Universitat Autònoma de Barcelona

Socio-ecological complexity and ecosystem services. An analysis of ecosystem services coproduction and access in the case of Barcelona's cruise ship tourism

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PhD Thesis

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An analysis of ecosystem services coproduction and access in the case of Barcelona's cruise ship tourism

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Supervisor statement

I STATE that the present study, entitled 'Socio-ecological complexity and ecosystem services. An analysis of ecosystem services coproduction and access in the case of Barcelona's cruise ship tourism', presented by Liliana Solé Figueras for the award of the degree of Doctor, has been carried out under my supervision at the Department of Geography of this university.

Bellaterra, 17th Setember 2019.

Doctoral thesis supervisor	PhD student
Director de la tesis doctoral	Doctoranda
Eduard Ariza Solé	Liliana Solé Figueras

Summary

Coastal landscapes are highly dynamic and complex socio-ecological systems resulting from the interface of land and sea. This interface creates rich and dynamic ecosystems that provide valuable benefits to humans. Much of the world's social, cultural, and economic development is concentrated within coastal zones, and they comprise manifold and overlapping actors, activities, and interests. Moreover, coastal socio-ecological systems are under constant transformation. These transformations operate on different temporal and spatial scales in a non-linear manner; hence, unexpected properties and processes emerge.

In this context, coastal research to inform and enable coastal management presents the particular need to consider socio-ecological complexity. This research frames the concept of ecosystem services (ES) within socio-ecological systems and political ecology through socio-ecological complexity. Ecosystem services, which are benefits obtained by humans from ecosystems, are the result of coproduction processes between ecological and social components and their multifaceted relations in complex socio-ecological system interactions. Through a systematic literature review, this dissertation critically examines how socio-ecological complexity factors are included in coastal ES literature. The results show the following significant gaps, especially in terms of comprising social aspects of ES: missing cascade-model components of flow and demand; a partial understanding of coproduction with missing core aspects (such as governance, social representations, and technology); a lack of understanding of how power underpins coproduction, trade-offs and access to ES; a lack of assessments that combine different scales (e.g., multi-scale and cross-scale assessments); a gap concerning the intrinsic and relational dimensions of human wellbeing (HWB), as well as the understanding of HWB distribution among social groups; and a lack of uncertainty assessments.

To fill the abovementioned gaps, a holistic socio-ecological framework is created. This framework aims to understand the complex and non-linear interactions and feedback processes of coastal ES production, supply, demand, and use. The framework articulates the relationship between coproduction and access and power relations. The created framework serves to study ES demanded by cruise ships in Barcelona through a mixed-method approach by combining semi-structured interviews, official documents, reports (analysed qualitatively using grounded theory analysis), and a survey of cruise ship passengers.

This study identifies the ES demanded by cruise ships and their flows from ES provisioning to receiving systems and how these flows have been co-produced through the multi-scalar interactions of different socio-ecological components. The results show that the ES flows of cruise ships embody global, regional, and local scales as well as multi-scale relations and interdependencies. Cruise ships are interconnected worldwide through ES flows. The coproduction of these flows comprises coevolutionary processes, as socio-ecological components co-determine each other. Institutional agreements and social representations are fundamental components of coproduction and coevolution, and both reinforce other component transformations. Adding to that, this research also empirically studies the mechanisms by which stakeholders can access ES at different cascade-model steps and how these mechanisms are underpinned by power relations, and the derived trade-offs of ES from provisioning to receiving systems. Right-based agreements, negotiation via social relations, knowledge, and financial capital are fundamental access mechanisms mediated by power structured through scalar relations. The analysis of access and power reveals who is excluded from ES and how and who receives associated trade-offs and how (i.e. who the winners and losers are).

The conceptual apparatus of this thesis (i.e. the cascade-model, coevolution model, scalar relations analysis, access theory, and political ecology approach) serves to study the socio-ecological complexity. Because the study integrated the symbolic and material elements of ES, the study obtains a profound understanding of the complex relations between the social and ecological components.

Resum

Els paisatges costaners són sistemes socioecològics altament dinàmics i complexos que resulten de la interfície terrestre i marítima. Aquesta interfície crea ecosistemes rics i dinàmics, els quals proporcionen valuosos beneficis a les persones. Per aquest motiu, part del desenvolupament social, cultural i econòmic del món es concentra a les zones costaneres on hi conviuen i es solapen múltiples actors, interessos i activitats. A més, els sistemes socioecològics costaners estan en constant transformació, els quals funcionen a diferents escales temporals i espacials de manera no lineal, per tant, sorgeixen propietats i processos emergents i impredictibles.

En aquest context, la recerca sobre els sistemes costaners requereix tenir en compte la complexitat socioecològica. Aquesta recerca emmarca els Serveis dels Ecosistemes (SE) dins d'aquesta complexitat. Els SE, que són els beneficis que els humans obtenen dels ecosistemes, s'entenen com el resultat de processos de coproducció entre components ecològics i socials caracteritzats per múltiples interaccions dins de sistemes socioecològics complexos. Mitjançant una revisió sistemàtica, aquesta tesi examina de forma crítica com la literatura científica referent als SE costaners inclou els factors de la complexitat socioecològica. Els resultats mostren buits importants, especialment pel que fa a la inclusió d'aspectes socials dels SE: una comprensió parcial de la coproducció que no inclou aspectes com governança, representacions socials i tecnologia; manca de comprensió de com el poder articula la coproducció, els costos, els beneficis i l'accés als SE; falta d'avaluacions que combinin diferents escales (multi-escalars i trans-escalars); un buit pel que fa a les dimensions intrínseques i relacionals del benestar humà, com també pel que fa a la distribució de benestar entre els grups socials; i la manca d'avaluacions sobre la incertesa.

Aquesta tesi doctoral proposa un marc conceptual holístic que integra els buits identificats. Aquest marc té com a objectiu comprendre les interaccions complexes i no lineals, així com els processos de retroalimentació de la producció, oferta, demanda i ús dels SE costaners. D'aquesta manera, el marc articula la relació entre coproducció, accés i relacions de poder. El marc conceptual també serveix per estudiar els SE que utilitzen i/o consumeixen els creuers quan arriben a la ciutat de Barcelona, mitjançant una metodologia mixta que combina entrevistes semiestructurades, documents i informes oficials, que s'analitzen qualitativament mitjançant la teoria fonamentada i una enquesta per a passatgers de creuers.

Aquest treball identifica els SE sol·licitats pels creuers i els seus passatgers, així com el flux d'aquests serveis, és a dir el camí que segueixen des dels sistemes de subministrament fins als de recepció. També s'analitzen els processos de coproducció dels SE, els quals es componen de les interaccions multi-escalars de diferents components socials i ecològics. Els resultats mostren com els fluxos dels SE poden ser globals, regionals i locals. Per tant, els vaixells de creuers estan interconnectats mundialment a través dels fluxos dels SE. Els resultats també mostren com els processos de coproducció d'aquests serveis es basen en dinàmiques de coevolució, ja que els components socials i ecològics es codeterminen els uns als altres. Els acords institucionals i les representacions socials són components fonamentals de coproducció i coevolució, ambdós reforcen altres transformacions de components socioecològics.

Aquesta recerca també estudia empíricament els mecanismes d'accés que permeten als agents interessats accedir als SE en les diferents etapes dels serveis, així com les relacions de poder que condicionen els mecanismes d'accés i els impactes derivats del subministrament i demanda dels SE. Els acords formals, la negociació a través de les relacions socials, el coneixement i el capital financer són mecanismes fonamentals d'accés, articulats per relacions de poder estructurades a través d'interrelacions escalars. L'anàlisi dels mecanismes d'accés permet entendre qui té accés als SE, qui en queda exclòs i qui rep els impactes, és a dir, qui són els guanyadors i qui són els perdedors.

L'aparell conceptual d'aquesta tesi (el model en cascada, el model de coevolució, l'anàlisi de relacions escalars, la teoria d'accés i l'enfocament de ecologia política) serveix per estudiar la complexitat sociocultural ecològica, és a dir, serveix per obtenir una comprensió profunda de les complexes relacions entre els components socials i ecològics, ja que integra els elements simbòlics i materials dels SE.

Resumen

Los paisajes costeros son sistemas socio-ecológicos dinámicos y complejos que resultan de la interfaz terrestre y marítima. Esta interfaz crea ecosistemas ricos y dinámicos, los cuales proporcionan valiosos beneficios a las personas. De este modo, parte del desarrollo social, cultural y económico del mundo se concentra en las zonas costeras, en el que conviven y se solapan múltiples actores, intereses y actividades. Además, los sistemas socio-ecológicos costeros están en constante transformación, los cuales funcionan a diferentes escalas temporales y espaciales de manera no-lineal, por lo tanto, surgen propiedades y procesos emergentes e impredecibles.

En este contexto, la investigación sobre los sistemas costeros requiere tener en cuenta la complejidad socio-ecológica. Esta investigación enmarca los Servicios de los Ecosistemas (SE) dentro de la complejidad socio-ecológica. Los SE, que son los beneficios que los humanos obtienen de los ecosistemas, se entienden como el resultado de procesos de coproducción entre componentes ecológicos y sociales caracterizados por múltiples interacciones dentro de sistemas socio-ecológicos complejos. Mediante una revisión sistemática, esta tesis examina de forma crítica como la literatura científica de los SE costeros incluye los factores de la complejidad socio-ecológica. Los resultados muestran los siguientes vacíos, especialmente en cuanto a la inclusión de aspectos sociales de los SE: la falta de los componentes de flujo y demanda del modelo en cascada; una comprensión parcial de la coproducción que no incluye aspectos como gobernanza, representaciones sociales y tecnología; falta de comprensión de cómo el poder sustenta la coproducción, los costes, los beneficios y el acceso a los SE; falta de evaluaciones que combinen diferentes escalas (multiescalares y trans-escalares); un vacío con respecto a las dimensiones intrínsecas y relacionales del bienestar humano, así como de la distribución de bienestar entre los grupos sociales; y la falta de evaluaciones sobre la incertidumbre.

Esta tesis doctoral propone un marco conceptual holístico que integra los vacíos identificados. Este marco tiene como objetivo comprender las interacciones complejas y no lineales, así como los procesos de retroalimentación de la producción, oferta, demanda y uso de los SE costeros. De este modo, el marco articula la relación entre coproducción, acceso y relaciones de poder.

Mediante una metodología mixta que combina entrevistas semiestructuradas, documentos e informes oficiales, que se analizan cualitativamente mediante teoría fundamentada y una encuesta para pasajeros de cruceros, el marco conceptual se aplica en el estudio de los SE que demandan los cruceros cuando llegan a la ciudad de Barcelona. Así, se identifican los SE solicitados por los cruceros y el flujo de estos servicios, es decir, el flujo desde los sistemas de suministro hasta los de recepción, y cómo se han coproducido mediante interacciones multiescalares de diferentes componentes sociales y ecológicos. Los resultados muestran que los flujos de los SE pueden ser globales, regionales y locales y cómo los procesos de coproducción se basan en dinámicas de coevolución, ya que los componentes sociales y ecológicos se codeterminan unos a otros. Los acuerdos institucionales y las representaciones sociales son componentes primordiales de coproducción y coevolución, ambos refuerzan otras transformaciones de componentes socio-ecológicos. Esta tesis doctoral también estudia empíricamente los mecanismos de acceso que permiten a los actores acceder a los SE en las diferentes etapas de los servicios, así como las relaciones de poder que condicionan los mecanismos de acceso y los impactos derivados del suministro y demanda de los SE. Los acuerdos formales, la negociación a través de relaciones sociales, el conocimiento y el capital financiero son mecanismos fundamentales de acceso, mediados por relaciones de poder estructuradas a través de interrelaciones escalares. El análisis de los mecanismos de acceso permite entender quién tiene acceso a los SE, quien queda excluido y quien recibe los impactos, es decir, quiénes son los ganadores y quiénes los perdedores.

El aparato conceptual de esta tesis (el modelo en cascada, el modelo de coevolución, el análisis de relaciones escalares, la teoría de acceso y el enfoque de ecología política) sirve para estudiar la complejidad socio-ecológica. Es decir, para obtener una comprensión profunda de las complejas relaciones entre los componentes sociales y ecológicos porque integra los elementos simbólicos y materiales de los SE.

Agraïments

La realització d'aquesta tesi doctoral ha estat un procés llarg durant el qual m'han acompanyat i encoratjat moltes persones, a les quals vull expressar el meu agraïment. En primer lloc i de forma molt especial vull agrair al director d'aquesta tesi, l'Eduard Ariza, seu guiatge. Gràcies per les teves reflexions i les hores de converses compartides, gràcies també per la paciència i el teu suport en tots moments.

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Main acronyms and abbreviations

ES	Ecosystem Services
MEA	Millennium Ecosystem Assessment
TEEB	The Economics of Ecosystems and Biodiversity
CICES	Common International Classification of Ecosystem Services
PES	Payments for Ecosystem or Environmental Services
REDD	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
HWB	Human Wellbeing
CZM	Coastal Zone Management
ICZM	Integrated Coastal Zone Management
UNCED	United Nations Conference on the Environment and Development
WSSD	World Summit on Sustainable Development
EBM	Ecosystem-Based Management
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
GT	Grounded Theory
EUNIS	European Nature Information System
CMECS	Coastal and Marine Ecological Classification Standard
GDP	Gross Domestic Product
Gt	Gigatons
CO_2	Carbon dioxide
CO_2e	Equivalent carbon dioxide
ECC	European Cruise Council
CLIA	Cruise Lines International Association
MSDs	Marine Sanitation Devices
AWTS	Advanced Wastewater Treatment Systems
OWS	Oil Water Separator
NO_x	Nitrogen oxides
NO_2	Nitrogen dioxide
SO_x	Sulphur oxides
SO_2	Sulphur dioxide
O_3	Ozone
CO_x	Carbon oxides
BC	Black Carbon
SLCP	Short Lived Climate Pollutants
EEA	European Environment Agency
PM	Particulate Matter
GHG	Greenhouse Gasses
UFPs	Ultrafine Particulates Matter
CAFT	Comisión de Atracción de Forasteros y Turistas
SAF	Sociedad de Atracción de Forasteros
EU	European Union
ECA	Emission Control Area
SECA	Sulphur Emission Control Area
NCP	Nature's Contributions to People

Chapter I. Introduction

Georgescu-Roegen argues that '[scientific] analysis must proceed by some heroic simplifications and totally ignoring their ultimate consequences' (1971, p. 212).

1. Introduction

Coastal landscapes are where land and sea interact. They are widely known as some of the most valuable landscapes on our planet because coastal ecosystems are immensely rich in terms of biodiversity and productivity. For these reasons, they are highly coveted by humans. As a result, coastal landscapes have been under major pressure from humans in the form of urbanization (which has especially increased in recent decades), major infrastructures, industries and touristic activities (Mee 2012, Roca Bosch 2008). Human pressure endangers the maintenance of coastal social and ecological contributions to humans and non-humans. This is especially true for the Mediterranean basin, where human pressure is particularly high and keeps increasing (Roca Bosch 2008). In the Mediterranean basin there is an increasing concentration of human activities, such as dwellings, ports, airports, industrial activities, touristic infrastructures and power facilities. Moreover, in the coming decades coastal areas will be exposed to growing risks because of climate change (Nicholls et al. 2007, Spalding et al. 2014, Vallega, 1999). Future sea-level rises and coastal erosion will have severe impacts on coastal landscapes and their social and ecological contributions.

Humans rely on ecosystem contributions, such as food, fresh water, air quality regulation and aesthetic values (MEA 2005). In the last decade, the relation between ecosystems and human wellbeing has been widely studied through the concept of Ecosystem Services (ES). Although there is not a unique definition of ES, current conceptualizations are based on the assumption that ecosystems or nature are something external to humans that provides useful things for human wellbeing and these should be valued (Kull 2015). Accordingly, the most common definition is the one provided by the Millennium Ecosystem Assessment (MEA) (MEA 2005) that defines ES as the benefits that people obtain from ecosystems.

Generally, ES are classified as provisioning services, such as food, fresh water, biotic materials and genetic resources; regulating and maintenance services, which include air quality regulation, climate regulation, coastal protection, water purification and pest regulation, among others; and cultural services, such as recreation and tourism, aesthetic values, cultural heritage, spiritual values and others. Many classifications like MEA (2005) also include supporting services, which refer to services such as soil formation, pollination and nutrient cycling.

There are multiple ES classifications, including The Economics of Ecosystems and Biodiversity (TEEB) and the Common International Classification of Ecosystem Services (CICES) (Costanza et al. 1997, de Groot et al. 2002, Boyd and Banzhaf 2007, Fisher at al. 2009, Barragán-Muñoz 2010, Liquete et al. 2013). The discussion on how to classify ES is still ongoing (Boyd and Banzhaf 2007, Costanza 2008, Fisher et al. 2009, Kosoy 2010, Wallace 2007). The main aspect of discussion is the difference between services and benefits. For some authors, such as Boyd and Banzhaf (2007), ES assessments need to clearly differentiate between services and benefits; services are the aspects that humans use (directly or indirectly) to obtain wellbeing, while benefits are explicit effects on human wellbeing. Others, such as MEA (2005), consider services and benefits to be equal concepts. Hence, some authors emphasize the importance of ecosystem processes and functions, while others stress the benefits obtained, and how they should be valued (Boyd and Banzhaf 2007, Fisher et al. 2009, Kull et al. 2015, Lele et al. 2013)

1.1. The rise of the ecosystem service framework

ES have become one of the most influential frameworks for environmental research and management (Kull et al. 2015), especially since the publication of MEA in 2005, a report that put ES onto the academic and political agendas (Fisher et al. 2009).

