.

McDonald, R.I. & Boucher, T.M. (2011). Global development and the future of the protected area strategy. *Biological Conservation*, 144(1), pp.383–392.

McGinnis, M.D. & Ostrom, E. (2014). Social-ecological system framework: Initial changes and

continuing challenges. *Ecology and Society*, 19(2).

Morillo J.G., Martín M., Camacho E., Díaz J.A.R. and Montesinos P. (2015). Toward precision irrigation for intensive strawberry cultivation. , 151, pp.43–51.

Moss, P., Jones, J. P., Nast, H. J., & Roberts, S. M. (1999). Thresholds in Feminist Geography: Difference, Methodology, Representation (Review). *Economic Geography*, 75(2), pp.203–205. Available at: http://www.jstor.org/stable/144254?origin=crossref%5Cnhttp://www.jstor.org.spot.lib.auburn.edu/stable/pdfplus/144254.pdf?&acceptTC=true&jpdConfirm=true.

Murray, W.E. & Overton, J. (2003). Designing Development Research. In *Development Fieldwork: A Practical Guide*. pp. 17–35.

Neslen, A. (2016). *Spain could be first EU country with national park listed as 'in danger'*. [online] the Guardian. Available at: https://www.theguardian.com/environment/2016/sep/15/spain-could-be-first-eu-country-with-national-park-listed-as-in-danger [Accessed 9 May 2018].

Ness, B., Anderberg, S. and Olsson, L. (2010). Structuring problems in sustainability science: The multi-level DPSIR framework. *Geoforum*, 41(3), pp.479–488. Available at: http://dx.doi.org/10.1016/j.geoforum.2009.12.005.

Newton, A. and Weichselgartner, J. (2014). Hotspots of coastal vulnerability: A DPSIR analysis to find societal pathways and responses. *Estuarine, Coastal and Shelf Science*, 140, pp.123–133.

Nieto-Romero, M., Oteros-Rozas, E., González, AJ. and Martín-López, B. (2014). Exploring the knowledge landscape of ecosystem services assessments in Mediterranean agroecosystems: Insights for future research. *Environmental Science and Policy*, 37, pp.121–133.

Nobre, A.M. (2009). An Ecological and economic assessment methodology for coastal ecosystem management. *Environmental Management*, 44(1), pp.185–204.

OECD (1993). *OECD Core Set of Indicators for Environmental Performance Reviews: A Synthesis Report by the Group on the State of the Environment*. Environment Monograph, Organization for the Economic Co-Operation and Development, Paris.

Ostrom, E. (1998). A behavioral approach to the rational choice theory of collective action. *American Political Science Review*, 92(1), pp.1–22.

Ostrom, E. (2009). A General Framework for Analyzing Sustainability of Social-Ecological Systems. *Science*, 325(5939), pp.419–422. Available at: http://www.sciencemag.org/cgi/doi/10.1126/science.1172133.

Ostrom, E., Gardner, R. & Walker, J. (1994). Rules Games and Common Pool Resource Problems. In *Rules, Games, and Common-Pool Resources*. pp. 3–21.

Palomo, I., Martín-López, B., López-Santiago, C. and Montes, C. (2011). Participatory scenario planning for protected areas management under the ecosystem services framework: the Doñana social-ecological system in southwestern Spain. *Ecology and Society*, 16(1).

Palomo, I., Martín-López, B., Potschin, M., Haines-Young, R. and Montes, C. (2012). National Parks, buffer zones and surrounding lands: Mapping ecosystem service flows. *Ecosystem Services*, 4, pp.104–116.

Palomo, I., Montes, C., Martín-López, B., González, JA., García-Llorente, M., Alcorlo, P., Mora, MRG. (2014). Incorporating the social-ecological approach in protected areas in the anthropocene.

BioScience, 64(3), pp.181–191.

Pinto, R., de Jonge, VN., Neto, JM., Domingos, T., Marques JC. and Patricio, J. (2013). Towards a DPSIR driven integration of ecological value, water uses and ecosystem services for estuarine systems. *Ocean and Coastal Management*, 72(January 2011), pp.64–79.