The rise of the ES conceptual apparatus is a response to the claim of putting environmental sustainability and the limitations of economic growth at the centre of the debate on development (Gómez-Baggethun at al. 2010). In the late 1960s and early 1970s, as a means to increase social awareness of biodiversity conservation, it started to develop a utilitarian understanding of ecosystems. Several academic contributions highlighted how ecological functions served to benefit human wellbeing (Helliwell 1969, Odum and Odum 1972). Gómez-Baggethun et al. (2010) explain that in the 1970s and 1980s, the terms 'ecosystem services' and 'natural capital' started being used. Natural capital refers to a metaphor based on the understanding of nature as a limited capital stock with finite capacity for ES flows (Costanza and Daly 1992, Norgaard, 1994). This conceptualization of nature highlights human dependency on limited natural resources and the importance of their conservation, which is considered a basic conceptual tool for increasing public awareness of biodiversity conservation. Gómez-Baggethun et al. (2010) point out that in order to increase the attention given by the public to biodiversity conservation, environmentalists and economists started to frame human and nature relations in economic terms and began to use the term 'ecosystem services' or similar terms, such as 'ecological services' or 'environmental services' (Groot 1987, Kellert 1986). The idea behind the use of these concepts was mostly pedagogic: they were used to show how biodiversity loss can affect ecosystem functions that are necessary for human wellbeing (Gómez-Baggethun et al. 2010)

The development and consolidation of the term 'ecosystem service' took place during the 1990s (Gómez-Baggethun et al. 2010, Raffaelli and White, 2013), with special emphasis on the development of techniques and tools to account for ecosystem service values (e.g., Costanza and Daly 1992, Costanza 1999, Martínez et al. 2007). An important milestone was the paper written by Costanza et al. (1997), which calculated the monetary value of global ecosystem services. From then on, there was an increase in monetary ES assessments, such as in the development of techniques and instruments for monetary valuation (Gómez-Baggethun et al. 2010, Raffaelli and White 2013, Costanza et al. 1997, Costanza 1999). Monetary valuation refers to methods and tools to account for the economic value of ecosystem services. These methods and tools are subjected to market logics and monetary metrics (e.g., methods based on how much people are willing to pay to benefit from aesthetic experiences).

In the early 2000s, the ecosystem service scheme was consolidated in the ecological research arena, especially because of the MEA (Gómez-Baggethun et al. 2010, Raffaelli and White 2013, Fisher et al. 2009). Since then, the number of publications has grown exponentially (Fisher et al. 2009, Raffaelli and White 2013), from 53 papers in 2005 to 1.148 in 2018 (Figure 1).

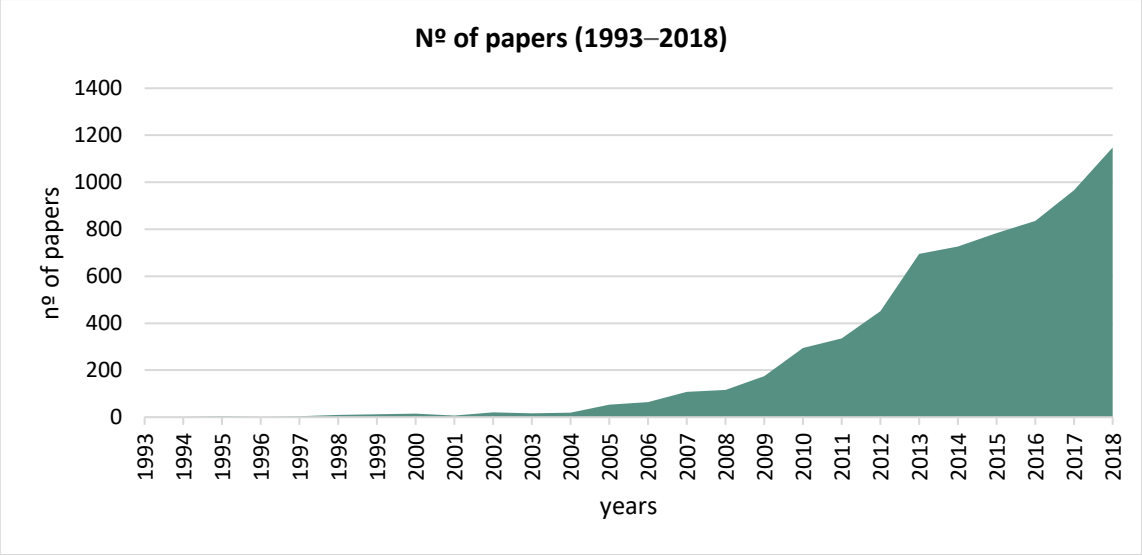


Figure 1. Number of publications with ecosystem service terms from 1993 to 2018, at date 18/08/2019. Publications found by a bibliographical search on Scopus database using as keywords 'ecosystem services' in the title, keywords or abstract. Source: own elaboration.

The increasing interest in ES monetary valuations has been translated into market instruments. These instruments offer economic incentives to promote environmental conservation, such as Payments for Ecosystem or Environmental Services (PES). PES are defined as voluntary transactions over well-defined ES between a buyer and a supplier of the service (Wunder 2005). Therefore, users of ES compensate ES providers. According to Gómez-Baggethun et al. (2010), some of the most frequent ES encompassed in market schemes are carbon sequestration in biomass or soils, habitat provision for scarce species, landscape protection, and ES related to the water quality and quantity of freshwater flows. From early 2000s until the present day, a growing number of PES schemes were developed, especially in Central and South America (Corbera et al. 2007, Kosoy et al. 2008, Corbera 2012b, Farrell 2012). The spread of PES mechanisms in the global south derives from the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD), which supports national REDD+ projects. Basically, the objective of REDD is for carbon emission buyers to pay emission sellers, for parallel sellers to have to adopt sustainable land-use practices and carbon emission reduction (Corbera 2012b). In practice, this is translated into economic compensations paid by rich countries to poor countries and communities that work to stop deforestation (Farrell 2012). REDD+ commodifies carbon sequestration ES by segregating them from other services that forests provide (Corbera 2012b).

1.2. The commodification of nature

Commodities are an object outside us that, depending on their characteristics, can please some sorts of human demands (Kosoy and Corbera 2010). As objects that satisfy human demands, they have a use value, i.e. the utility gives use value. Moreover, when commodities are exchanged, an exchange value emerges, which embodies 'the proportion in which values in use of one sort are exchanged for those of another sort, a relation constantly changing with time and place'(Marx 1867).

Objects or services can only become commodities if they can be owned and traded by someone, and if they have delimited boundaries, as property rights cannot be applied without defined boundaries (Vatn 2010). ES fit these requests as they can be bounded and owned by someone. Therefore, ES can be treated as commodities. The process of transforming ES into commodities is called 'commodification'. Kosoy and Corbera (2010) argue that the process of ES commodification relies on three steps: first, the conceptualization of ecosystem functions as services to human wellbeing; second, the establishment of a standard exchange value to these services; third, the establishment of market relations between users and providers of these services. During the decades of the 1970s and 1980s, ecologists started to frame ecological functions as services for humans in order to communicate the importance of nature conservation (Raffaelli and White 2013). Hence, they started to address human-nature relations through utilitarian frames as a communicative tool. In the 90s, monetary valuation of ecosystems and their services started to spread because a growing number of natural scientists adhered to the idea that monetary valuations would be appealing and help decision-makers (Gómez-Baggethun et al. 2010). The last commodification step, as previously mentioned, has been the development of market schemes supported by institutional structures for ES appropriation and trading. However, the processes of nature resource appropriation and commodification are not new; rather, the novelty from late 1980s is the commodification of intangible ES (e.g., carbon sequestration) (Gómez-Baggethun et al. 2010).

The commodification of ES is embedded in a wider market-based environmentalism ideology[1] (Kosoy and Corbera 2010, Kull et al. 2015) that defends the pricing and exchange value of ecosystem services, the establishment of property rights of nature services, and the creation and maintenance of commodity markets of these services. Market environmentalism can be framed within a broader ideology of neo-liberal capitalism, which considers market-led capitalism the way to manage environmental issues (Kosoy and Corbera 2010, Dempsey and Robertson 2012, Kull et al. 2015). Market-based environmentalism defends the establishment of property rights for efficient resource management. Resource stewardship requires individual property and trade rights. Natural resources are then traded within market dynamics that will allocate low prices to abundant resources and high prices to scarce resources (Liverman 2004, Kosoy and Corbera 2010). Thus, market-based environmentalism assumes that individual property and market dynamics will lead to sustainable management of natural resources.

According to Gómez-Baggethun et al. (2010) and Kosoy and Corbera (2010), the theoretical supports of ecosystem service commodification and market environmentalism are grounded in the Tragedy of the Commons (Hardin 1968) studies tradition. Hardin (1968) argued that in environmental conservation, property rights, preferably private, need to be clearly defined, as the lack of clear property rights can lead to overexploitation of natural resources. Many authors, such as Vatn (2005) and Gómez-Baggethun et al. (2010), argue that Hardin misunderstood open access and common property. Nevertheless, Hardin's manuscript had a great impact on natural resource management.

[1] In the same line, authors such as Castree (2008) and Corbera (2012b) have written as about a 'neo-liberalizing nature' to explain how neo-liberal ideologies and practices have entered the nature realm and environment conservation. These ideologies are characterized by reregulation of conservation policies by public and private institutions through ES commodification; a growing complexity and actors aiming for conservation; new processes of territorialization that define new spaces of control; and a linked distribution of benefits and costs.

The critics of ES commodification argue that, in fact, ES commodification is associated with the development of new markets, which create new socio-economic orders (Kosoy and Corbera 2010), i.e. new actors emerge, new power relations are established and there are new inequalities in access to resources and wealth. Therefore, ES commodification can strengthen or replace unequal power relationships (Corbera et al. 2007) and social injustice (Daw et al. 2011, McAfee 2012). Furthermore, ES markets are also part of broader capitalism dynamics as commodification of nature creates new spaces for capital accumulation by a global elite (Heynen and Robbins 2005, McAfee 2012, Farrell 2014) and accumulation by dispossession (Kallis et al. 2013). Harvey (1982, 2005, 2007), building on Marx's theory, coined the concept of accumulation by dispossession. In Marx's theory, accumulation is the need of a capitalist system to separate workers from their means of subsistence through extra-economic means (changes in law, violence and forced expropriation), and to recollect part of their wages. Accumulation is not a finished project, but rather a constant mechanism that opens up new possibilities for capital accumulation, such as the privatization of resources and services, ecosystem services and land acquisitions. These are mechanisms of accumulation by dispossessing others from their means of subsistence (Kallis et al. 2013). Thus, capital is expanded through processes of accumulation that result in the dispossession of means of subsistence.

Harvey (1982) argue that capital accumulation processes are always taking place but especially when there is a crisis of overaccumulation – crises characterised by a growing flow of 'surplus' capital that cannot be reinvested lucratively (Moore 2014). Since 1970, the national-based capital economy has scaled up to a global capital economy in order to find new spaces of accumulation during overaccumulation crises (Latorre et al. 2015). Thus, new accumulation opportunities at global level completed existing national accumulation arenas.

ES markets are new global opportunities for capital accumulation by dispossession. Here, Latorre et al. (2015) coined the concept of 'accumulation by environmental dispossession', which refers to the processes of accumulation of capital by transferring environmental burdens. Carbon sequestration markets are a clear example of accumulation by environmental dispossession. Throughout carbon markets, a globalized capital class, which includes national and transnational elites, can accumulate capital. This accumulation is enabled by the displacement and dispossession of local communities. Thus, under the use of ES rhetoric, it hides the appropriation of natural resources that are needed by local communities. Consequently, these people are excluded from their land and means of living. It is fair to say these outcomes are not the intentional result of the use of the ES concept, but rather the political and economic context where the ES concept has been applied in recent decades (Gómez-Baggethun et al. 2010, Gómez-Baggethun and Ruiz-Perez 2011, Kull et al. 2015), as in the case of REDD+. Authors such as Corbera (2012a) and Farrell (2012, 2014) have studied how REDD+ programmes hide unequal power relations and social injustices.

Lele (2013) points out that ES markets are built upon unequal power relations that limit the negotiation capacity of marginalized groups, generally those more dependent on ecosystem services, as shown by McAfee and Shapiro (2010). ES markets are supported by new property rights over public goods supplied by ecosystems. These new property rights and markets can reproduce unequal power relations between suppliers and buyers. O'Neill (2001) argues that these new property rights are defined by actors who have social and economic power. Thus, they will answer to the interest of those actors. Moreover, current property rights over

natural resources that supply ES can also define the new property rights over those services and hence who will benefit from ES commodification and selling (Corbera et al. 2007).

1.3. Silencing complexity

Corbera et al. (2007), Kosoy and Corbera (2010), Norgaard (2010) and Farrell (2005), among others, argue that the ES frame and associated monetary valuation and commodification simplify complex reality in such a way that it neglects complexity and plurality. Spangenberg and Settele (2010) argue that ES commodification overlooks other value definitions and scales of analysis. Through ES monetary valuation and commodification, ecosystems may be reduced to one service. Consequently, multiple services of ecosystems are neglected. Moreover, the complexity of ecosystems might be reduced to a single exchange value, generally a monetary value. Therefore, monetary valuation fails to integrate the plurality of values that can be attributed to ES.

In this regard, monetary valuation can be totally useless when valuing ES that are essential for the survival of poor communities who have no money to buy other alternatives (Martinez-Alier 2009). In fact, measuring only in quantitative terms, specifically monetary valuation, has negative effects when the objective is to assess non-dominant world views, valuations and environmental perceptions (Funtowicz and Ravetz 1994, Martinez-Alier et al. 1998); i.e. monetary valuation undermines the legitimacy of values such as human rights, common land rights, sacredness and aesthetic values (Martinez-Alier 2009). ES monetary valuation also omits to display the social relations behind the processes of producing, selling and using ES. However, authors such as Kallis et al. (2013) and Jacobs et al. (2016) suggest a reformulation of monetary valuation to integrate value pluralism, distributive justice and opposing neo-liberalism dynamics of commodification. Value pluralism is necessary to confront the reduction of complexity caused by commodification reduction.

The ES framework not only hides value complexity, but also ecological complexity. Norgaard (2010) states that the ES concept is based on the stock-flow model. Stock-flow models conceptualize nature as a limited stock of natural capital that can supply a finite flow of ES (Costanza and Daly 1992, Jansson et al. 1999). Models are simplifications of realities that intend to promote the understanding of such realities. The stock-flow model is a simplification of reality that links ecological and economic systems. Nevertheless, the stock-flow model does not integrate the transformation of energy and matter necessary for production and consumption processes. Thus, the model assumes that the energy and matter required for both processes are infinitely available. In addition to that, the model does not consider the pressure on, and degradation of, ecosystems. Therefore, the model assumes the feasibility of infinite growth if demand is properly regulated. Georgescu-Roegen (1971) proposed an alternative model, the flow-fund model. The flow-fund model distinguishes between stock and fund. Stocks are non-renewable resources of energy and matter, such as oil. There are limited reservoirs of stock resources. Thus, stock resources can only be extracted for a limited amount of time, whilst fund resources such as wood, water and food are renewable, if the conditions for renewal are appropriate. Hence, funds can be used indefinitely but their availability is subjected to specific processes and conditions, such as the ecological reproduction cycle. The distinction between fund and stock highlights biophysical limits, as humans can use stock flows at any rate, but they will be exhausted. Funds cannot be exploited at limitless rates, but they are renewed (Dafermos et al. 2014, Dafermos et al. 2017). Thus, fund consumption is possible but limited.

In recent decades, the ES framework, underpinned by the stock-flow model, has become a central framework for studying ecosystem change. As a result, many other frameworks and associated understandings of natural systems have been excluded as flow-fund model or social science based approaches (Norgaard 2010, Díaz et al. 2018). Norgaard (2010) argued that the use of ES and associated monetary valuations was considered necessary by those who appreciate nature to communicate ecological degradation, but the 'eye-open metaphor' became a 'complexity blinder'. In other words, the ES service framework hides the complexity of ecosystems, and it neglects other models and knowledge that could be used that highlighted core aspects such as the differentiation between stock and fund. In addition, ES and their associated commodification have become a central paradigm for designing and developing environmental management programmes (Pagiola et al. 2004, World Bank 2009). Therefore, the environmental management programmes designed under the ES paradigm do not comprehend the complexity of the ecosystems they aim to manage.

1.4. The utilitarian alienation

The choices made in selecting and applying the ES concept shape human-nature relations (Kull et al. 2015). ES are a political concept that frames human-nature relations in a specific way, as a result of the growing dominance of (neo-)liberal frames to support effective environmental management and 'ecological modernization', which seeks modernization and technical solutions to solve environmental degradation (Kull et al. 2015). Thus, ES are part of a broader technological, institutional, narrative and symbolic process of change that reshapes human-nature relationships (Kallis et al. 2013).

This relationship is supported by a utilitarian perspective and alienation. Alienability refers to the physical and moral detachment of commodities from their sellers (Castree 2003). The commodification of ES reinforces alienability, that is, ES are physically and morally separated from their producers and sellers. Therefore, ES commodification increases the detachment of humans from nature; i.e. nature is seen as something external that needs to be controlled, rather than jointly co-produced.

This detachment is part of nature and human dualism. Dualism has been a central element of Western civilization: subject vs object, reason vs emotion, nature vs human. Nature and human dualism has been a core element of Western civilization since the Enlightenment; i.e. nature exists separately from humans but is ruled by humans and serves their interests. Loreau (2014) argues that environmental degradation is the result of human-nature dualism, as it enforces the idea of alienation and that humans are different from nature, which they can exploit and dominate. The biggest challenge of our society is to overthrow this dualism (Loreau 2014), and hence to break down the barrier between humans and nature and consolidate the idea of humans as part of nature. Thus, Western societies need to conceptualize humans as a part of a complex net of relationships with other biotic and abiotic components.

In this regard, Max-Neef (2005), based on Nicolescu (2013, 2000), suggests understanding reality through transdisciplinary lenses. Nicolescu (2013, 2000) argues that reality is that 'which resists our experiences, representations, descriptions, images or mathematical formalizations'. So reality is not just the result of a social construction, but rather it also has a trans-subjective dimension (Nicolescu 2000, 2013). Therefore, nature is not only an intermediary abstraction to describe reality and, hence, a step between humans and nature but is one of the parts that constitute nature and, thus, reality (Nicolescu 2013, 2000). To

understand the trans-subjective dimension of reality it is necessary to comprehend reality at its different levels. Current disciplinary investigations only conceptualize one level of reality, whilst transdisciplinarity, proposed by Nicolescu (2000), looks at different levels. Levels of reality refer to a 'set of systems that are invariant with respect to the action of certain general laws'(Max-Neef 2005, p.11). Therefore, two levels of reality are distinguished because there is a shift of the laws and core concepts, such as causality.

Reality goes beyond the two levels of reality framed within the Aristotelian classical linear logic (Max-Neef 2005). According to Max-Neef (2005), this logic is structured by three main principles: the principle of identity, where A is A; the principle of non-contradiction, where A is not non-A; and the principle of the excluded middle, where there is not a middle term that is at the same time A and non-A. Thus, there exists no third term that is simultaneously A and non-A. Max-Neef (2005), based on Nicolescu (2000, 2013), argues that a middle term, named the 'T' term, actually exists; there is an included middle. T is together A and non-A. A and non-A are located at different levels of reality to T, while influencing their adjacent levels of reality (Nicolescu in Max-Neef 2005). The integration of the middle term, T, allows the classical linear logic and dualism to be left behind. Thus, it provides a more systemic and holistic perspective of reality (Max-Neef 2005).