Plieninger, T. & Bieling, C. (2013). Resilience-based perspectives to guiding high-nature-value farmland through socioeconomic change. *Ecology and Society*, 18(4).

Popper, E.R. (1959). The Logic of Scientific Discovery. *Physics Today*, 12(11), pp.53–54.

Pretty, J. (2003). Social Capital and the Collective Management of Resources. *Science*, 302(5652), pp.1912–1914.

Ribot, J.C., Lund, J.F. & Treue, T. (2010). Democratic decentralization in sub-Saharan Africa: Its contribution to forest management, livelihoods, and enfranchisement. *Environmental Conservation*, 37(1), pp.35–44.

Rittel, H.W.J., W.M.M. (1973). Dilemmas in a General Theory of Planning. *Policy Sciences*, 4(2), pp.155–169.

Robards, MD., Schoon, ML., Meek, CL. and Engle, NL. (2011). The importance of social drivers in the resilient provision of ecosystem services. *Global Environmental Change*, 21(2), pp.522–529.

Rockström, J., Williams, J., Daily, G., Noble, A., Matthews, N., Gordon, L., Wetterstrand, H., DeClerck, F., Shah, M., Steduto, P., de Fraiture, C., Hatibu, N., Unver, O., Bird, J., Sibanda, L. and Smith, J. (2017). Sustainable intensification of agriculture for human prosperity and global sustainability. *Ambio*, 46(1), pp.4–17.

Rodríguez, J. & Stefano, L. De (2012). Intensively irrigated agriculture in the north-west of Doñana. , pp.269–280.

Rose, G. (1997). Situating knowledges: Positionality, reflexivities and other tactics. *Progress in Human Geography*, 21(3), pp.305–320.

Rosegrant, M.W., Ringler, C. & Zhu, T., (2009). Water for Agriculture: Maintaining Food Security under Growing Scarcity. *Annual Review of Environment and Resources*, 34(1), pp.205–222. Available at: http://www.annualreviews.org/doi/10.1146/annurev.environ.030308.090351.

Scheyvens, R. & Storey, D. (2003). *Development Fieldwork: A Practical Guide*, Available at: http://books.google.com/books?id=vZPzPc-Vg54C&pgis=1.

Simon, H.A. (1957). Models of Man: Social and Rational. *Book*, 18(3), p.287. Available at: http://search.ebscohost.com/login.aspx?direct=true&db=psyhref&AN=1998.02489.0030237&site=ehost-live.

Singh, M. and Capri, E. (2016). *Unsolved conflicts between water users in Huelva - Case study about the slow implementation of the WFD in the Guadalquivir River Basin.* Presented at GLOBAQUA, 1st International Conference, Freising Session IV Management and Policy, 12 January 2016.

Sobrino, I., Baldó, F., García-Gonzalez, D., Cuesta, J.A. and Silva-García, A. (2005). The effect of estuarine fisheries on juvenile fish observed within the Guadalquivir Estuary (SW Spain). *Fisheries Research*, 76(2), pp.229–242.

Sousa A.; Garcia-Murillo, P.. M.J.. G.-B.L. (2009). Anthropogenic and natural effects on the coastal

lagoons in the southwest of Spain (Doñana National Park). *ICES Journal of Marine Science*, 66(7), pp.1508–1514.

Stanners, D. & Bourdeau, P. (1995). Europe's environment - The Dobris assessment. *Europe's Environment: The Dobris Assessement*, (36), p.712.

De Stefano, L., Hernández-Mora, N., Iglesias, A. and Sánchez, B. (2017). Defining adaptation measures collaboratively: A participatory approach in the Doñana socio-ecological system, Spain. *Journal of Environmental Management*, 195, pp.46–55.

Sciencing (2018). *The Three Cycles of the Ecosystem*. [online] Available at: https://sciencing.com/three-cycles-ecosystem-8300277.html [Accessed 22 Apr. 2018].

Stoecker, R. (1991). Evaluating and rethinking the case study. *The Sociological Review*, 39(1), pp.88–112.