1.5. The holistic understanding of nature

During the twentieth century different theories emerged that questioned the reductionist Cartesian logic and deterministic models such as Newton's laws. These theories were part of an increasing understanding of our planet and processes taking place as extremely complex. Especially significant in the consolidation of the understanding of complexity were general systems theory, chaos theory and complexity theory. These theories influenced many disciplines, such as ecology and coastal management, both of which integrate aspects of system theory and complexity theory in some aspects of their fields of study, such as conceptualising the Earth or the coast as a complex system (e.g., Earth system science).

1.5.1. General systems theory

General systems theory was pioneered in the 1930s and 1940s by Von Bertalanffy (1968). General systems theory is intended to explore wholes and wholeness (Berkes et al. 2003). Von Bertalanffy (1968) describes general systems theory as a new model that aims to establish general principles for systems that are organized entities independently of their nature. General systems theory emphasizes that understanding the properties of the parts of a system depends on understanding these parts and their interrelations with other parts of the system (Von Bertalanffy 1968, Laszlo 1996, Berkes et al. 2003). Therefore, understanding derives from assessing how the parts of a system are connected and which feedback processes take place, rather than only understanding the parts separately. During the second half of the twentieth century, the general systems theory perspective was applied to different areas of knowledge and developing theories, such as chaos and complexity theories.

1.5.2. Complexity theory

Chaos theory was the antecedent of complexity theory and became a popular theory in the 1970s and 1980s. Lorenz (1963) demonstrated that systems are non-linear, that is, that systems are unpredictable in their behaviour and that a small change can result in unpredictable transformations (Holland 2014); i.e. the butterfly effect, the movement of a butterfly's wings in one place, could conduce to a hurricane on the other side of the planet

(Lorenz 1963). However, Lorenz (1963) and other chaos theorists found out that the behaviour of non-linear systems was not random, but rather structured by patterns. Hence there was order within chaos (Bremer 2013). Late in the second half of the twentieth century, scientists from different disciplines started to develop a new theory to understand systems, and hence to improve general systems theory and chaos theory, called 'complexity theory'. Like chaos theory, complexity theorists distinguished between deterministic models such as Newton's laws and unpredictable complex systems. Chaos theory aims at comprehending simple systems that change in an unexpected or irregular manner. However, unlike chaos theory, complexity theory focuses on complex systems and aims to discover the behaviour of multiple interacting parts, which frequently produce unexpected changes (Rickles et al. 2007).

Simon (1962, p.468) defines complex systems as 'made up of a large number of parts that interact in a non-simple way. In such systems, the whole is more than the sum of the parts'. Kovacic (2015) exemplified the interrelations between components of complex systems by comparing the roles and interactions between five individuals. The roles and interactions between these five individuals determined whether the whole is a family or a basketball team. In both cases, a separate understanding of their behaviour and relations is not enough to understand the whole, the family or the team. To understand the identity of the whole system, multiple scales of analysis are needed as means to identify the functional and structural properties of the components, e.g., the interactions on different scales between the members of the family or the basketball in concordance with the predictable rules (Kovacic 2015). Moreover, multiple scales of analysis also enable understanding of the influence of emergent properties of the whole system over the functions of the parts; e.g., the operationalization of the whole system requires different roles for each member of the team or family on different scales (Kovacic 2015).

From the example of Kovacic (2015) it follows that complex systems are organized in a hierarchical way, and hence smaller components are nested in larger components. Thus, at one level of analysis one component can be a whole, and at the same time be part of a larger whole at another level of analysis (Allen and Starr 1982, Allen and Giampietro 2014). This duality is reflected in the concept of holon. Holon is a core concept in hierarchical organizations as it represents the existing dualities in complex systems; i.e. holon is at the same time an autonomous whole and a part of a larger level of structure (Allen and Giampietro 2014). The duality entailed by the concept of holon makes it possible to distinguish between structural and functional types at different levels of analysis (Allen and Starr 1982, Allen and Giampietro 2014). For instance, at one level of analysis the human body is an autonomous whole that defines the structure of the functions carried out by smaller parts, the organs. At the upper level of analysis an individual human is part of bigger structures, such as communities, that define the functions of the parts.

Complex systems are formed by different components that are interrelated among them, operating at multiple temporal and spatial scales (Holland 2014). That is why, to address complex systems, an analysis is needed that integrates multiple levels of analysis (from the components of a system to the whole system and the context of the system), hence a multi-scale analysis. Multi-scale analysis needs to be complemented by the analysis of interrelations between levels (Holling 2001, Gunderson and Holling 2002), as parts of a whole on one scale are interrelated with other parts on other scales, hence cross-scale analysis.

In summary, complex systems are characterized by the following properties: non-linearity, uncertainty, emergence, hierarchy and self-organization. Non-linearity is related to inherent uncertainty (Berkes et al. 2003). Inputs in non-linear systems, such as complex systems, might have unexpected outputs. Therefore, complex system behaviour cannot be predicted based on cause and effect analysis. Likewise, complex systems are characterized by emergent properties – emergent unexpected properties that result from hierarchical interrelations, yet the action of the whole is more than the summation of the actions of the parts (Holland 2014). Scale is also important in complex systems as they are structured hierarchically. In other words, smaller subsystems are nested in larger subsystems, which are interconnected and have emergent properties at each level (Berkes et al. 2003). Furthermore, complex systems tend to self-organize themselves at critical points of instability (Berkes et al. 2003, Holland 2014).

1.5.2.1. The abstraction and observation of complexity

Complexity surges because of the unpredictability of a system when using a formal model (Allen et al. 2017). As Rosen (1991, p.9) points out, complexity 'requires, at best, an infinite number of distinct formalizations to capture all the qualities'. Allen et al. (2017) argue that complexity is on the spin between materiality and abstraction. Materiality is outside us, something outside the observer, whilst we, the observer, create the abstraction. Complexity is not material, although it has material connections as it relates to material situations (Allen et al. 2017). Complexity feels real, something concrete; however, it is only concrete because of previous decisions on what to look at. Furthermore, complexity answers a specific goal and function defined by the observer (Allen et al. 2017). For instance, in the case of an observer looking for ecosystem services for a mangrove forest, the services are found because the observer seeks them.

The confusion around complexity as being something real might be related to the deficient differentiation between complex and complicatedness (Allen et al. 2017). The levels of analysis are different between complexity and complicatedness. Complexity is addressed from outside the limits of the system, which is conceptualized as a whole, whilst complicatedness is analysed from a lower level, hence from inside where the components are conceptualized as independent and the whole is not considered. Both require observer judgment, but judgment is focused on different aspects of observable things (Allen et al. 2017). For instance, complicatedness might refer to the number of parts of a structure. The number of parts is a decision taken by the observer, and is not the reality. As pointed out by Allen and Hoekstra (2015) in Allen et al. (2017) it is possible that things exist in our world, but distinct to things, yet 'thingedness' derives from observer decisions to set boundaries. Although complexity is not material and is dependent of the observer, quantum physics has proven that abstraction is not only a mechanism for reality description, but also one of the components of reality (Max-Neef 2005). As previously mentioned, reality is not solely a social construction but also has a trans-subjective dimension (Nicolescu 2013).

1.6. Socio-ecological complex systems

The understanding of reality through complexity and system theory lenses entered the ecology field during the 1970s[2]. For example, Odum and Barrett (1971) integrate some

[2] Moreover, according to Anand et al. (2010), the publications by May (1973) and Allen and Starr (1982) were also core contributions to the development of the study of ecological complexity

complexity aspects in ecology studies. They argue that ecosystems progress from an initial situation of disorder towards a complex equilibrium situation. They also suggest that the earth is a closed ecosystem organized in a hierarchical way: *'hierarchies in nature are nested – that is, each level is made up of groups of a lower level unites (populations are composed of groups of organisms, for example)'* (Odum and Barrett 1971, p.7). Also, Odum and Barrett (1971) criticize reductionism and advocate holism. In this holistic approach, humans are seen as consumers of natural capital, and also as destroyers of ecosystems. The brother of E. Odum, H.T. Odum (1971), addresses ecosystems through energy flows. In his approach, H.T. Odum (1971) also considers humans to be a major component of natural systems. H.T. Odum (1971) highlights the effects of humans on the exploitation of fossil fuels, and links them to social and economic forms of organization.

The integration of complexity and human-nature holistic approaches influenced the development of socio-ecological systems theory. Socio-ecological systems theory aims to analyse living environments by bridging ecological and social systems. The concept was first coined by Ratzlaff in 1970[3] (in Colding and Barthel 2019). Nevertheless, only in 1998 did the concept become a framework, studies of which intertwined social and ecological systems and the resilience of these systems (Berkes et al. 1998). Ostrom (2009) also uses socio-ecological theory to further develop the theory of the commons.

Socio-ecological theory argues that socio-ecological systems are complex systems that rely on the interactions between natural and social systems (Berkes et al. 2003). Berkes et al. (2003) define social systems as those concerned with governance – including property rights and access, systems of knowledge, world views and ethics. Furthermore, Berkes et al. (2003) define ecological systems or ecosystems as those communities of organisms that interact among each other and with the surrounding environment, and are able to self-regulate. Odum and Barrett (1971, p.2) recall that the term 'ecology' derives from the Greek word *oikos*, which means 'house', and *logos*, which means 'study'. Thereafter *ecology 'is the study of the environment house that includes all the organisms and the functional processes that make the house habitable'*. Understanding socio-ecological complexity requires the integration of social and ecological knowledge. It is therefore necessary to integrate social and ecological knowledge. It is also necessary to acknowledge complexity when analysing socio-ecological aspects, such as complex multi-scale interactions between ecosystems and society (Kelly et al. 2019).

Hierarchy theory serves to understand multi-scale interactions in complex socio-ecological systems. As explained in Section 1.5.2, complex systems are organized in hierarchy levels. Thus, systems and parts of a system, or holons, lie on multiple scales with top-down and bottom-up interactions over scales (Allen and Starr, 1982). Larger holons constrain or bound lower holons, because larger holons provide the limits and/or structure of the function of lower holons. For example, mangrove forests regulate the climate and humidity conditions needed for species and organisms that inhabit those forests. At the same time, ocean currents regulate the climate conditions needed for mangrove forests. Thus, holons are both part and whole. Kovacic (2015) states that the integration of multi-scalar approaches between the whole and the parts is not only significant for representing the system but also for identifying and understanding the interactions between different representations of the system.

[3] Ratzlaff, E. D. 1970. *Applications of engineering systems. Analysis of the human social-ecological system.* Thesis. Department of Mechanical Engineering, University of California, Davis, USA.

Complexity theory enables identification of the different descriptions of the system or problem analysed on multiple scales. That is why complexity theory and hierarchy enable the capture of pluralism.

Furthermore, as a result of the interactions across scales between social and ecological components, emergent properties and patterns might emerge. As stated by Rosen (1991), complexity is in essence an issue of emergence. Emergence does not happen over time, as it can occur immediately as a result of interactions between parts (Bremer 2011). For instance, one water drop in a saturated water body produces an overflow. Thus, emergent properties are unpredictable and non-linear. As a result, uncertainty is a fundamental characteristic of socio-ecological systems.

The interactions between social and ecological components constantly produce transformation. According to Prigogine (1986), systems are always in constant evolution. Any part of a complex system, such as a brain or urban traffic, is always in constant transformation and in constant flow as a result of the interaction between the parts and the context of the system. In socio-ecological systems, this constant evolution results from the interaction between social and ecological components. The constant evolution of socio-ecological systems was conceptualised by Norgaard (1994)[4] through the idea of coevolution. Coevolution understands socio-ecological transformation as a process of evolution carried out jointly by humans and their environment. Therefore, evolution is not only the result of natural factors or social factors (such as technology) but rather is a double-direction process (Norgaard 1994).

To summarise, this research understands socio-ecological systems as complex systems. In this way, socio-ecological systems are composed of the interactions between natural and social systems. These interactions are conceptualised through complexity. That is, systems and parts of a system, or holons, lie on multiple scales. Hence, socio-ecological systems and parts of a socio-ecological system are wholes or parts of wholes at different scales. Moreover, systems and parts of a system are structured in hierarchy-nested levels (i.e. systems constrain parts of a system because they articulate the function of parts of a system). Socio-ecological systems and parts of socio-ecological systems constantly interact and reshape each other. These interactions take place at multiple scales and across scales.

The abovementioned understanding of complexity serves to address socio-ecological complexity in this study. Socio-ecological complexity results from the inherent and coevolutionary relations between social and ecological components taking place at multiple scales and across scales. Socio-ecological complexity is defined in this research through five essential properties: ecological and social interrelations, multi-scale analysis, co-evolution, plurality and uncertainty (Table 1). In the following section, these socio-ecological complexity properties are applied to review the ES framework. Moreover, in Chapter 2 these properties are used to select socio-ecological variables in order to assess coastal ES literature.

[4] Richard Norgaard is not a complexity theorist but rather an ecological economist theorist. Nevertheless, his coevolution theory (Norgaard 1994) is linked to an understanding of socio-ecological systems as complex systems because transformation processes in coevolution are multi-causal and multi-scalar.

Table 1. Socio-ecological complexity properties addressed in this dissertation, based on Berkes et al. (2003, 1998), Hou et al. (2013), Norgaard (1994) and Scholes et al. (2013)

Socio-ecological property	Short definition
Socio-ecological interrelations	Social and ecological systems are inherently related.
Multi-scale analysis	Socio-ecological systems are hierarchically organized. The wholes are formed by smaller parts, which at the same time are wholes formed by smaller parts. These parts are interrelated on multiple scales and across scales.
Co-evolution	Socio-ecological systems are in constant evolution as a result of interrelations between the parts and context of the system.
Plurality	Socio-ecological systems have multiple dimensions and representations.
Uncertainty	Socio-ecological systems are non-linear and unpredictable.

1.7. The socio-ecological complexity of ecosystem services: coproduction, scale and wellbeing

ES are generated by complex processes and interactions between ecological and social components. In other words, ES are the outcome of ecological and social constituents and their relations in complex socio-ecological systems; i.e. ES require biophysical processes and functions as their basis, but also the supply of non-natural factors (Palomo et al. 2016).

In the last decade, ES frameworks have been developed with the aim of comprehending socio-ecological system complexity, such as the following: (1) the MEA (2005), which focuses on the links between ecosystem change and human wellbeing; (2) the cascade-model (Haines-Young and Potschin 2009), which represents a 'production line' from biophysical structures and processes to components of human wellbeing through a series of intermediate stages; (3) The Economics of Ecosystems and Biodiversity (TEEB) (de Groot et al. 2010), which pays particular attention to the economic benefits generated by ecosystem services and biodiversity, and the costs linked with their damage (Baral et al. 2016); (4) the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) (Díaz et al. 2015), which aims to bridge the science policy gap by seeking to support decision-making on how to stop the further degradation of ecosystems (Baral et al. 2016); and (5) the ES capacity and flow models (Villamagna et al. 2013, Burkhard et al. 2014), which look at spatial distribution and assessment of capacity, flow and demand as means to inform policymaking on potential ES mismatches (Geijzendorffer et al. 2015).

ES frameworks are set within a linear-cyclical approach, i.e. the flow from ecosystems to human benefits (Jones et al. 2016). This linear-cyclical flow is composed of different parts: capacity, flow, benefit, value and demand. Capacity refers to 'the potential of an ecosystem to deliver an ecosystem service' (Villamagna et al. 2013, p.116). Flow denotes 'ecosystem services in point of fact received by people' (Villamagna et al. 2013, p.116), and at the same time, in this dissertation, flow is also conceptualized as the ES spatial pathway from providing to benefiting areas (Bagstad et al. 2013). In Chapter 4 of this dissertation the ES flow as a spatial connection between providing and benefiting areas is analysed. Benefits are contributions to aspects of human wellbeing (Potschin and Haines-Young 2016), which are used and/or consumed by humans. Value, in this dissertation, refers to the criteria used by

people to assign importance to things, in this dissertation called 'value' (Potschin and Haines-Young 2016). Finally, demand is 'the total amount of service needed or desired by society' (Villamagna et al. 2013, p.116). The cyclical part of ES frameworks generally includes natural or human-induced drivers, such as decision-making and management, which in turn affect ecosystems and their derived ES (Van Oudenhoven et al. 2012).

Linear-cyclical models still place humans at the end of the sequence, by assigning a value to ES benefits (Fischer and Eastwood 2016), or human-induced drivers that affect ecosystems and their derived services. Nevertheless, as Rova and Pranovi (2017) state, humans not only act at the end of the linear-cycle process but also as co-producers of ES through knowledge, technology, values and institutions (Palomo et al. 2016). Anthropogenic intervention in ES production increases the complexity of ES assessment (Burkhard et al. 2014).

In the same vein, the relations between the actors and power distribution supporting them play an important role in the socio-ecological complexity of ES. Power interactions structure the relations between the actors, their interests and their values, i.e. which actors have access to ES and how they benefit from them, what interests are prioritized or excluded, what values are at stake and how value preferences are defined.

The socio-ecological complexity of ES is also expressed through a diversity of values, hence the importance assigned to them. Intrinsic, relational and instrumental values[5] are highly diverse, and stakeholders might hold multiple values and value preferences (Díaz et al. 2015). Furthermore, stakeholders' values might differ in different socio-spatial and temporal contexts. For example, one may hold different value preferences at local or regional level.

Another fundamental aspect of the socio-ecological complexity of ES is human wellbeing (HWB), as a 'positive physical, social and mental state' (Summers et al. 2012, p.328). It is the outcome of social processes and varies with space and time (Jax and Heink 2016). ES can play an essential role in satisfying human needs for HWB (Summers et al. 2012). For example, provision services play a role in basic needs like nutrition (food provision) and shelter (biotic materials), regulation services provide personal safety and security from disasters (climate regulation, coastal protection, water purification and flood regulation) and cultural services are fundamental for cognitive processes (local and scientific knowledge, educational values and cultural heritage values). Despite the increasing academic work on ES, many of the links between ES and HWB are still poorly understood and controversial (Balmford et al. 2005, Butler et al. 2005, Butler and Oluoch-Kosura 2006, Busch et al. 2011, Abunge et al. 2013, Jax and Heink 2016). There is still little knowledge regarding benefits or dis-benefits (negative impacts of ES on HWB). Consequently, in many decisions regarding HWB dimensions (education, housing, security, etc.), the role of ecosystem services is unnoticed. This oversight may result in unplanned consequences (Summers et al. 2012).