Sultana, F. (2007). Reflexivity, positionality and participatory ethics: Negotiating fieldwork dilemmas in international research. *ACME*, 6(3), pp.374–385.

Svarstad, H., Petersen, L.K., Rothman, D., Siepel, H. and Wätzold, F. (2008). Discursive biases of the environmental research framework DPSIR. *Land Use Policy*, 25(1), pp.116–125.

Tomich, TP, Brodt, S, Ferris, H, Galt, R, Horwath, WR, Kebreab, E, Leveau, JHJ, Liptzin, D, Lubell, M, Merel, P, Michelmore, R, Rosenstock, T, Scow, K, Six, J, Williams, N & Yang, L (2011). Agroecology: A Review from a Global-Change Perspective. *Annual Review of Environment and Resources*, 36(1), pp.193–222. Available at: http://www.annualreviews.org/doi/10.1146/annurev-environ-012110-121302.

UNEP-WCMC & IUCN (2016). *Protected Planet Report 2016*, Available at: http://wdpa.s3.amazonaws.com/Protected_Planet_Reports/2508 Global Protected Planet 2016_FR.pdf%0Ahttps://wdpa.s3.amazonaws.com/Protected_Planet_Reports/2445 Global Protected Planet 2016_WEB.pdf.

Vandenberghe, F. (2013). *What's critical about critical realism?: Essays in reconstructive social theory*, New York, Routledge.

Villamor, G.B., Hill, J., Oteros-Rozas, E., Palomo, I. and Santiago, CA. (2014). Assessing stakeholders' perceptions and values towards social-ecological systems using participatory methods. *Ecological Processes*, 3(1), p.22. Available at: http://www.ecologicalprocesses.com/content/3/1/22.

Water, Land and Ecosystems (2017). Building resilience through sustainable groundwater use. , (1). Available at: http://www.iwmi.cgiar.org/publications/briefs/wle-towards-sustainable-intensification-briefs/building-resilience-through-sustainable-groundwater-use/.

Wilson, J., Yan, L. & Wilson, C. (2007). The precursors of governance in the Maine lobster fishery. *Proceedings of the National Academy of Sciences*, 104(39), pp.15212–15217. Available at: http://www.pnas.org/cgi/doi/10.1073/pnas.0702241104.

Water Integrity Network (2018). *Intro to Water Integrity*. [online] Available at: http://www.waterintegritynetwork.net/water-integrity/introduction/ [Accessed 23 Apr. 2018].

Winch, P. (1958). The Idea of a Social Science. In *The Idea of a Social Science and the Relation to Philosophy*. pp. 142–158.

World Economic Forum (2018). *The global risks report 2018, 13th edition*, Available at: http://www3.weforum.org/docs/WEF_GRR18_Report.pdf%0Ahttps://www.weforum.org/reports/the

-global-risks-report-2018.

WWF (2007). *Strawberry cultivation and Nature in Doñana*. World Wildlife Fund, Spain.

WWF (2016a). *Living planet report: risk and resilience in a new era*, Available at: http://awsassets.panda.org/downloads/lpr_living_planet_report_2016.pdf%0Ahttp://www.footprintnetwork.org/documents/2016_Living_Planet_Report_Lo.pdf.

WWF (2016b). *Saving Doñana - From Danger To Prosperity*. World Wildlife Fund, Spain.

Yin, R.K. (2003). Case study methodology R.K. Yin (2003, 3rd edition). Case Study Research design and methods. Sage, Thousand Oaks (CA)..pdf. In *Case Study Research: design and methods*. pp. 19-39-106.

Zorrilla-Miras, P., Palomo, I., Gomez-Baggethun, E., Martin-Lopez, B., Lomas, PL. and Montes, C. (2014). Effects of land-use change on wetland ecosystem services: A case study in the Doñana marshes (SW Spain). *Landscape and Urban Planning*, 122, pp.160–174. Available at: http://dx.doi.org/10.1016/j.landurbplan.2013.09.013.