Moreover, current conceptualizations of the link between ES and HWB are based on the misleading assumption that improving ES conditions and guaranteeing ES flow ensure humanity's wellbeing (Daw et al. 2011). Several authors (Butler and Oluoch-Kosura 2006, Dietz et al. 2009, Raudsepp-Hearne et al. 2010, Summers et al. 2012) consider the

[5] Díaz et al. (2015) define intrinsic, relational and instrumental values. Intrinsic values refer to values inherent in natural systems. Relational values concern desired relationships, such as relationships between nature and humans. Instrumental values are associated with human benefits obtained from nature.

aforementioned assumption to be an oversimplification of the reality. Yet the benefits that different individuals and social groups obtain from ES depend on multiple and complex processes combining elements of access, value, social relations, collective conceptualization of wellbeing, personal understanding of wellbeing, power relations, institutions, technology and knowledge. Therefore, improvements to ES conditions and flow might have little impact on the HWB of certain social groups, as they might not have access to the benefits (Daw et al. 2011) as ES and HWB are non-linear but complex relations.

ES complexity is also manifested when different scales are included in the analysis, with multiple multi-scale and cross-scale processes involved. In fact, as explained in Section 1.5.2., scale effects are one of the keystones of complexity theory, since the interaction between system components might lead to unexpected phenomena once they are coupled into systems (Scholes et al. 2013), i.e. non-linear systems with emergent properties: for example, air pollutants' interaction with other pollutants' outcome in secondary pollutants, which have different behaviour and patterns. Scholes et al. (2013) argue that the analysis of ES through multi-scale analysis shows different aspects of complexity. First, ES arise from complex interlinked socio-ecological systems and are hence reliant on interactions and feedback processes from several components that operate on many scales. Second, ES might be supplied, used, managed and valued on a variety of spatial and temporal scales. Third, social and ecological processes and structures that support ES also function on various scales.

Last but not least, another cornerstone of ES complexity is uncertainty, which is an essential characteristic of socio-ecological systems (Hou et al. 2013), such as complex and non-linear systems. Authors such as Funtowicz and Ravetz (1994) point out that socio-ecological systems are complex systems and as such their analysis and governance rely on an irreducible (in part) uncertainty (Mayumi and Giampietro 2006, Ariza et al. 2016). Therefore, because of their high complexity and their interlinked position between humans and nature, ES carry remarkable levels of uncertainty (Scolozzi et al. 2012). Hou et al. (2013) describe three sources of uncertainty in ES assessment – uncertainty associated with ecological systems, which are themselves highly complex and dynamic, in the course of delivering ES. Another source of uncertainty is related to individual and shared preferences in terms of ES. ES preferences are subjective: they might vary among scales and in relation to the available knowledge and information. The last source of ES uncertainty concerns the methods and tools used to assess ES.

1.8. Political ecology: the social production of ecosystem services

As a result of complex socio-ecological processes, ES are not something that occur outside the human realm, but are rather intertwined in social and political processes (Ernstson 2013). Similarly, Ernstson (2013) points out that ES production is not an apolitical process, but rather ES are 'socially produced'. The social production notion of nature is not new: for example, authors such as Swyngedouw and Heynen (2003) have studied in depth the social construction of nature in urban spaces. For urban political ecologists, such as Ernstson (2013), Swyngedouw and Heynen (2003), Norgaard et al. (2009) and Depietri et al. (2016), societies are constantly shaping their living environments, and at the same time these transformations lead to new changes in a co-evolutionary process (Norgaard 1994), thereby constantly creating what political ecologists call new socio-natures. These co-evolutionary processes and new socio-natures are not apolitical and neutral (Depietri et al. 2016), but rather they reproduce end embody positions of social power (Swyngedouw and Heynen 2003). Therefore,

new socio-natures answer to power interests, as well as ES derived from existing socio-natures.

The social production of nature not only mediates in the creation of socio-natures and ecosystem services, but also in who gets the access to, and benefits of, these ES, hence the distribution of ES (Ernstson 2013). In this regard, the ES concept concerns environmental justice. Environmental justice refers to the spatial distribution of environmental goods, in this case ES, and negative impacts among communities, whilst also including 'fairness in the distribution of environmental wellbeing' (Low and Gleeson 1998, p.102).

This research aims to contribute to environmental justice and ES framework research. Clearly, the ES framework has been framed within a market environmentalism approach that leads to uneven distribution of ES and trade-offs. Whilst being aware of this fact, I intend to expand the ES framework towards the integration of political ecology and environmental justice perspectives. Thus, I integrate socio-ecological complexity in coastal ES assessment as a means to analyse the socio-ecological process and mechanisms that reproduce power relations and uneven distribution of coastal ES and trade-offs.

1.9. The socio-ecological complexity of coastal systems

Barragán-Muñoz (2004) suggests the following definition of coastal areas: 'Coastal areas can be defined as strips of variable width, resulting from the interactive contact between nature and human activities that takes place in areas that share the existence or influence of the sea.' Similarly, McFadden (2008) describes coastal systems as complex systems with ecological and social interactions that vary significantly over space and time. These definitions go beyond narrow discipline views and understand the coast as a socio-ecologically complex system resulting from the interaction of social and ecological components but adding the sea-land interface.

The above definitions are framed within the general systems theory and socio-ecological complexity perspective supported by authors such as Berkes et al. (1998), Farrell (2009) and Norgaard (1994). The system and socio-ecological perspectives applied to coastal zones are aimed at understanding coastal zones via a holistic approach; i.e. social and environmental dimensions are addressed as interconnected and interdependent realities, rather than separate. Similarly, authors such as Turner (2000) and Jentoft and Chuenpagdee (2009) assert that the coastal context needs to be understood as a 'humans-in-nature' or 'socio-ecological system', described in terms of tightly interwoven social and ecological systems interacting in novel and unpredictable ways.

Coastal ecosystems comprise interactions from land and sea. The socio-ecological processes that operate in this land-sea interface can take place on different temporal and spatial scales and across scales. Hence, processes on different scales interact and produce changes and effects on other scales. For instance, coastal erosion results from regional processes, such as regional urbanization or harbour construction, but its impacts are suffered on a local or micro scale as beach regression. That is, socio-ecological systems, such as coastal systems, are hierarchically organized (Giampietro 1994). Thus, local processes are nested within regional processes, and at the same time these processes are part of national and international processes (Ariza et al. 2016). Consequently, local institutions should be nested in regional institutions, and those nested at national and international institutions (Folke et al. 2007, Ariza et al. 2016). Nevertheless, current governance structures do not follow a hierarchical

organization. This is especially true for lower system scales: for example, local institutions still did not integrate the interplay between local processes and wider-scale phenomena (Folke et al. 2007). Ariza et al. (2016) argue that one of the causes of this lack of integration is because at lower scale levels, local or national, private interests and sectorial approaches still prevail.

Coastal systems are also characterized by being highly dynamic; they are in constant transformation in terms of social and environmental change. In fact, coastal systems experience high dynamism and complex functioning (biological, geological, chemical and social interactions) in very short periods of time (Barragán-Muñoz 2004). The high dynamism of coastal spaces results in an increasing awareness of the intrinsic complexity and uncertainty when managing the coast (Bremer 2011). In addition, global environmental changes, such as climate change, increase the uncertainty associated with coastal spaces (Bremer 2011). Coastal areas are especially affected by climate change consequences, such as rises in sea level, due to the vulnerability of coastal systems (Vallega 1999, Bremer 2013).

Environmental issues, such as coastal issues, are characterized by uncertainty, values in conflict and high stakes and pressing decisions (Funtowicz and Ravetz 1990, 2003, Ravetz 1999). Within this context, scientists must go beyond the traditional assumptions that science is value-free and holds an objective truth. The science community should embrace the idea that in complex environmental issues there are no certain, neat and non-conflicting solutions (Ravetz 1999). Rittel and Webber (1973) define wicked problems as non-technical issues with no specific definition and potential solutions, but rather their definition and potential solutions depend on the perspective of stakeholders. In other words, the problems depend on how they are looked upon, as one person or community may see a problem in one way, and others in another way (Jentoft and Chuenpagdee 2009).

Wicked problems are the result of social constructions where multiple perceptions and interests are at stake. In fact, the definition and delimitation of a problem is already a wicked problem, yet its delimitation is also a social construct with perceptions and interests at play. The solution of wicked problems is not technical; it cannot be defined scientifically, but rather by collective processes of decision and research. Understanding complex socio-ecological systems, such as coastal systems, requires the integration of multiple and appropriate methodological approaches (Mayumi and Giampietro 2006). Therefore, environmental management, such as coastal management, requires support from the actors involved in the decision-making and research on several scales to reach effective and functional decisions (Funtowicz and Ravetz 1990, 2003, Ravetz 1999). In agreement with that, Jentoft and Chuenpagdee (2009), who argue that coastal and fisheries governance have to deal with essentially wicked problems, built a framework to assist the governability of wicked problems in these fields.

1.9.1. Coastal management and socio-ecological complexity

Coastal management needs to be grounded in socio-ecological complexity; thus, it must be driven by a holistic and hierarchical approach. Furthermore, as dynamic and contested spaces, coastal space management needs to acknowledge constant change as inherent and desirable for coastal systems (McFadden 2008).

The evolution of coastal management shows how socio-ecological complexity approaches have slowly been introduced into the coastal debate. Coastal conflicts were introduced onto the political agendas between the 1960s and 1970s, such as the Coastal Zone Management

Act adopted in 1972 in the USA. This regulation was aimed at creating coastal planning decision-making structures and systems at national and federal level (Bremer 2011). Coastal Zone Management (CZM) in the 1960s and 1970s followed the dominant paradigm in planning, and many other fields, namely the 'modernist' approach. Decision-making was based on the rational capacity of coastal managers because of their access to technical knowledge and their role as defenders of the public interest (Bremer 2011). According to Bremer (2011), during the 1970s the CZM discipline suffered two big transformations: the first was the increasing realization of the coast as a complex system and space of interconnection between land and sea; the second was the will to equilibrate the use of coastal resources and to maintain coastal ecosystems' integrity.

During the 1980s, in some developed countries, such as the USA, France and Spain, coastal planning laws were endorsed (Roca Bosch 2008, Font 2013, Pons Cánovas 2015, Ariza et al. 2016). These regulations were aimed at coastal dune and landscape protection, with a view to guaranteeing public access to the coast (Ariza et al. 2016). In addition, in the 1980s a conceptual change in coastal management took place. The influence of complexity theory meant the decline of the sectorial approach and the rise of a more integrated and holistic approach (Garcia Sanabria 2016). The 1980s saw the transition from CZM to Integrated Coastal Zone Management (ICZM), which integrated a wide range of coastal uses (Cicin-Sain and Knecht 1998). Furthermore, ICZM was influenced by postmodern theories, and as a result coastal systems were conceptualized as plural spaces, where multiple perspectives and value systems converge (Bremer 2011). The rise of ICZM anticipated the UN Conference on the Environment and Development (UNCED) in Rio de Janeiro held in 1992 (Cicin-Sain and Knecht 1998).

The UNCED Rio Earth Summit and Agenda 21 in 1992 meant the consolidation of ICZM as the central concept for coastal management worldwide. The objective set at the conference was that by the year 2000 ICZM programmes should be implemented in all coastal countries. The rise of ICZM as the international frame for coastal management helped to advance further the notion of integration. ICZM progressed from interdisciplinary towards transdisciplinary approaches (in a limited way) (Bremer 2011). In 1996, ICZM was defined as follows: 'A dynamic and continuous process oriented to the sustainable development and protection of coastal zones. ICZM requires the active and constant implication of the public and stakeholders with interests in coastal resources and the mediation of conflicts' (GESAMP 1996).

In 2002, the World Summit on Sustainable Development (WSSD) was held in Johannesburg. In order to broaden the scope of ICZM, Ecosystem-Based Management (EBM) was introduced at the WSSD (Sardà et al. 2014, Garcia Sanabria 2016). EBM can be defined as 'an integrated approach to management that considers entire ecosystems, including humans. The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need' (McLeod et al 2005, p.1). EBM considers humans as part of ecosystems and emphasizes the relation between human wellbeing and ecosystem services.

Moreover, in the last two decades the conceptualization of the coast as a complex socio-ecological system with associated uncertainty has resulted in the evolution from coastal management towards coastal governance (Bremer 2011). Here, broader governance debates and ideas have influenced coastal authors, such as Jentoft (2007), Stojanovic and Barker

(2008) and Bremer (2011), who have written about governance theories such as 'interactive governance theory' and 'adaptive governance', among others. In management, goals and institutions are clearly defined. On the other hand, governance 'is a process that engages all elements of society simultaneously within multiple settings, and mediates across their various interests, rights and obligations' (Bremer 2011, p.293).

Shipman and Stojanovic (2007) review the success and failure of ICZM programmes. One of the aspects that the authors claim obstruct the development and implementation of ICZM is the fragmentation and complexity responsibilities that prevent institutions from consolidating a united approach. Other failures and obstruction issues include: the temporality of the projects, the lack of financing, the lack of action in the implementation phase, the failure to integrate coastal communities and sectors, a policy vacuum preventing the conversion from national to local policies, the lack of coordination between sectors due to obstacles in communication and information, and finally the democratic deficit in coastal areas, especially those beyond local jurisdiction.

ICZM still has many aspects to improve and further advance in the integration of coastal communities and institutions. In this regard, coastal management is moving towards integrated socio-ecological approaches; i.e. more integrated approaches in relation to environmental management have been developed, such as EBM. Nevertheless, there is still a lack of knowledge on coastal socio-ecological complexity (Sardá et al. 2015), such as how coastal social and ecological components are integrated, how they generate ecosystem services on multiple scales, how the degradation of costal ecosystems affects human wellbeing and how social relations and values underpin governance systems and ecosystem services. Although some efforts have been made by some authors, such as Bremer (2011), Ariza et al. (2016) and Stojanovic et al. (2016), existing environmental and coastal assessment still needs to better understand socio-ecological complexity. To this end, the second chapter of this dissertation evaluates how the ES framework integrates socio-ecological complexity, such as by developing an integral socio-ecological framework for coastal ES assessment. Then, the second and third chapter apply the framework to provide an integral ES analysis in the case of cruise ships in Barcelona.

1.10. Research design and strategy

This section presents the research design followed to approach the objectives and research questions of this dissertation. The research presented here intends to reflect on socio-ecological complexity and coastal ES, i.e. explore the integration of socio-ecological complexity properties, such as ecological and social interrelations, multi-scale processes, coproduction, value pluralism, uncertainty and human wellbeing dimensions within the ES framework. To do so, I carried out a systematic literature review to identify socio-ecological complexity gaps within coastal ES literature. As a result, I built a holistic framework aimed at filling the gaps identified.

I use this framework to study a highly complex and contested case study, namely the cruise ship sector in the city of Barcelona. I study the ES demanded by the cruise ship sector through the lenses of socio-ecological complexity. The research strategy I follow combines case study and grounded theory methodologies; the selection of both methodologies is motivated by the need to study the phenomenon in a comprehensive manner. Rosen (1991) argues that in order to capture all the features of complexity we will need a countless number of different

formalizations. Since that is not possible, the research strategy I follow aims to cover as many socio-ecological features as possible.

1.10.1. Objectives and research questions

The motivation for this research is both theoretical and practical. At the theoretical level this dissertation aims to understand how coastal socio-ecological complexity can be addressed by the ES framework. Similarly, this research tries to understand the limitations of ES, the current environmental mainstream framework and the consequences of these limitations. ES are a political concept, and their consolidation in the academic arena has consequences beyond academic research, as explained in 1.2. This dissertation aims to determine whether the expansion of the ES framework towards socio-ecological systems and political ecology through socio-ecological complexity can serve to revert these consequences and identify neglected trade-offs and world views (i.e. is it possible to change 'the system', in this case, market environmentalism, using some of the system tools themselves?)

In more practical terms, this dissertation emerges from the need to identify and understand the socio-ecological complex processes and interrelations of ES demanded by the cruise ship sector. The cruise ship sector is a contested sector, with multiple perspectives and interests at stake. The goal of the research methodology followed is to embrace the complexity and plurality of perspectives to provide a deep understanding of the phenomenon. Moreover, there is a lack of research of the phenomenon in the Mediterranean and in Barcelona. So this research intends to fill this gap. Thus, the broader research questions are as follows:

1- How does the current coastal ES literature integrate socio-ecological complexity?

2- What is the characterization (ES flows, coproduction and multi- and cross-scale interactions) of ES used by cruise ships?

3- How do power relations condition: a) access to ES, and b) the distribution of externalities derived from the use of ES?

With these questions in mind, the research objectives are divided into subobjectives. The first objective is to understand how socio-ecological complexity is approached by coastal ES literature. To the best of my knowledge, such a literature review has not been done before. Therefore, it is intended to contribute to coastal ES research, but also to general ES literature. Moreover, the literature review is also aimed at creating an integral framework that articulates socio-ecological complexity within ES. The further application of this framework serves to understand the limitations of ES in terms of integrating socio-ecological complexity.

The framework is applied in the case of the cruise ship sector in Barcelona's harbour. That is why the second objective of this research is to identify and characterize ES demanded by cruise ships (ships and their passengers). By characterization I mean: first, to identify where these ES are being produced and demanded, e.g., production and benefiting areas; second, to understand the coproduction process of these ES; third, to figure out multi- and cross-scale interactions, as well as emerging properties resulting from these interactions. The study of flows, coproduction and multi- and cross-scale processes allows us to understand where ES are coming from, what actors and socio-ecological components conform to ES and what scales are embedded in ES. These are necessary steps for carrying out the third objective.

The third objective is to understand how power relations condition: a) access to ES, and b) the distribution of externalities derived from the use of ES. The study of ES access requires

identification of the mechanisms through which actors have access or control access to ES, and which actors are excluded from this access. Thus, through the analysis of access it is possible to understand how actors can use ES or are excluded from it. The access analysis is complemented by an assessment of the power relations that condition the access to these ES. Moreover, I also complement the access analysis with a study of the distribution of social and environmental externalities among different actors derived from the use of ES. Thus, I aim to identify and understand inclusion and exclusion mechanisms and the distribution of externalities.

1.10.2.Research design

This dissertation is divided into three main phases, each corresponding to a different research objective. The three phases overlap in time. The first phase addresses the first research objective through a systematic literature review. The second and third objectives share methodology and methods. By means of an explanatory and revelatory case study combined with grounded theory analysis, I aim to approach both research objectives (Figure 2).

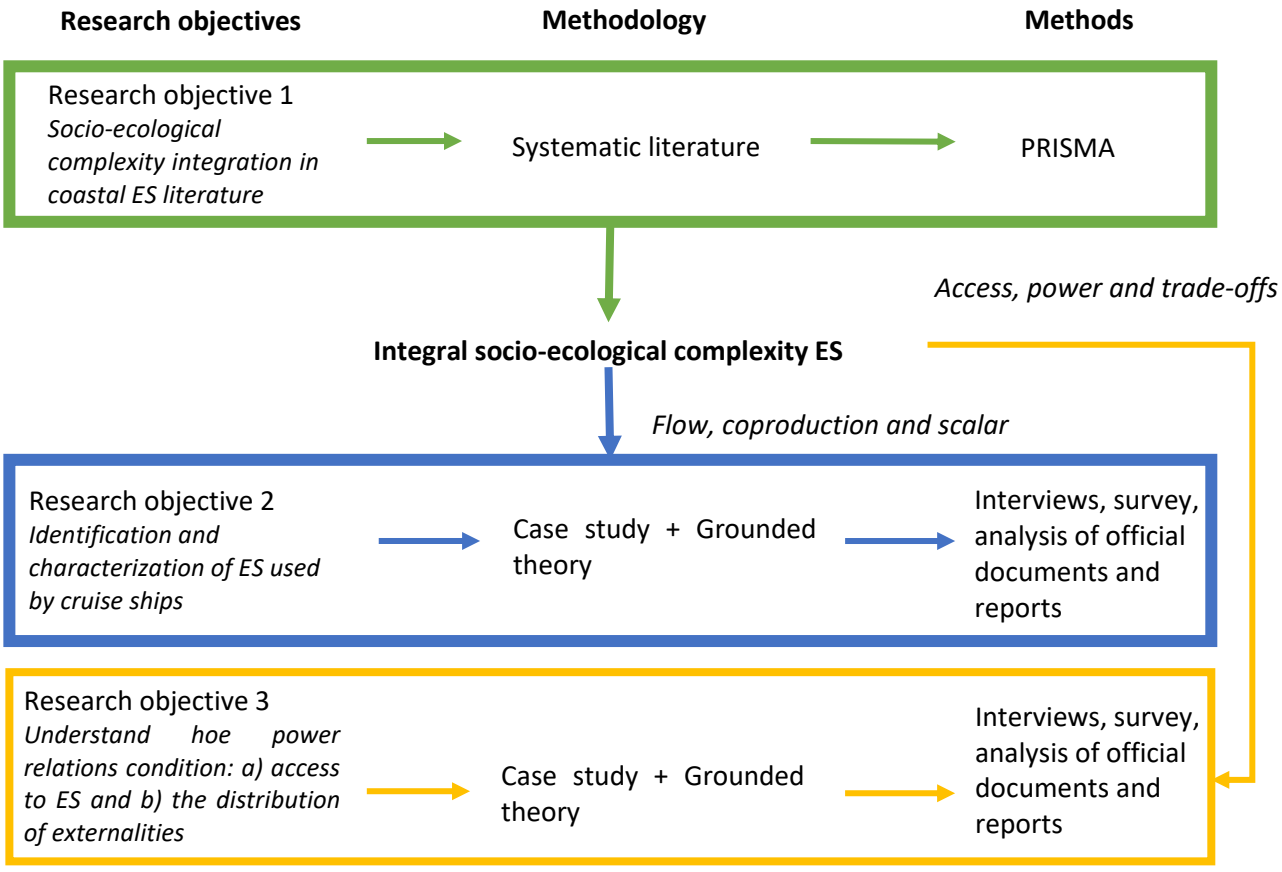


Figure 2. Research design of this dissertation. The first research objective is carried out by a systematic literature review using the PRISMA method. As a result, an ES framework that integrates socio-ecological complexity gaps is built and applied to study the second and third research objectives, both through case study and grounded theory methodology using interviews and survey as the main methods. Source: own elaboration

1.10.2.1. Objective 1. Literature review

A systematic review is aimed at critically and systematically selecting, apprising, summarizing and bringing together selected bodies of literature and the evidence presented (Petticrew and Roberts 2008, Moher et al. 2009). It has been a common method in health studies, and has recently been gaining popularity in environmental studies (Roggero et al. 2018). In the field of ES research there has also been a rise in the popularity of systematic literature reviews (Liquete et al. 2013, Harrison et al. 2014, Garcia Rodrigues et al. 2017, Hølleland et al. 2017, Czúcz et al. 2018).

The main characteristic of systematic reviews is the application of a predefined and structured method to identify, screen, select and assess literature in order to answer a specific focused question related to existing scientific literature. In other words, a systematic review allows the researcher to survey existing scientific literature using a structured method (Greenhalgh et al. 2018, Roggero et al. 2018). As a matter of fact, by being systematic the selection and analysis processes of literature reviews aim to be reproducible by others. Therefore, the processes ought to be transparent and reproducible; i.e. the selection and exclusion criteria need to be clearly defined and followed step by step. Greenhalgh et al. (2018) question the idea of systematic literature reviews being more objective and less biased than narrative literature reviews. As in the case of the scientific method, with systematic reviews a 'view from nowhere' is assumed, i.e. a neutral and impartial way of analysing (Greenhalgh et al. 2018). However, the study topic and the research questions are not framed impartially but rather defined by the researcher's (or researchers') interests and values. Also, Greenhalgh et al. (2018) argue that there is a growing assumption that systematic reviews have more scientific quality than narrative reviews. This simplistic assumption undervalues the benefits of narrative reviews. Narrative reviews provide a deeper understanding and a linked critical reflection on the topic being studied. Nevertheless, narrative reviews can be criticized because they preselect the manuscripts as a means to support their arguments.

The selection of a systematic review or a narrative review depends on the objectives of the review, and whether the researcher needs to answer a specific question or have a deeper understanding of a broader topic. For the needs of this dissertation, a systematic literature review was carried out, as the aim of the review was to answer two specific questions: 1) How is socio-ecological complexity addressed within coastal ES literature, and hence, what socio-ecological complexity aspects are addressed within coastal ES literature? 2) What human wellbeing aspects are studied, and how are they studied, within existing coastal ES literature? Furthermore, due to the nature of the topic being studied, the amount of existing literature is abundant, and systematic literature reviews are used for reviews with large number of publications, which ensures that the sample is representative.

The systematic literature review in this dissertation is carried out using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) model developed by Moher et al. (2009). The PRISMA model provides a checklist of elements to improve the transparency and robustness of the review process. The checklist consists of 27 items and a flow diagram that divides the review process into four phases. With these tools in mind, the objective of the PRISMA model is to assist reviewers in improving the robustness and reporting of systemic literature reviews (Moher et al. 2009).

Following the flow diagram of the PRISMA model, I divided our review into four different phases: identification, screening, eligibility and inclusion. The identification phase consisted

of collect articles to be reviewed. Articles were collected by a database query for a combination of keywords (Section 2.3.). The results of this query allowed me to compile a database of scientific papers indexed in Scopus during the period from 1998 to December 2017. Next, I filtered the papers to be reviewed; to this end I screened each manuscript, and I applied the eligibility criteria. Filtering is a continuous process. First, the researcher looks at titles, keywords and abstracts to exclude non-pertinent papers. In this process the reviewer might make wrong decisions and exclude papers that should be included, known as 'false negatives' (Roggero et al. 2018). To avoid false negatives, I screened titles, keywords and abstracts twice, and when doubts appeared, I screened the whole body of the paper. The remaining articles were those included in the final literature review. The data extracted from the reviewed articles were synthetized in a database using Access software. The data collected were analysed using descriptive statistics

1.10.2.2. Objectives 2 and 3: Case study and grounded theory

The research strategy applied to study objectives 2 and 3 is supported by the integration of two methodologies, namely case study and grounded theory. The integration of the two methodologies is based on the work developed by Halaweh and Kim (2012). The next sections provide a summary of the main elements of both methodologies and their combination.

Yin (2009, p.18) describes case study research as 'an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident'. The objective of choosing a case study approach is a deeper understanding of the phenomenon being studied, and hence to answer 'how' or 'why' questions posed by the researcher Yin (2009). The objective of this research is to answer 'how' questions in the case of cruise ships in Barcelona. That is why the case study research strategy is suitable for studying complex socio-ecological phenomena, such as socio-ecological complexity and ecosystem services for cruise ships, the phenomenon that I study in this dissertation.

Case studies are characterized by getting as close to the subject as possible by means of different sources of data collection, such as documents, interviews and observations. Therefore, addressing the investigation through a case study allows the researcher to triangulate evidence from different sources, thereby enabling the researcher to discover emergent results that go further than the summation of the collected data (Yin 2009). In this dissertation, different sources of data collection have been used and triangulated. Triangulation has provided more robustness to the results. Moreover, the collection of data from different sources enables reflection on the plurality of perspectives of the phenomenon studied, in this case cruise ships. Consequently, it provides a better understanding of complexity, which is one of the objectives of the research.

There are different categories of case study: exploratory, descriptive and explanatory (Zainal 2007). An exploratory case study explores a phenomenon in the data that serves as a starting point for further research, such as a pilot study. A descriptive case study describes a phenomenon using the data and a descriptive theory to endorse the portrayal of the studied aspect. An explanatory case study analyses the data in depth in order to understand and explain the phenomenon. Hence, the intention of an inductive approach explanatory case study is to find out about processes and relationships and to construct theories. The case study of this dissertation is exploratory and explanatory as it aims to expose a phenomenon

previously unexplored, as well as to understand in depth the complexity of ES and cruise ships through the lenses of socio-ecological complexity.

The nature of the case study approach raises some criticism. Critics of case studies argue that the lack of a standard analytical frame makes generalization impossible (Darke et al. 1998, Laws and Mcleod 2004), and that it is impossible to generalize from a single case study. However, these critics are reproved by Flyvbjerg (2006), who states that is not true that generalization from one case study is incorrect as it depends on how the case study is selected, and some single cases can be generalized as they serve to explain larger samples. Flyvbjerg (2006) also explains that generalization is just one form of scientific knowledge accumulation, and societies can also accumulate knowledge without generalization. Yin (2009) also refutes case study criticisms by arguing that case studies aim to provide a generalization of the analysis, and hence to make theoretical analysis generalizable. In other words, the case study objective is not to make a sample or population universal, but to build concepts and theory. From data collected in a real-life context my objective is to build theoretical arguments. Moreover, we complement the case study methodology with grounded theory, which in fact proposes a set of processes to systematize qualitative inductive research.

Glaser and Strauss developed grounded theory (GT) (1967) as a qualitative method aimed at building new theory resulting from data (Charmaz 2006). Grounded theory is defined as 'a qualitative research method that uses a systematized set of procedures to develop and inductively derive grounded theory about a phenomenon' (Strauss and Corbin 1994, p.24). GT can be summarized as the systematic analysis of documents, interviews or field notes by constantly coding and comparing data to build theory regarding the phenomenon studied (Charmaz 2006). Therefore, GT is based on an inductive, rather than deductive, approach based on systematic, iterative data collection analysis and a validation process as a means to understand the surrounding complex reality (Laws and Mcleod 2004).

The original version of GT was further developed by Strauss and Corbin (1994). The differences between two of the original authors have resulted in two different variants of GT, called the 'Glaserian approach' and the 'Straussian approach' (Charmaz 2006, Halaweh et al. 2008). The Glaserian approach, or classical approach, is characterized by the strong conviction that GT researchers should not examine any literature related to the phenomenon to be studied before starting the research (Charmaz 2006, Halaweh et al. 2008, Halaweh and Kim 2012). The lack of preconceived knowledge guarantees that the researcher does not base the investigation on preconceived ideas or assumptions, a '*tabula rasa*'. The research questions and the problem description emerge when the researcher starts coding the data (Halaweh and Kim 2012). In contrast, the Straussian approach, which is followed in this dissertation, argues that GT research has to start with a literature review to acquire some knowledge on the phenomenon studied before the fieldwork. This literature review is used to narrow down the subject of study; it guides the data collection process and it serves as a complementary validation by comparing empirical results with existing literature (Halaweh and Kim 2012). The selection of the Straussian approach was motivated by the fact that I was far away from a '*tabula rasa*' situation. I started this PhD research through a literature review on socio-ecological complexity and I was born and raised in Barcelona, the location of the case study. In addition, the harbour is a very complex space, a city within a city. Hence, I needed some guidance, in the form of a literature review, to be able to define the research questions.

Therefore, using the Straussian approach I carried out an exploratory literature review to define the research questions.

As Halaweh and Kim (2012) state, there is a similarity between the Straussian approach and the case study strategy. According to Yin (2009), a case study should start with a defined problem statement and research questions and objectives, which derive from existing literature. Furthermore, the research questions and objectives are used to guide data collection and the analysis process. Nevertheless, researchers do not have to be limited by initial research questions and objectives; they should be open to new findings and iteratively review prior objectives and theoretical assumptions (Halaweh and Kim 2012). Likewise, the Straussian approach argues that the GT researcher cannot start the investigation without any reading of existing literature on the object of study. Also, research questions help the researcher to focus on what she/he intends to study. However, as in the case study strategy, in GT it is important to acknowledge that existing literature and pre-assumptions should not act as restrictive inputs; rather, the GT researcher always needs to embrace new emerging concepts (Halaweh and Kim 2012). Moreover, Halaweh and Kim (2012) also state that GT and case study generalize and construct arguments in a similar way, as both aim to develop theories from a deeper understanding of the study object/s. In the case of GT, theory construction is based on abstraction (Strauss and Corbin 1994, Halaweh and Kim 2012). Since both methodologies coincide in fundamental aspects, their combination is possible (Figure 3). Certainly, the combination of GT and case study serves to palliate the weaknesses of case study.

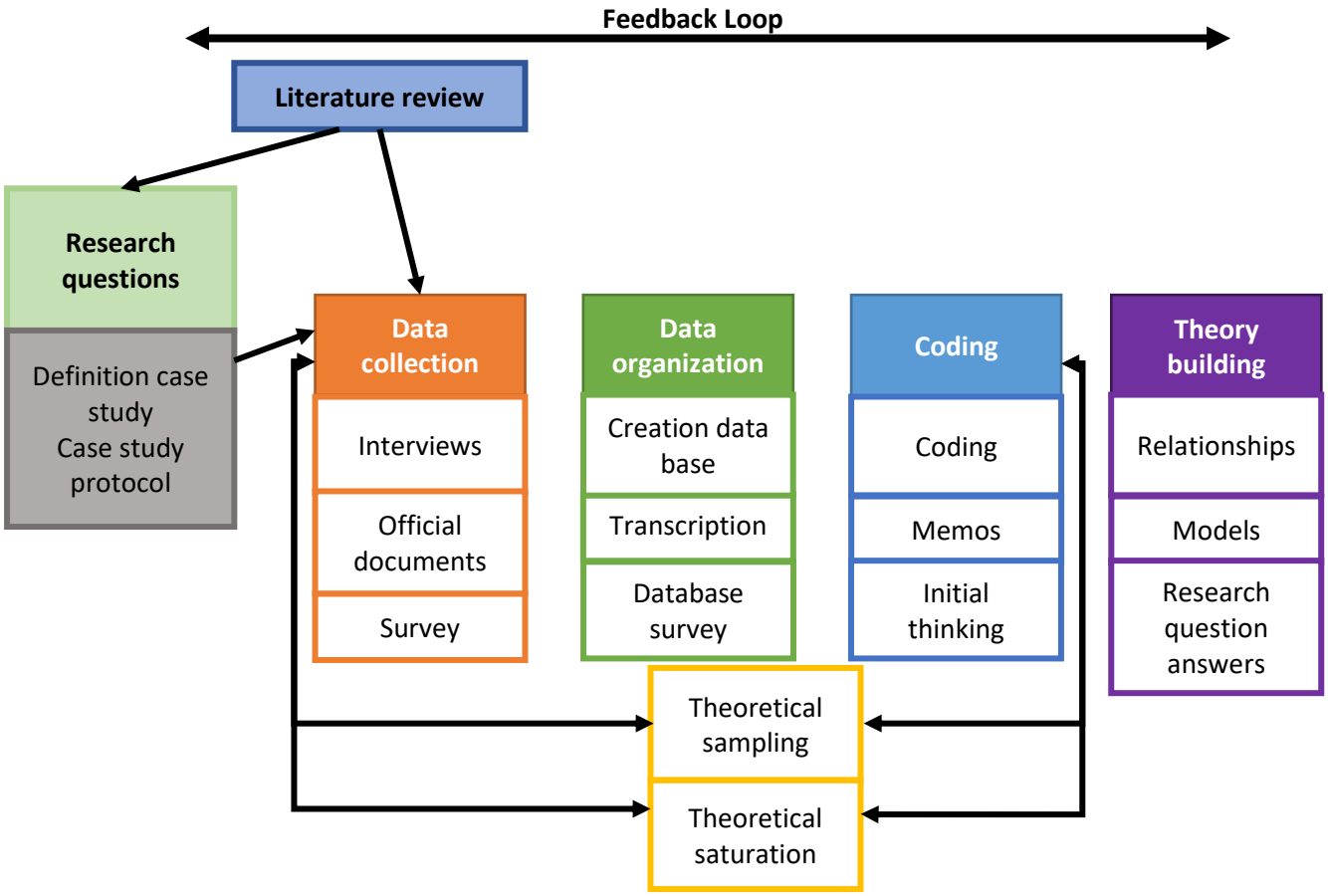


Figure 3. GT and case study merge. Methodology research objectives 2 and 3. Source: own elaboration based on Halaweh et al. (2008) and Halaweh and Kim (2012)

GT provides a systematic frame for analysing data collected. Hence, GT is used to support case study research (Halaweh and Kim 2012). Further, the necessary delimitation of a specific and bounded unit of analysis for the case study approach can limit the researcher to studying emerging issues and cross-scalar interactions and analysis (Halaweh and Kim 2012), which are highly relevant to socio-ecological complex issues as in this dissertation. GT does not stick to specific boundaries, rather moving inside and outside of the boundaries (Halaweh and Kim 2012). The openness of the boundaries is especially relevant for this dissertation. So GT provides flexible delimitation of the unit of analysis. The unit of analysis in this research is the cruise ship activity within the harbour of Barcelona, however the socio-ecological complexity of the phenomenon results in multiple flows and relations on different scales and across scales (cross-scale). Therefore, the phenomenon studied is not encapsulated within the harbour of Barcelona, but rather moves across borders and scales.