Appendices

Appendix A: Main Figures of WEF's Global Risks Report

Top 5 Global Risks in Terms of Impact

(2015 – 2018)

2015	2016	2017	2018
Water crises	Failure of climate-change mitigation and adaptation	Weapons of mass destruction	Weapons of mass destruction
Rapid and massive spread of infectious diseases	Weapons of mass destruction	Extreme weather events	Extreme weather events
Weapons of mass destruction	Water crises	Water crises	Natural disasters
Interstate conflict with regional consequences	Large-scale involuntary migration	Major natural disasters	Failure of climate-change mitigation and adaptation
Failure of climate-change mitigation and adaptation	Severe energy price shock	Failure of climate-change mitigation and adaptation	Water crises

Source: World Economic Forum 2018

Top 10 Global Risks

Top 10 risks in terms of **Likelihood**	Top 10 risks in terms of **Impact**
1 Extreme weather events	1 Weapons of mass destruction
2 Natural disasters	2 Extreme weather events
3 Cyberattacks	3 Natural disasters
4 Data fraud or theft	4 Failure of climate-change mitigation and adaptation
5 Failure of climate-change mitigation and adaptation	5 Water crises
6 Large-scale involuntary migration	6 Cyberattacks
7 Man-made environmental disasters	7 Food crises
8 Terrorist attacks	8 Biodiversity loss and ecosystem collapse
9 Illicit trade	9 Large-scale involuntary migration
10 Asset bubbles in a major economy	10 Spread of infectious diseases

Source: World Economic Forum 2018.

Appendix B: Definitions

Aquifer: An aquifer is a geological formation (or sometimes part of a formation or a group of formations) that contains saturated material of sufficient permeability to yield 'useful' quantities of water to wells and/or springs. An aquifer may be confined or unconfined. Unconfined aquifers can receive direct recharge from rainfall infiltrating and percolating through the unsaturated zone down to the water table. Confined aquifers are separated from the surface by impermeable materials and cannot be recharged directly by rainfall.
Aquifer overexploitation: Intensive abstraction of groundwater, where the 'overall cost of the negative impacts of groundwater exploitation exceeds the net benefits of groundwater use'.
Groundwater: Underground water that has come mainly from the seepage of surface water and is held in pervious rocks or sediments.
Groundwater table: The level below which the ground is completely saturated with water.
Recharge: The replenishment of groundwater from infiltration and percolation of precipitation, seepage through stream and lake beds, and from return flows from human activities.
Sustainable abstraction: An estimated acceptable rate of use of groundwater that does not cause aquifer overexploitation. They are relative terms and involve value judgments.
(Total) water withdrawal/abstraction: Annual quantity of water withdrawn for agricultural, industrial and municipal purposes. It includes renewable freshwater resources as well as potential over-abstraction of renewable groundwater or withdrawal of fossil groundwater and potential use of desalinated water or treated wastewater. It does not include in-stream uses, which are characterized by a very low net consumption rate, such as recreation, navigation, hydropower, inland capture fisheries, etc.
Water use: Refers to use of water by agriculture, industry, energy production and households, including in-stream uses such as fishing, recreation, transportation and waste disposal.
Water consumption: The part of water use which is not distributed by the water distribution sector to other economic units and does not return to the environment (to water resources, sea and ocean) because during use it has been incorporated into products, consumed by households or livestock. It is calculated as a difference between total use and total supply, thus it may include losses due to evaporation occurring in distribution and apparent losses due to illegal tapping and malfunctioning metering. Per definition, consumed water is not available for immediate or short-term reuse within the same watershed.

Source: Water, Land and Ecosystems 2017; Ecologic Institute and SERI 2010.

Appendix C: Elinor Ostrom's Analytical SES Variables

Social, economic, and political settings (S)

S1 Economic development. S2 Demographic trends. S3 Political stability. S4 Government resource policies. S5 Market incentives. S6 Media organization.