The selection of the case study is justified because of the socio-ecological complexity of coastal areas, and particularly harbours and cruise ships. Harbours are spatial fixities connected and interrelated to distant places (environments) (Ng et al. 2014). Cruise ships are temporal spatial fixities (at berth) and/or moving fixities (navigation) connected and interrelated to distant places through flows of ES, which are co-produced through multi-scale and cross-scale interrelations. Since Barcelona is the main cruise ship harbour in the region, it has been selected as an upfront case to identify and analyse ES enjoyed by cruise ships' activities and their passengers within the socio-ecological complexity frame.

Data collection techniques

Interviews, official documents and reports, and a survey of cruise ship passengers are the main data sources used for this research. The selection of interviews as a data collection method is justified because the main strength of interviews is the profound understanding of processes and behaviours that can be obtained (Babbie 2013), which is necessary for understanding socio-ecological complex processes. Moreover, they represent a flexible method that can be adjusted throughout the research and complemented with official documents and reports. However, interviews cannot provide statistical data and they are dependent on the subjective perspective of the researcher (Babbie 2013). That is why data collection in this dissertation is complemented by a survey. Surveys are useful data collection methods to describe large communities that cannot be studied directly. Hence, in this dissertation, through specifically designed questionnaires, quantitative data regarding ES demanded by cruise ship passengers are obtained.

Respondents to semi-structured interviews were selected to portray a wide-ranging spectrum of interests and knowledge concerning cruise ships, by means of the snowball sampling method. Interviews were conducted in Catalan, Spanish and English, recorded with the informed consent of the respondent and later transcribed. I followed a semi-structured questionnaire of themes to be addressed and asked. I maintained an open interview style and left the respondents enough time to give long explanations. As a result, new relations and subjects came up during the data collection phase.

Interviews were carried out between October 2017 and September 2018. Within this period interviews for data collection were carried out in two different rounds. From October 2017 until December 2017, 20 interviews were carried out. After the analysis of these interviews

and following theoretical sampling,[6] new interviews were planned. Therefore, from June 2018 until September 2018, 22 more interviews were carried out, until reaching theorical saturation (Charmaz 2006). In other words, I stopped interviewing actors related to the cruise ship sector when the answers provided repeated outcomes in relation to already collected data.

The qualitative data from interviews were complemented by the review of official documents and other collected documents and a survey of cruise ship passengers. A cruise ship passenger survey was conducted to evaluate what and how cruise ship travellers use ES. Responses were recruited via a random intercept method within harbour limits, inside a shuttle bus from cruise ship terminals to Barcelona city centre and in specific touristic spots.

Data analysis

After interview transcription, all texts were analysed and managed in NVivo 11 (QSR International Inc., Burlington, Massachusetts, USA). Data analysis in GT is a systematic process that starts with coding. Coding is a core process in GT (Strauss and Corbin 1994) and is parallel to data collection. In short, coding means 'categorizing segments of data with a short name that simultaneously summarizes and accounts for each piece of data' (Charmaz 2006, p.43). According to Charmaz (2006), coding encompasses three different steps: initial coding, focused coding and theoretical coding. Initial coding can be done line by line, as in this research, and is the process used by the researcher to ask what the data suggest, and what action the data refer to. Hence, codes should be close to actions and grounded in the data. The second step is focused coding, where codes are more directed. In focused coding the researcher uses initial codes to categorize large amounts of data. Therefore, the researcher has to decide which initial codes are more relevant to categorize the data and to the emerging concepts (Charmaz 2006). The last step is theoretical coding. This step follows the codes selected during focused coding and looks for relationships between categories as main categories to explain the phenomenon being studied.

Transcriptions were coded sentence by sentence, i.e. codes (called 'nodes' in NVivo) relevant to the research. Codes were refined or combined, creating categories and subcategories (focused coding), following the principles of grounded theory analysis (Strauss and Corbin 1994). Next, codes were related to each other and integrated into a theory, following theoretical coding (Charmaz 2006). Theoretical coding should emerge by analysing the data, avoiding preconceived idea or theories (Strauss and Corbin 1994). However, it is not possible to remove the researcher's own views and assumptions; these will be reflected in the study (Charmaz 2006), and thus it is important to recognize and make them explicit. In this research, the authors have used existing literature to complement the understanding of emerging relations and theories. Similarly, the analysis of the semi-structured interviews was complemented by the analysis of official documents and reports. The data collected through these materials reinforce categories that emerged through theoretical coding.

Throughout the process of coding the process of constant comparison occurs (Glaser and Strauss 1967), which means that the researcher constantly compares the data in order to

[6] Data collection in GT is based on the principle of theoretical sampling, which is that sampling of new data is supported by the analysis of previous data collected (Charmaz 2006, Halaweh and Kim 2012). Theoretical sampling serves to focus data collection and increase data analysis abstraction by identifying patterns and gaps that require more data (Charmaz 2006).

identify emerging concepts, patterns and hypotheses. Hence the researcher constantly reflects on the data, generally by using memo writing (Charmaz 2006). Memo writing is the intermediate step between data collection and theory construction. Writing memos is the time when the researcher reflects on the data and analyses the codes in any way it occurs to her/him (Charmaz 2006). Therefore, the researcher analyses the data in early stages of the research and develops hypotheses to be confirmed during the process. The final step in GT is the construction of a model to describe the processes behind the phenomenon being studied. Through the articulation of this model to answer the research questions, the proposed theory emerges (Figure 4).

1.11. Thesis structure

In terms of structure, this Ph.D. dissertation is structured in six chapters. Chapter 1, the introduction, presents the topics addressed in this research and locates the research within a theoretical framework. It also explains the research design, the research questions and the methods used in this dissertation. The next chapter (Chapter 2) covers the literature review. Then, the following three chapters (Chapters 3, 4 and 5) comprise the case study description and analysis. After that, Chapter 6 includes a discussion and conclusions drawn from the results.

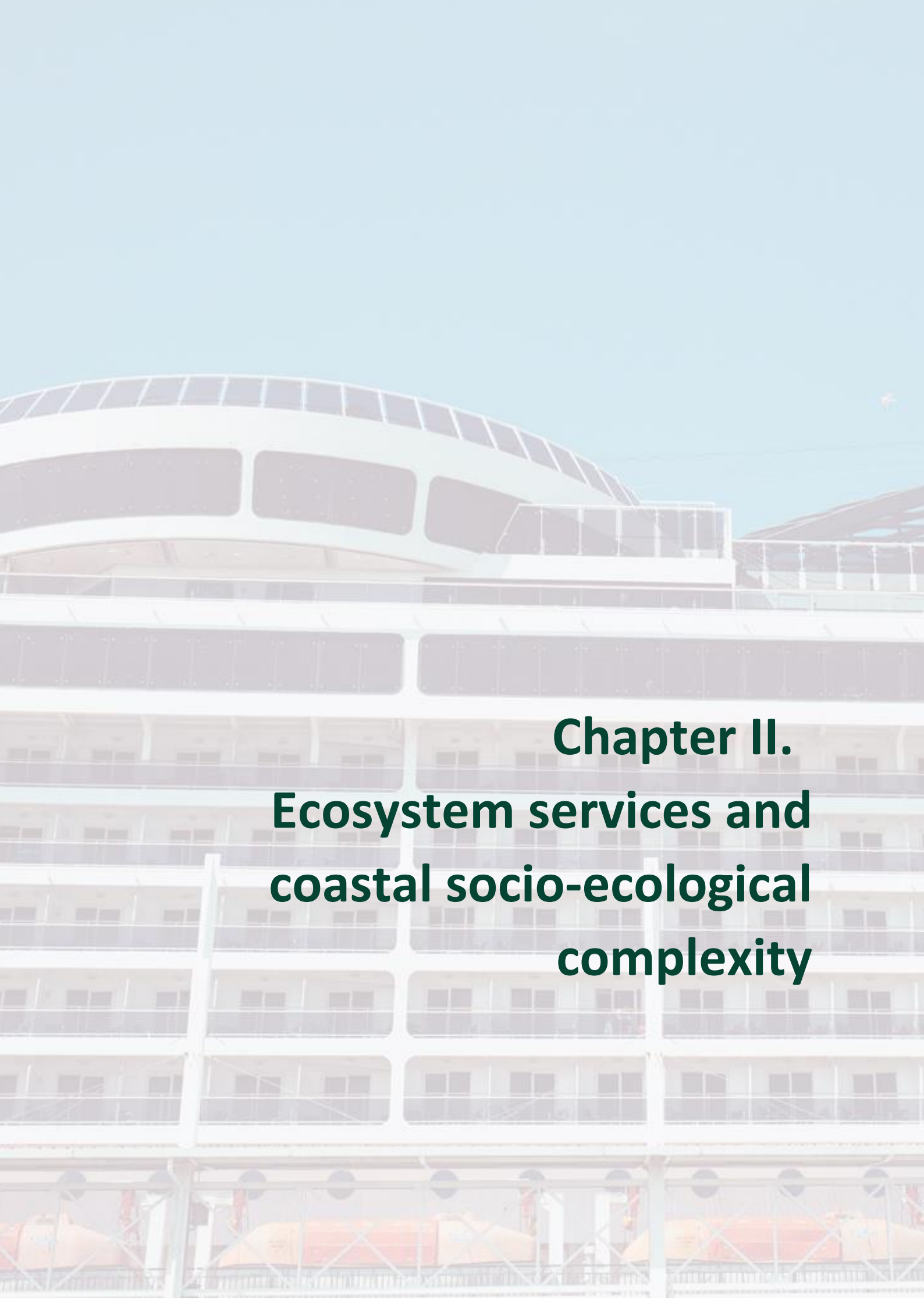
Chapter 2 reproduces the content of a paper published in the journal *Ecology and Society*, co-written with my supervisor Eduard Ariza. The paper was developed under my personal lead (i.e. I am the first author). The paper presents the results of a systematic literature review on socio-ecological complexity and coastal ecosystem services. The objective of the literature review is to understand how socio-ecological complexity is integrated into coastal ES literature. The results are structured along eight socio-ecological variables: integration of social and ecological components, coproduction of ES, institutions and governance, trade-offs and power, temporal and spatial scales, value pluralism, uncertainty and human wellbeing. The last section of the chapter reflects on the results and proposes a framework to improve the integration of socio-ecological complexity to study coastal ES.

In Chapter 3, I introduce the case study, namely the cruise ship sector in Barcelona. I start with a brief introduction to the tourism sector and how ES literature and tourism studies are connected. Second, I describe the cruise ship tourism sector, its history and its economic contribution and environmental impacts. Then, I explain the case of cruise ship tourism in Barcelona, its rise and its current situation. Finally, I describe in detail the research design of the case study.

In Chapters 4 and 5, I present the results of the case study. In Chapter 4, the results I analyse refer to transcalar processes of ES coproduction – in other words, how ES demanded by cruise ships and passengers are co-produced by different process and actors on different scales. In Chapter 5, I present the results of ES access and power relations analysis, as well as trade-offs. I explain what the mechanisms are to access ES and the power relations that underpin these access mechanisms. As a result, it is possible to identify who has access and who is excluded from ES. Moreover, I also analyse what the trade-offs derived from the demand for ES by cruise ships and passengers are. Therefore, in Chapter 5, I reveal who has and who does not have access, and who carries the costs of the demand for ES.

In Chapter 6, I summarize and discuss the overall results of the thesis. In this chapter, I relate the thesis findings to their relevance for current and future research and policy actions. I

divide this chapter into seven sections where I reflect about different aspects: the integration of socio-ecological complexity, coproduction and co-evolution processes, the links between access and power relationships, the contribution of this research to coastal management, the methodological contributions to ES research, future ES research and policy recommendations and reflections.



Chapter II. Ecosystem services and coastal socio-ecological complexity

2. Ecosystem services and coastal socio-ecological complexity[7]

2.1. Introduction

Ecosystem service research, as explained in Section 1.7, has acknowledged the importance of socio-ecological systems complexity. However, important questions remain unaddressed, as the social dimension is still under-studied in ES assessments (Geijzendorffer et al. 2015). Although there have been efforts to study how institutions and governance systems link to ES (e.g., Ernstson 2013, Spangenberg et al. 2014, Díaz et al. 2015, Berbés-Blázquez et al. 2016, Fischer and Eastwood 2016, Palomo et al. 2016, Outeiro et al. 2017), the role of humans as co-producers at different stages in the process of ES is still uncertain (Jones et al. 2016).

Improvement is needed to understand ES coproduction processes (Palomo et al. 2016), i.e. identifying and analysing the natural and non-natural components and their interactions such as knowledge, infrastructures, technology, institution arrangements, governance systems, and social representations. Hence, grasping the processes that make up a service, which are also embedded in past social and cultural legacies (Church et al. 2011, Outeiro et al. 2017). Sustainable environmental management needs to embrace the complexity of ES coproduction processes, to acknowledge when and how non-natural components assist or even substitute natural components (Palomo et al. 2016). Furthermore, from an environmental-justice perspective, because certain human inputs and processes are demanded to coproduce ecosystem services, questions arise regarding the equal distribution and access of these inputs and related ecosystem services (Fischer and Eastwood 2016).

Importantly , an influential aspect of the coproduction of ecosystem services is power (Felipe-Lucía et al. 2015). Power is embedded within institutional arrangements and governance systems, i.e. all formal and informal social organization systems and processes (Díaz et al. 2015). The interactions and feedbacks between biophysical processes and power relations embedded within institutional and governance systems (alongside knowledge, infrastructures, technology, and social representations) shape the coproduction process of ecosystems services. Power relations shape not only the coproduction of ES, but which actors or groups benefit from those ES (Ernstson 2013). For example, the creation of terrestrial protected areas has, in some cases, excluded local communities and traditional uses in favour of recreation or ecotourism (Berbés-Blázquez et al. 2016). Such management decisions and linked trade-offs respond to certain institutional arrangements and governance processes shaped by power, which define ES access and benefit distribution, i.e. winners and losers. Thus, trade-offs between different ES also lead to trade-offs between the wellbeing of different social groups (Daw et al. 2011).

Actors might have different access to ES benefits and hence to HWB, or they might hold different conceptions of benefits to HWB (Butler and Oluoch-Kosura 2006, ESPA 2018). Local fishing communities may consider symbolic spaces to be part of the benefits for HWB, while other larger fishing companies may not consider these symbolic spaces to be relevant for HWB. Furthermore, wellbeing benefits might vary depending on spatial and temporal scales. On a global scale, marine protected areas produce benefits to humanity (enhance biodiversity), but at smaller temporal and spatial scales these can have little benefit or be costly for local communities, or they might need more time to be enjoyed by local communities (Daw et al. 2016). In fact, socio-ecological systems are characterized by multi-

[7] This section has been adapted from Solé and Ariza (2019) (Appendix F)

scale and cross-scale interactions and feedbacks, and hence, ecosystem services and associated benefits can be coproduced, used, and valued, all at different spatial and temporal scales (Scholes et al. 2013). Hence, HWB is multidimensional, dynamic across time and space and context-dependent (Narayan et al. 2000, Pereira et al. 2005, Adams et al. 2016). Consequently, ES assessments cannot aggregate wellbeing, i.e. considering humanity as a homogeneous group. ES assessments need to develop a disaggregate analysis (Daw et al. 2011). They ought to account for multidimensional aspects of wellbeing among different social groups integrating intrinsic, instrumental, and relational aspects (Díaz et al. 2015) and assessing different value dimensions (monetary, ecological, and socio-cultural) (Jacobs et al. 2016, 2018). Disaggregate approaches must also include distributional spatial patterns and scale context dependencies.

HWB is maintained through the accomplishment of fundamental human needs (Max-Neef et al. 1998). These needs are constant across time and space, but the means of accomplishing them vary depending on socio-cultural contexts (McGregor 2010). Therefore, this perspective embraces wellbeing dynamism, and context and scale dependency. Max-Neef's universal needs are divided into two categories: existential (four needs) and axiological (nine needs). Existential needs refer to experiences, i.e. needs to be, do, have and interact, while axiological needs relate to values that humans hold. Hence, humans will be, do, have and interact to achieve needs that they value (McGregor 2010). Remarkably, individuals are beings of multiple and interconnected needs that work as a system. Therefore, HWB not only depends on the satisfaction of subsistence needs, but also on multiple interrelated dimensions of wellbeing: the objective, subjective, and relational dimensions of wellbeing.

All the above mentioned aspects of socio-ecological system complexity are embedded with uncertainty, which as aforementioned is an essential characteristic of socio-ecological systems (Hou et al. 2013). Uncertainty comes from different sources: these sources include the complexity of natural and social systems (inherent variability of ecological and social processes that underpin the services function), the complexity of socio-ecological interactions (variability of socio-ecological interactions that support ES provision), the complexity of values and HWB conceptions (multiple understanding of what to value and HWB), the imperfection or limitation of knowledge (how much we know and understand), the deficiency of valuations and assessment methods (every method transfers a certain degree of uncertainty to the results), and technical uncertainty (intrinsic probability of error in the results) (Grêt-Regamey et al. 2013, Hou et al. 2013).

2.2. Coastal ecosystem services and socio-ecological complexity

Coastal zones are highly complex socio-ecological systems resulting from the land and sea interface (Turner and Schaafsma 2015) (Figure 4). This interface is characterized by interactions, synergies, and trade-offs between marine and terrestrial systems, e.g., the use of fertilizers in agriculture increases productivity, but means there is a nutrient surplus flowing to the sea, producing eutrophication (MEA 2005, Turner and Schaafsma 2015). The outcomes of these interactions are the products of a vast number of important, even unique, ecosystem services that directly or indirectly underpin human activities (Zaucha et al. 2016) (Figure 4).