Resource systems (RS)	*Governance systems (GS)*
RS1 Sector (e.g., water, forests, pasture, fish)	GS1 Government organizations
RS2 Clarity of system boundaries	GS2 Nongovernment organizations
RS3 Size of resource system*	GS3 Network structure
RS4 Human-constructed facilities	GS4 Property-rights systems
RS5 Productivity of system*	GS5 Operational rules
RS6 Equilibrium properties	GS6 Collective-choice rules*
RS7 Predictability of system dynamics*	GS7 Constitutional rules
RS8 Storage characteristics	GS8 Monitoring and sanctioning processes
RS9 Location	
Resource units (RU)	*Users (U)*
RU1 Resource unit mobility*	U1 Number of users*
RU2 Growth or replacement rate	U2 Socioeconomic attributes of users
RU3 Interaction among resource units	U3 History of use
RU4 Economic value	U4 Location
RU5 Number of units	U5 Leadership/entrepreneurship*
RU6 Distinctive markings	U6 Norms/social capital*
RU7 Spatial and temporal distribution	U7 Knowledge of SES/mental models*
	U8 Importance of resource*
	U9 Technology used

Interactions (I) → outcomes (O)

I1 Harvesting levels of diverse users	O1 Social performance measures (e.g., efficiency, equity, accountability, sustainability)
I2 Information sharing among users	O2 Ecological performance measures (e.g., overharvested, resilience, bio-diversity, sustainability)
I3 Deliberation processes	O3 Externalities to other SESs
I4 Conflicts among users	
I5 Investment activities	
I6 Lobbying activities	
I7 Self-organizing activities	
I8 Networking activities	

Related ecosystems (ECO)

ECO1 Climate patterns. ECO2 Pollution patterns. ECO3 Flows into and out of focal SES.

Source: Ostrom 2009.

Appendix D: Interview Form Sample - Interview with a Natural Tourist Guide

[Note that interview forms are not uniform. Each form is tailored according to the presumed knowledge and experience of the interviewee and her representational standpoint (as of a representative to a larger group.).]

Acknowledgement:

Q: Dear Interviewee, this interview is conducted by the master's student, Burag Gurden,from Lund University, Sweden. Do you confirm hereby your participation to his research and consent to the usage of data, your input in this case, for research-related purposes?

A:

Can you confirm that there is no obligation to take part in this research? You can give breaks during the interview, ask for further explanation of questions, refuse to answer questions and you may cancel the interview without giving explanation. There is also no consequence resulting from any of the said scenarios.

A:

Q: Do you consent the interview to be recorded by the researcher to ease the transcription process?

A:

Beginning of the interview.

Interview:

Q: Can you tell me more about yourself and your organization?

A:

Q: What does the Park mean to the tourism industry in Doñana?

A:

Q: Who demands park services?

A:

Q: Do you see a trend in its popularity among Spanish people / among foreign visitors?

A:

Q: Do you mean, even if water is abstracted in a legal way, it is going to damage the park?

A:

Q: What happened 15 years ago, how did farmers transform the lands?

A:

Q: Who are the conflicting actors in and around the park?

A:

Q: How much politics is involved in the park management?

A:

Q: What are the institutions taking park in the management of the park?

A:

Q: How is the state of water in the wetlands?

A:

Q: How about the biodiversity in the park?

A:

Q: Why is this happening?

A:

Q: Can farming be sustainable here?

A:

Q: Is there an organization working for and promoting sustainable solutions?

A:

Q: What can bring change to the region?

A:

Q: Why do you think the consumers do not know about the water conflict here?

A:

Q: Do you mean environmental laws are short in protecting the hydrological-cycle here?

A:

End of the interview.

Acknowledgement:

Thank you for participation.

Appendix E: Surveys Questions

Question type	Question	Answer
Acknowledgement	This short survey is prepared by a master's student at Lund University, and it will be used for academic purposes. Name, gender and nationality is not required by the researcher, please do not indicate these during the survey. The survey is rather short, please take your time and try to answer all questions if possible.	I agree. (mandatory field)*
Acknowledgement	Make sure you fulfil the following criterion: I reside in Sweden and do my shopping in Sweden.	I agree. (mandatory field)*
Personal	How old are you?	…
Personal	Are you a student?	a) Yes. b) No.
Select one	I buy strawberries/berries	a) year-round. b) often. c) every now and then. d) only during the season. e) very seldomly. f) never.
Select one	I buy	a) only locally produced strawberries/berries. b) only imported Spanish strawberries/berries. c) both.

Select one	Please select one,	a) I have an opinion about the social and environmental conditions strawberries/berries are produced in Spain. b) I am aware of the social and environmental conditions strawberries/berries are produced in Spain. c) I do not know much about the social and environmental conditions strawberries/berries are produced in Spain.
Multiple selection	I think imported strawberries/berries are,	a) organic (produced without the use of chemical fertilizers, pesticides, or other artificial chemicals). b) eco-friendly (friendly to the environment that plants, animals, and humans live together and affect each other). c) produced in a fair manner (offering better trading conditions to, and securing the social rights of, producers and field workers). d) none of the above. e) all of the above.
Select one	I would drop my strawberry/berry consumption, if I knew	a) they are produced in poor social conditions. b) they are produced in poor environmental conditions. c) they are produced in poor social and environmental conditions. d) none of the above. I am not concerned about the social and environmental conditions they are produced.
Multiple selection	If I knew strawberries/berries are produced in poor social or environmental conditions, I would urge,	a) producers to take measures. b) Spanish government to take measures. c) Swedish government to take measures. d) European Union to take measures. e) distributors and supermarkets to take measures. f) all of the above g) none of the above.

Appendix F: Migratory Birds of Doñana

Source: A photograph made at the SEO-BirdLife observatory in El Rocio, Spain.

Appendix G: Survey Results

Number of respondents	37
Age (mean)	26.46
Number of students	29
Number of non-students	8

Survey results:

I buy strawberries/berries:

Value	Frequency
every now and then.	12
only during the season.	12
very seldom.	10
often.	3

I buy:

Value	Frequency
both.	23
only locally produced strawberries/berries.	13
only imported Spanish strawberries/berries.	1

Please select one:

Value	Frequency
I do not know much about the social and environmental conditions strawberries/berries are produced in Spain.	20
I am aware of the social and environmental conditions strawberries/berries are produced in Spain.	2
I have an opinion about the social and environmental conditions strawberries/berries are produced in Spain.	2

I think imported strawberries/berries are:

Value	Frequency
none of the above.	19
produced in a fair manner (offering better trading conditions to, and securing the social rights of, producers and field workers).	3
organic (produced without the use of chemical fertilizers, pesticides, or other artificial chemicals).	2
all of the above.	1

I would drop my strawberry/berry consumption, if I knew:

Value	Frequency
they are produced in poor social and environmental conditions.	16
none of the above. I am not concerned about the social and environmental conditions they are produced.	3
they are produced in poor environmental conditions.	3
they are produced in poor social conditions.	2

If I knew strawberries/berries are produced in poor social or environmental conditions, I would urge:

Value	Frequency
European Union to take measures.	17
distributors and supermarkets to take measures.	12
Swedish government to take measures.	8
Spanish government to take measures.	5
producers to take measures.	5
none of the above.	3

Appendix H: Fieldwork Pictures

Picture 1: Artistic map of Huelva. The map was hanging on the wall of a guesthouse in an organic multi-cropping farm, northern Doñana.
Picture 2: Artistic depiction of Doñana's pasture. The drawing was on a full-sized wall at an olive cooperative, northern Doñana.
Picture 3: Field trip to strawberry greenhouses, Almonte, western Doñana.
Picture 4: Doñana tourist centre, El Rocio, western Doñana.
Picture 5: Doñana tour bus, El Rocio, western Doñana.
Picture 6: Two pictures of Doñana National Park, made during one of the many visits to El Rocio, western Doñana.
Picture 7: Terrestrial map of Doñana, made at the Visitor Centre of José Antonio Valverde during the National Park tour, Doñana.
Picture 8: "Birds of Spain", made at the SEO-BirdLife observatory in El Rocio, western Doñana.
Picture 9: "Aquatic birds of Spain", made at the SEO-BirdLife observatory in El Rocio, western Doñana.
Picture 10: "Birds of Doñana", made at the SEO-BirdLife observatory in El Rocio, western Doñana.
Picture 11-12: Dried river beds, Villamanrique de la Condesa, northern Doñana.
Picture 13: Information sign about shrikes, made during a walk through ecological corridors, Aznalcázar, northern Doñana.