Coastal socio-ecological complexity is augmented by the fact that 41% of the global population lives in coastal areas, including much of the world’s poorest population and 70% of its megacities. Moreover, many coastal areas feature an outstanding peculiarity: the growing phenomenon of global tourism, which increases the seasonality of coastal activities

and zones. Many coastal areas have become important poles of economic activity during holiday periods and of low activity during non-holiday times. Therefore, within coastal areas there is a wide range of actors, activities, interests, values and human wellbeing conceptions (Bremer 2011) (Figure 4). Multiple governance mechanisms and institutions aim to administer coastal space, ruling over overlapping actors, activities, interests, values and human wellbeing conceptions and their associated conflicts. Coastal governance is characterized by its vertical and horizontal fragmentation (Powell et al. 2009, Sardà et al. 2014) (Figure 4). In addition, the abovementioned fragmentations do not usually correspond to the spatial and temporal scales of coastal-system components and processes. Very often human and ecological spatial and temporal scales do not fit, therefore there is a misfit between management scales and ecological processes (Cumming et al. 2006). For instance, land and sea might be regulated by different administrations, jurisdictions, hierarchical levels or objectives (Zaucha et al. 2016).

The complexity of coastal socio-ecological systems also generates vast uncertainty, which is intensified by the lack of or limited knowledge of coastal and marine areas (Liquete et al. 2013, Zaucha et al. 2016), and which affects our understanding of current and future marine and terrestrial interactions, synergies, and trade-offs. Consequently, there are still important knowledge limitations regarding climate-change effects, decision making, and management.

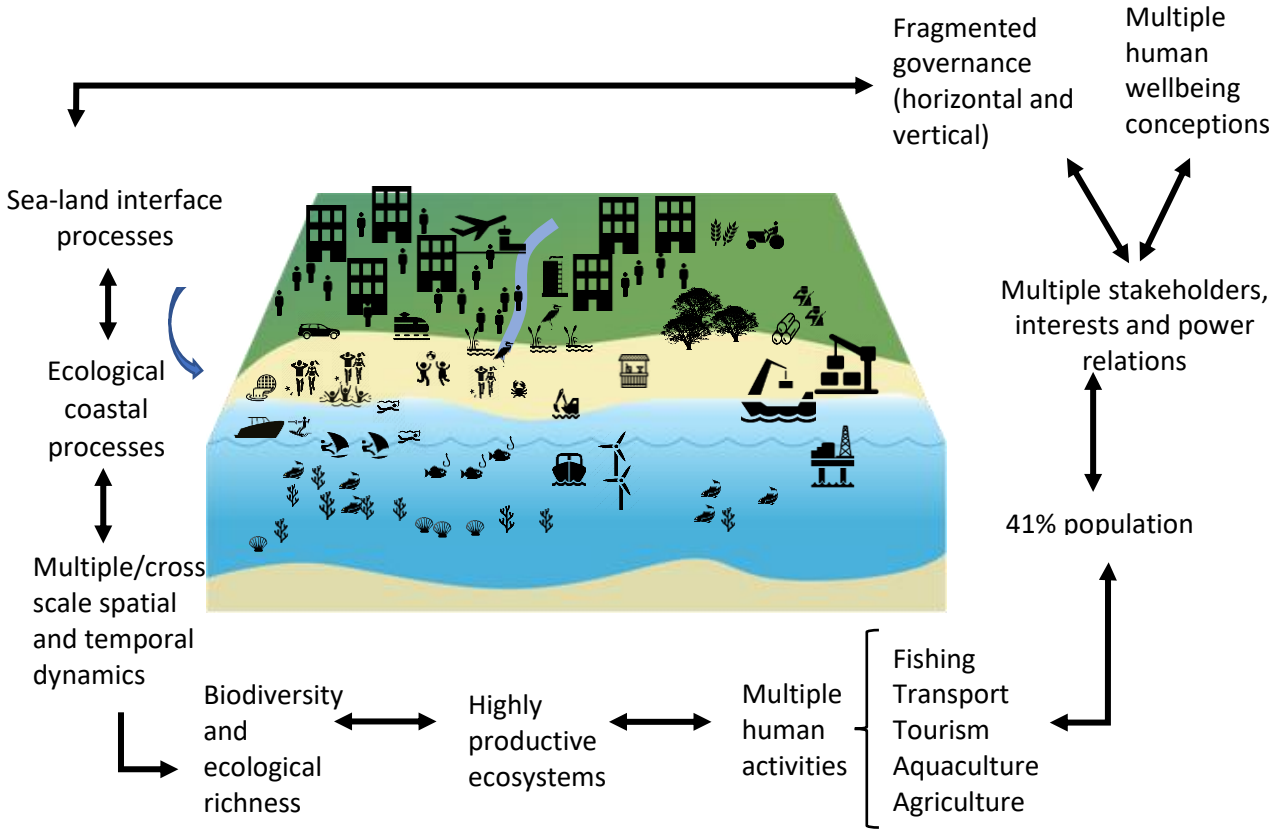


Figure 4. Coastal socio-ecological complexity. Coastal areas are complex socio-ecological systems; they are the sea-land interface where infinite and complex abiotic, biotic and social components interact on different temporal and spatial scales that generate multiple ES. Coastal ES richness provide the ground for economic, social and cultural concentration, whose effect at the same time can impact (negatively or positively) on ES. Moreover, the abovementioned concentration means multiple actors, interests, power relations and values are at stake. Thus, coastal socio-ecological systems are characterized by infinite interactions and feedback processes on different temporal and spatial scales. Source: own elaboration.

Coastal ES research informs and enables coastal management. The omission of socio-ecological complexity diminishes management debates and interventions because nonlinear interactions and feedbacks among social and ecological components are partially understood, especially stakeholders' relations, their roles, and the links to ES. In this context, coastal ES assessment poses the particular need to take socio-ecological complexity into consideration. Through a systematic literature review, we study how coastal socio-ecological complexity is taken into account within coastal ES literature by (1) analysing coastal socio-ecological complexity factors within coastal ES literature: integration of ecological and social components, ES coproduction, institutions and governance, power relations, uncertainty, spatial scales, value pluralism, and HWB links; (2) identifying gaps regarding socio-ecological complexity within coastal ES literature; and (3) proposing a framework for coastal ES socio-ecological complexity for future research by highlighting societal aspects as central components of the ES framework.

2.3. Methods

This systematic literature review follows the PRISMA statement (Moher et al. 2009) to enhance robustness. The PRISMA statement provides a flow diagram and a checklist that are both used as a guide for the review process.

2.3.1. Literature search

To identify relevant literature, a bibliographic search of the Scopus database was conducted. Only papers explicitly using the concept of ecosystem services have been considered. The bibliographical search[8] was limited to any peer-reviewed publication published from 1998 to December 2017 with the following terms in the title, keywords or abstract ("ecosystem service" or "environmental service") and ("coastal" or "littoral") and coastal habitats in all fields, including singular and plural forms of all key words. Coastal habitats were defined based on Liquete et al. (2013), EUNIS and CMECS classifications. A total of 373 papers were found, 366 after removing duplicates (Figure 5).

[8] (TITLE-ABS-KEY ("ecosystem service" OR "environmental service") AND TITLE-ABS-KEY ("coastal" OR "litoral" OR "littoral")) AND ("mangroves" OR "wetlands" OR "coral reefs" OR "litoral forest" OR "beach" OR "dunes" OR "saltmarshes" OR "seagrass" OR "littoral sedmiment" OR "coastal shores" OR "cliffs" OR "coastal mudflat" OR "machair" OR "sandy shore" OR "ledges and shores" OR "coastal lagoons" OR "Littoral rock" OR "sublittoral rock" OR "sublittoral sediment") AND ("provisioning" OR "supporting" OR "regulating" OR "regulation and maintenance" OR "cultural") AND (EXCLUDE (PUBYEAR , 2018)) AND (EXCLUDE (DOCTYPE , "ip") OR EXCLUDE (DOCTYPE , "bk") OR EXCLUDE (DOCTYPE , "no")) AND (EXCLUDE (LANGUAGE , "Chinese") OR EXCLUDE (LANGUAGE , "Spanish") OR EXCLUDE (LANGUAGE , "German"))

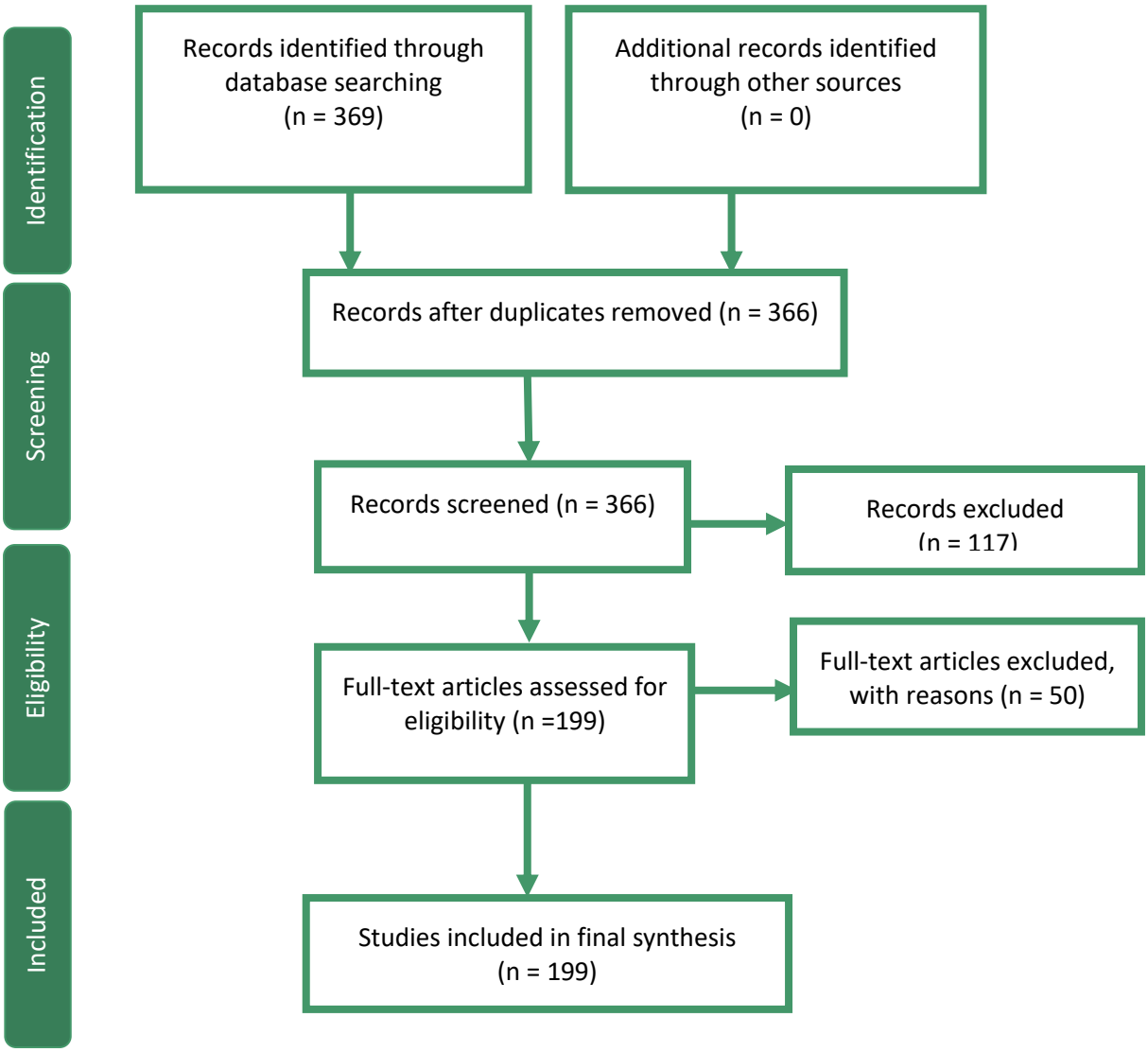


Figure 5. PRISMA flow diagram. Source: own elaboration based on (Moher et al. 2009)

2.3.2. Selection criteria

The selection criteria defined for this review were: 1) evaluate/conceptualize/map/quantify/ value coastal ecosystems; 2) publications in refereed journals; 3) publications written in English; and 4) papers located in a specific coastal area, between 1 kilometre from the upper boundary of the coastline and the outer limit of territorial waters (12 nautical miles). This boundary corresponds to the space generally included in many regulatory coastal frameworks (Ariza et al. 2016). These boundaries were set to reduce the number of papers to review due to the vast number of ES publications. Taking abovementioned criteria into account and following the PRISMA statement, titles and abstracts of 366 publications were reviewed, resulting in the rejection of 117, as they were not related to coastal ecosystem services. The next full text screening was performed, discarding 50 publications because they use the term ecosystem service as justification or introduction (for example in the first sentences of the abstract or introduction, to contextualize or justify environmental research) without addressing the issue. ES has become a modish concept and is often cited as a reason for the research or as a fashionable keyword, but without being particularly applied or assessed (Liquete et al. 2013). The total final number of articles was 199 (Appendix B).

2.3.3. Data collection and analysis

The data in the systematic review included thirty variables and their corresponding response categories (Table 2) to assess the socio-ecological complexity of coastal ES. One of the variables analysed is HWB. To that aim we use the Max-Neef matrix (Max-Neef et al. 1998), since it provides the necessary tools to analyse wellbeing as multidimensional, dynamic and context and scale dependent. It is composed of nine axiological human needs, namely, subsistence, protection, affection, understanding, participation, leisure, creation, identity and freedom, and four existential categories of human needs, namely, being (qualities), having (things), doing (actions) and interacting (settings). Using the abovementioned categories, Max-Neef created a 36-cell matrix. Each of these cells is completed with satisfiers, processes by which people can achieve axiological and existential needs. The data collected was analysed using descriptive statistics. A table was made to summarise the results (Appendix A).

Table 2. Data variables and categories for data collection

	Definition	**Variables**	**Categories**
General information	Paper's descriptive and contextual information	Year	e.g., 1999; 2003
		Author	e.g., Barbier; Costanza
		Institution of 1st author	e.g., Cardiff University; University of Wyoming
		Country of 1st author's institution	e.g., USA; Denmark
		Location of the study	e.g., France; USA
		Costal ES	e.g., provisioning; regulation and maintenance; cultural
		Coastal ES category	Classification by Liquete et al. (2013) that integrates and harmonizes most common classifications, and provides a cross-reference table. e.g., food provision; climate regulation; recreation.
		Type of habitat	e.g., dune; beach; mangroves; seagrass
		Type of study area	e.g., coastal; marine; terrestrial
Ecological and social systems	Links between ecological and social components of socio-ecological systems.	Does the article assess the cascade-model components?	Capacity as the potential of an ecosystem to deliver an ecosystem service (Villamagna et al. 2013, p.116). Flow as service in point of fact received by people (service delivered) (Villamagna et al. 2013, p.116). Benefit as contributions to aspects of human wellbeing (Potschin and Haines-Young 2016). Value as the criteria used by people to assign importance to things (Potschin and Haines-Young 2016).

(continuation Table 2)

		Does the article explicitly assess demand?	Demand as the total amount of service needed or desired by society (Villamagna et al. 2013, p.116).
		Does the article assess the differences between capacity, flow and demand?	Assessment of (un)sustainable uptake or (un)satisfied demand of ES (Villamagna et al. 2013, Baró et al. 2016).
Coproduction	Contributions of natural and non-natural inputs to the provision of ES. These contributions take place in the present and throughout time (heritages of past and present societies) (Church et al. 2014, Outeiro et al. 2017).	Historical analysis	Yes; No
		Time frame	Long term (+1 year). Medium term (- 1 year). Short term (1 month or less)
		Does the paper study drivers of change affect coastal ES	e.g., land use change; urbanization; eutrophication; overfishing
		Does the paper link coastal ES to legislative frameworks, institutions, knowledge, technology and values?	Yes; No
Institutional arrangements and governance systems	All structures and process of social organization. Institutions include all formal and informal human relations and structures that define human behaviours. Governance systems are interacting bundles of institutions at different spatial scales (from local to regional) (Díaz et al. 2015).	Identification of actors involved	Yes; No
		Does the article identify and analyse institutional arrangements (formal and informal)?	Yes; No
		Does the article identify and analyse institutional governance systems?	Yes; No
		Does the article study links between institutions or governance structures and coastal Es in terms of supply, delivery, use and access	e.g., property rights of specific areas; traditional agreements between local communities to access certain ES or areas.
		Does the article identify and analyse conflicts between informal and formal institutional arrangements	informal agreements between coastal local communities vs. national regulations limiting fishing activities

(continuation Table 2)

Power relations	Unequal power relations support the production, distribution and access of ES (Berbés-Blázquez et al. 2016); i.e. which actors have access to ES and how they benefit from them, what interests are prioritized or excluded, what values are at stake and also how value preferences are defined.	Identification of actors involved	e.g., Fishermen, tourists, inhabitants
		Does the article analyse the power relations between the actors?	Yes; No
		Identification of conflicts and trade-offs within coastal ES	e.g., negative impacts of energy production on aesthetics; negative impacts of aquaculture on coastal protection
		Does the article analyse the prioritization of values and interests?	Yes; No
		Does the article analyse actors' access to the benefits of coastal ES?	e.g., large fishing companies vs. small fishing companies; private access vs. public access, social groups that benefit from coastal protection vs. social groups that deal with negative effects
Temporal and spatial scales	ES are produced, supplied, used, managed and valued at a variety of spatial and temporal scales. Need for multi-scale and cross-scale analyses; Multi-scale conducts the assessment at two or more separate scales. Cross-scale analysis conducts a multi-scale assessment studying cross-scale interactions.	Spatial scale	Local as social or ecological community. Regional as part of a country with similar social or ecological features. National as national borders. Supra-regional as part of the world with similar social or ecological features. Supranational as more than 1 country. Global as worldwide.
		Time frame	Long term (+1 year). Medium term (- 1 year). Short term (1 month or less)
		Are multi-scale analyses performed?	Yes; No
		Are cross- scale analyses performed?	Yes; No

(continuation Table 2)

Value pluralism	Value pluralism aim for an inclusive approach to represent the diversity of the values held by different stakeholders, throughout diverse valuation approaches and methods (Díaz et al. 2015, Jacobs et al. 2016, Martín-López et al. 2014).	Types of valuation	Monetary, environmental and sociocultural values classification, based on Gómez-Baggethun et al. (2014). Monetary as assessments using money as a measurement unit. Environmental as assessment of ecological function, processes and components for ES p, also assessment of inherent value of biodiversity and ecosystems. Sociocultural as non-monetary methods to assess spiritual enrichment, cognitive effects, recreation, aesthetic experience and people's preferences regarding ecosystem service.
		Methodology for costal ES valuation	e.g., hedonic pricing, indicators, travel cost method
Uncertainty	Uncertainty 'as any departure from the unachievable ideal of complete determinism'(Walker, 2003, p.8). Funtowicz and Ravetz (1990a) state that uncertainty drives from inadequate information, due to three different reasons: inexactness, unreliability, and border with ignorance (Funtowicz and Ravetz 1990) . Nevertheless, new knowledge might either reduce or rise uncertainty, as in complex processes it can expose unknown or hidden uncertainties (Walker and Haasnoot 2011, Walker et al. 2003).	Does the paper assess uncertainty?	Yes; No
		Types of uncertainty	Technical as state of affairs in which possible outcomes are known and the probabilities associated to such results can be calculated (Kovacic 2015). Methodological as imperfection of valuation methods used for costal ES assessments. Epistemological as imperfection of our knowledge(Walker et al. 2003). Ontological as the inherent variability and complexity of socio-ecological systems (Walker et al. 2003).
Human wellbeing	HWB is sustained by the accomplishment of fundamental human needs (Max-Neef et al. 1998).	Which needs and satisfiers of human wellbeing are considered?	Max-Neef matrix (Max-Neef et al. 1998) of human needs. Nine axiological human needs - subsistence, protection, affection, understanding, participation, idleness, creation, identity and freedom- and four existential categories of human needs -being (qualities), having (things), doing (actions) and interacting (settings)- .