1


PORTUGAL
BADAJOZ
SEVILLA
CADIZ
PICOS DE AROCHE
SIERRA DE ARACENA
EL ANDEVALO
CUENCA MINERA
EL CONDADO
LA COSTA
MARISMAS DEL ODIEL
LUGARES COLOMBINOS
PARQUE NACIONAL DE DOÑANA
HUELVA
OCEANO ATLANTICO
MAPA DEL VIAJERO DE LA PROVINCIA DE
HUELVA
AUTOVIAS DEL ESTADO
RED DE CARRETERAS (RIGE)
CARRETERAS AUTONOMICAS Y LOCALES
EMBALSES Y RIOS PRINCIPALES
CAPITAL Y PUEBLOS
FRONTERA Y LIMITES PROVINCIALES

2

3

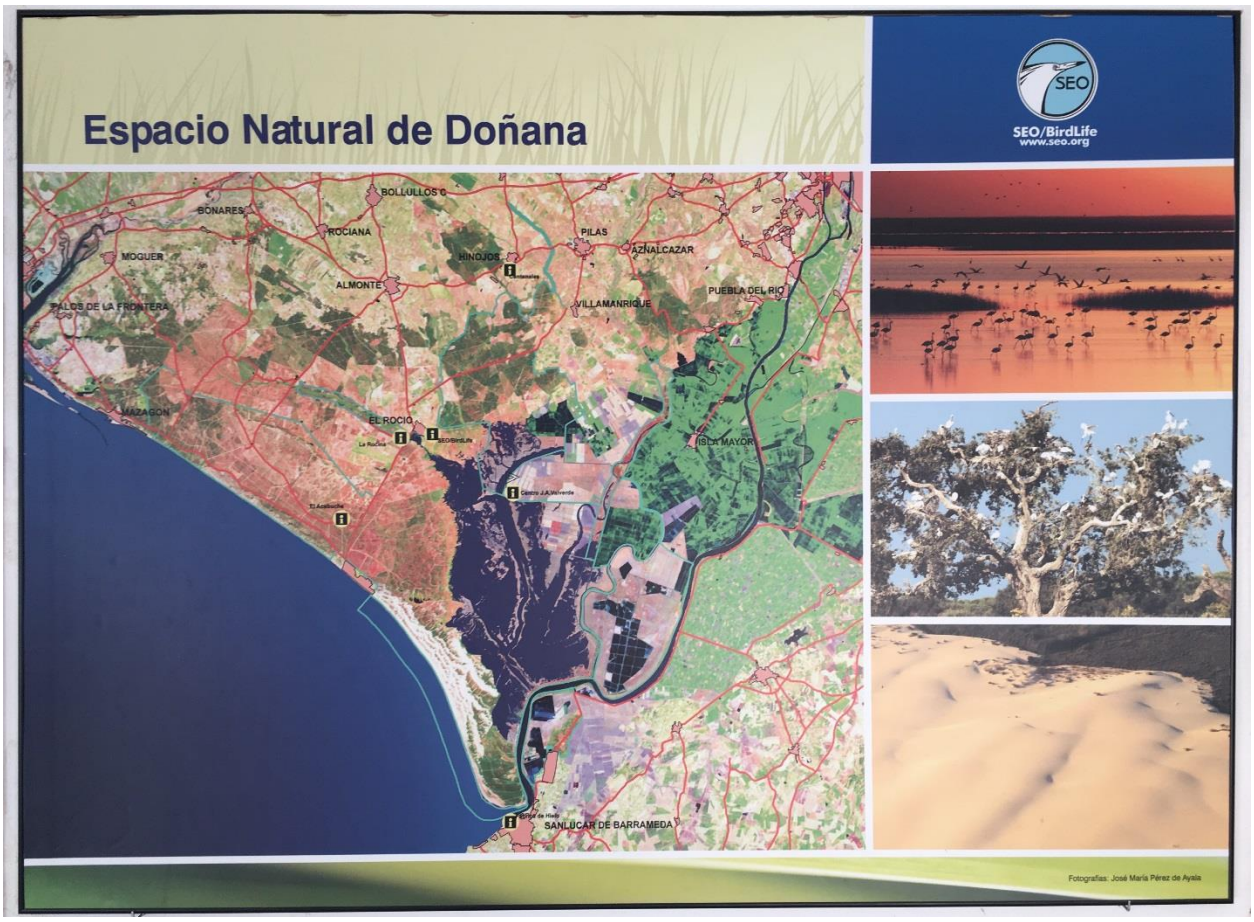
4

5


VISITAS A DOÑANA
DOÑANA RESERVAS
959 44 24 74
(El Rocío)
www.donanareservas.com
3

6

7


Espacio Natural de Doñana
SEO
SEO/BirdLife
www.seo.org
BOLLULLOS C
SONARES
ROCIANA
PILAS
AZNALCAZAR
MOGUER
HINOJOS
ALMONTE
PUEBLA DEL RIO
PALOS DE LA FRONTERA
VILLAMANRIQUE
MAZAGON
EL ROCIO
ISLA MAYOR
SANLUCAR DE BARRAMEDA
Fotografías: José María Pérez de Ayala

8


5€
Aves de España
Terrestres
Juan Varela
Diseño e ilustraciones © Juan Varela 2016
www.seo.org
BirdLife
INTERNATIONAL
SEO
BirdLife

9


5€
AVES ACUÁTICAS I · WILDFOWL I
JUAN VARELA
SEO
BirdLife
www.seo.org

10


Aves de Doñana
(Birds of Doñana)
SEO
SEO/BirdLife
www.seo.org
INVERNANTE (Wintering)
100-1.000 i
1.000-10.000 i
10.000-200.000 i
i: Individuos - i: Individuals
EN PASO (Migrant)
100-1.000 i
1.000-10.000 i
10.000-200.000 i
i: Individuos - i: Individuals
RESIDENTE (Resident)
1p-100 p
100 p-1.000 p
1.000 p-10.000 p
p: Parejas - p: Pairs
ESTIVAL (Breeding)
1p-100 p
100 p-1.000 p
1.000 p-10.000 p
p: Parejas - p: Pairs
PELIGRO DE EXTINCIÓN
(Endangered)
Ilustraciones: Juan Varela

11

12

13


Las Despensas
de los Alcaudones
Europa
invierte en las zonas rurales
PAISAJE PROTEGIDO
Corredor Verde
del Guadiamar
La pantalla vegetal que forman los enormes álamos del Corredor Verde del Guadiamar nos oculta el serpenteante río. En este tramo atraviesa olivares y espacios abiertos. Sin duda, el hábitat ideal para encontrar las dos especies de alcaudones de la Comarca de Doñana. Sobre un tendido eléctrico, el Alcaudón Real oteará su territorio estival. Pequeños roedores, lagartos y sobre todo, pequeñas aves, corren grave peligro de ser devorados por este agresivo predador alado. En caso de no poder tragarlos de un bocado, los restos del festín son clavados en espinos que casi siempre abandona. Son las famosas "despensas" de los alcaudones que les surtirán de alimento en el invierno.
A menor altura, sobre los alambres de una valla, en una rama prominente de un arbusto u olivo, moviendo su cola insistentemente arriba y abajo, está el Alcaudón Común. Recién llegado de sus cuarteles de invernada en el África Tropical ocupa dehesas, olivares y campiñas con árboles dispersos. Es menos fiero y mucho más insectívoro que el Alcaudón Real, capturando algún pollo volandero de vez en cuando. Una de las más impresionantes técnicas de caza de este pájaro es la imitación del canto de otros, para así atraérlos y hacérlos presa mediante el engaño.
♀
♂
Alcaudón Común
(Lanius senator)
Alcaudón Real
(Lanius meridionalis)
JUNTA DE ANDALUCIA
LiderA
Unión Europea
adad