2.4. Results

Since 2006, there has been an exponential increase in assessments of coastal ES, which have mainly focused on provision and regulating services (Liquete et al. 2013). Furthermore, assessments of coastal ES have targeted ecological and economic aspects, commonly through quantitative analysis. Our results show that even though these features of ES assessments are still valid, there are some changing trends; an increasing interest in cultural services, mainly in recreation services, whereas symbolic and aesthetic values and cognitive effects are often omitted or relegated to the background. The literature review also reveals a growing interest in the social aspects of ES, such as the human impact on ES conditions and rising qualitative and mixed analyses (combining quantitative and qualitative methodologies), including participatory approaches and upward efforts for ES mapping.

The abovementioned changes open coastal ES research up to multidisciplinary and interdisciplinary research, embracing manifold scientific disciplines, particularly social sciences, and new methodologies. These have been fundamental changes in the study of the socio-ecological complexity of coastal ES. However, the results prove that, largely, coastal ES research has yet to capture coastal socio-ecological complexity, especially the role and interactions of non-natural components and the links between ES and HWB.

2.4.1. Integration of social and ecological components

The analysis of the cascade-model categories for the articles reviewed demonstrates that, generally, assessments of coastal ES focus their attention on capacity and value, while flow and benefit received less attention (Figure 6). Consequently, value and capacity are the most common aspects of provisioning services; this is the case of food provision (fishing and increasingly also aquaculture) or biotic materials (mangrove wood). In the case of regulating and maintenance services, the articles target the capacity assessment and values of, especially, water purification, climate regulation, lifecycle maintenance and coastal protection. Within cultural services, the value part of the cascade-model is the focal point, most commonly for recreational services. Other cultural services, such as cognitive effects, aesthetic values and symbolic services are also addressed through the value category. Therefore, in this review, the main gaps identified regarding ES cascade-model components are capacity for provisioning and cultural services and the flow and benefit of provisioning, regulating and maintenance, and cultural services.

Demand is another missing aspect in scientific papers on coastal ES, (considered only in 3% of the papers analysed). Capacity, flow and demand assessments are needed in order to understand (un)sustainable uptake and (un)satisfied demand (Geijzendorffer et al. 2015, Wei et al. 2017). Nonetheless, the links between capacity, flow and demand are also dynamic and complex. (Un)sustainable uptake and (un)satisfied demand can be modified through technology (Rieb et al. 2017), or forms of social organization (Wei et al. 2017), hence through dynamic loops of coproduction.

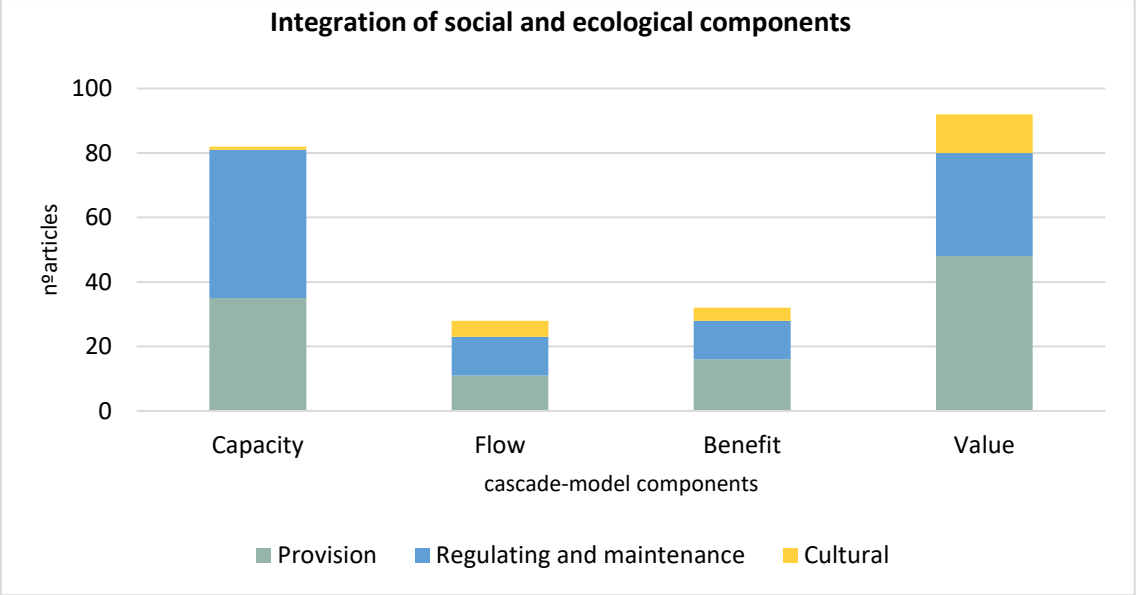


Figure 6. Integration of social and ecological components between 1998-2017, sample of 199 papers. The graph represents how many articles address each of the cascade-model components (capacity, flow, benefit, and value) by ecosystem services (ES) general categories (provision, regulating and maintenance, and cultural). Capacity and value receive more attention, whilst flow and benefit received less attention. Source: own elaboration.

2.4.2. Coproduction

The revised articles did not completely embrace the complex and dynamic loops of coproduction. First, the temporal perspective, highly relevant in coproduction processes, is included only in some of the papers, mainly through medium-term scales, and exceptionally, through short-term and long-term scales. In many cases, it refers solely to temporal evaluation of the ecological status for specific ecosystems and the link to coastal ES capacity (i.e. the links between the ecological integrity of fisheries for food provision, or wetlands and salt marshes for water purification, or mangroves and other biotic structures for coastal protection, or nursery habitats for lifecycle maintenance or marine biodiversity for recreational services). However, the functional link between ecological integrity and ES capacity is not entirely understood, due to ecological complexity and lack of data, especially in the case of marine ecosystems (Liquete et al. 2013, Maes et al. 2013). Furthermore, these papers assess the ecological integrity of coastal ecosystems, but overlook the interplay with social components. Second, there are papers that do take into consideration coproduction by socio-ecological interaction. In this regard, a common approach is the study of land-use evolution, as an illustration of social components, and the effects on ES capacity. Some examples are changes in land and use in mangrove forests and ES capacity for wood production, or land-use evolution in wetlands or saltmarshes and water purification capacity. Again, there is a gap in knowledge regarding the link between land use and ES provision, i.e. the functional relationships between land use and ES are still imprecise (Maes et al. 2013). In addition, this approach reduces the complexity of socio-ecological systems, as land use is one of the multiple expressions of socio-ecological systems, rather than a static one. Moreover, the papers describe changes in land use, but none provides an analysis of the socio-ecological processes behind these changes. Very few papers consider socioeconomic aspects, such as demographic trends or economic growth, as factors of coproduction. Thus, the reviewed

papers apply a descriptive approach rather than an analytical one. Third, other papers have aimed to integrate coproduction by studying the relationships between human impacts (overfishing, nutrient inputs, global warming) on coastal ES, such as articles applying the DPSIR framework. These papers partly integrate the complexity of coproduction, as they reduce socio-ecological complexity to linear causal relations (Gari et al. 2015). Fourth, fundamental aspects of coproduction such as the role of institutions and governance systems, knowledge, technology, socio-historical legacies, man-made structures and non-material interactions (Reyers et al. 2013, Felipe-Lucía et al. 2015, Fischer and Eastwood 2016, Palomo et al. 2016) are not commonly embraced in the reviewed papers. The link between institutions and governance systems and coastal ES is rather unexplored; some papers describe existing legislative context but without accounting for its relations to coproduction. Another often unexplored aspect is the role that man-made structures play. Man-made structures, such as waterfronts, harbours, dikes, breakwaters, wind energy farms and artificial reefs, provide coastal ES, but at the same time replace previously existing natural structures that also provided coastal ES (Garcia Rodrigues et al. 2017). Likewise, the roles of technology or knowledge in coproduction are not assessed either, such as value and value preference. Last, regarding the effects of socio-historical legacies, the reviewed papers did not seek to understand how past choices create path dependencies for the contemporary context.

2.4.3. Institutions and governance

Institutions and governance are not central elements of costal ecosystem assessments. Nevertheless, some papers aim to include institutions and governance from a legislative perspective, explaining principal policies and policy bodies, although without studying the relations with coastal ES capacity, flow or benefit. The links between ES and institutional arrangements and governance systems are poorly understood. Only a few papers identify and analyse actors, their institutional arrangements (formal and informal), their conflicts and decision-making processes. However, the literature reviewed does not assess how institutional arrangements and governance structures shape coastal ES supply, delivery, use and access, as the conflicts between informal and formal institutional arrangements (informal agreements between coastal local communities defining spatial borders over fishing areas, formal agreements between governance structures limiting fishing activities over certain areas without considering local communities' agreements). Coastal ES frameworks acknowledge the relevance of governance and institutions; however, this is not translated into ES assessments. ES assessments need more guidance and effort to link governance and institutions to ES. Although the link is still unclear, several articles (30), make policy recommendations.

2.4.4. Trade-offs and power

Trade-offs are frequently cited in coastal ES literature, such as those between food provision and water purification in wetlands, or biotic material and costal protection in mangroves, or recreation and tourism and lifecycle maintenance. The identification of trade-offs and the actors involved are increasingly more common in the reviewed coastal ES literature, but their assessment is less frequent. Hence, although an increasing number of papers identify trade-offs and the actors involved, they do not analyse them. Furthermore, in some cases, the approach concerns conflicts regarding ecosystem use, rather than trade-offs within coastal ecosystem services. The most common example of conflicts regarding ecosystem use is aquaculture versus other traditional uses of mangroves. The papers also identify conflicting

situations between anthropic impacts on coastal ecosystems and coastal ES. For example, how the urbanization of dunes obstructs coastal protection and lifecycle maintenance services. Similar to trade-offs, actors are identified but the conflicts are not actually analysed.

Although trade-offs and conflicts are acknowledged and mentioned, very few case studies assess them or—consequently—aim to understand the forces and dynamics behind them. As a result, few papers study power relations between actors and how they affect coastal ES, access to them, benefit distribution and value prioritization.

2.4.5. Temporal and spatial scales

Time and space are other overlooked aspects in terms of scale in the reviewed papers. The manuscripts typically locate the analysis on one singe spatial scale, particularly local and regional scales, and to a lesser extent, the national, supra-regional and in some cases global scales. However, there has been very little work that has combined different spatial scales, thereby understanding the spatial differences and trans-scalar interactions of coastal ES. Multi-scale and cross-scale assessments are not common, only a few examples can be found for services such as climate regulation, coastal regulation and food provision, which consider the local and regional scale in their assessments, but do not assess the interaction between the different scales. In terms of temporal scale, the articles also locate the analysis on one single scale, particularly medium-term, with very few exceptions focussing on short and long-term and multi-scale assessment for regulating services.

The review also recognised a relevant gap regarding spatial and temporal issues of coastal ES, as the temporal and spatial pathways of coastal ES are barely studied; coastal ES, capacity, flow and demand might have different spatial locations and time frames. Local demand for ES is sometimes met by ES being provided in distant places (Rieb et al. 2017), yet the coastal communities might bear the costs of distant benefits in time and space, e.g., the air purifications service provided by mangroves through carbon sequestration is produced locally or regionally but delivered globally.

2.4.6. Value pluralism

Monetary and environmental valuations are the most common type (Figure 7). However, the results demonstrate an increase in sociocultural value assessments since 2012 (Figure 7), particularly for cultural services in the form of rankings. Value assessment of provision services is mostly featured by defining monetary values and methods: market values of fisheries and aquaculture products, jobs and income provided by fishing and aquaculture activities, the market price of mangrove wood, employment and income created by wood extraction, or costs of water consumption and irrigation. Ecological valuations are also relevant, especially for food provisioning as a means to study biophysical processes and ecological functions that support service provision. Very few articles have studied the sociocultural values of these services (the few exceptions to this assess actors' preferences and social values regarding fishing and mangrove exploitation).

In the case of regulating and maintenance services, monetary—particularly—and environmental valuations are again the most common assessments of services such as water purification, morpho-dynamic coastal regulation, climate regulation and lifecycle maintenance. In the case of monetary valuations, this focusses on avoided costs of property damage and the market value of carbon. Furthermore, in some cases there is confusion between the value of the regulating service and the support or benefit for other services or

activities. For example, water purification is in many cases valued as a benefit or cost for fishing, or even lifecycle maintenance services are valued as a means for supporting recreation. Sociocultural valuations are less commonly applied, although there are some exceptions regarding actors' preferences for coastal protection and lifecycle maintenance. For example, some papers aim to assess the recreational and aesthetic values of marine biodiversity.

The most common valuations of cultural services are monetary and sociocultural. For recreation services, monetary valuations are more common (economic value, income, jobs) than sociocultural valuations. However, sociocultural values are also considered, such as perceived benefits and preferences by practitioners of tourism and recreation. Similar aesthetic services are valued in monetary terms, typically sea views and coastal landscape beauty. Nevertheless, the sociocultural values of aesthetic services are also considered, for example by assessing the public preferences and social perceptions of beach users. Cognitive effects are also assessed by monetary and sociocultural values, commonly evaluated through the monetary value of research (e.g., financial expenditure, research funds), social perception and valuation of education and cognitive processes (e.g., perceived benefit for education). Likewise, very few papers explore the sociocultural values of symbolic services such as spiritual, religious and social relations, cultural heritage or sense of place.

Sociocultural valuations are established by ranking methods to study stakeholders' priorities concerning coastal ES. Stakeholders individually or collectively express their preferences and perceptions on coastal ES via surveys, interviews, focus groups or other participatory methods. It was noted that the most common method of sociocultural valuations is surveys, which is not an open and inclusive method, as answers are highly restricted and might be subject to the values and perceptions of the researcher/s. In addition, results have proven that the most questioned actors are politicians and experts, as well as recreational users and tourists in the case of recreation-service valuations. Therefore, local stakeholders and communities are commonly excluded from such rankings.

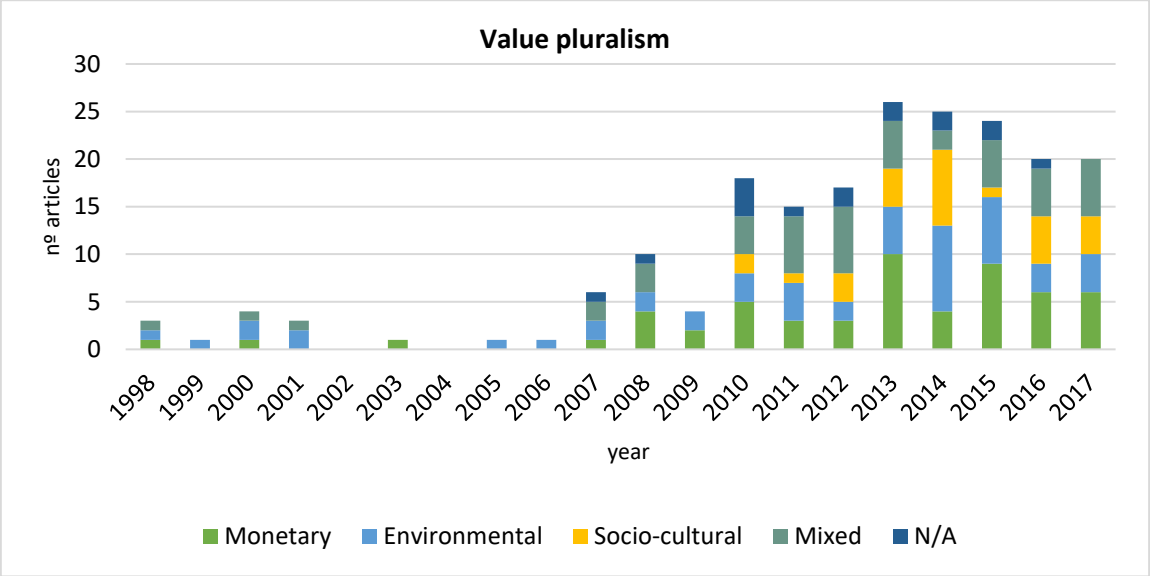


Figure 7. Number of papers and typology of assessed values per year, between 1998-2017. Sample of 199 papers. The graph shows the number of articles and type of assessed values per year, from 1998 to 2017. Monetary and environmental valuations are the most common type. Source: own elaboration.

2.4.7. Uncertainty

The revised literature makes occasional reference to uncertainty. However, in many such cases it is not assessed or quantified, except for *technical* uncertainty (i.e. quantification error), which usually does carry out this assessment or quantification. In some cases, methodological uncertainty is discussed. Specifically, papers discussing this are concerned with methods for the economic and cultural assessment of coastal ES, ecological assessment of regulating services in marine ecosystems, mapping coastal ES and the temporal dynamics of coastal ES. In these cases, uncertainty is acknowledged, but generally not assessed.

Epistemological and ontological uncertainty is mentioned only very exceptionally. Manuscripts also refer to epistemological uncertainty in terms of the lack of knowledge regarding ecological, and to a lesser extent, complex social processes—such as synergies, spatial and temporal dynamics and value preference. The aforementioned uncertainty could also be ontological, since a greater effort to create new knowledge might not reduce uncertainty, but rather increase it. Complex socio-ecological systems are characterised by an inherent ontological uncertainty (Biggs et al. 2015), due to their own complexity and variability, which is not analysed in the reviewed manuscripts. Very few articles have considered or assessed the inherent uncertainty of socio-ecological complexity, apart from some exceptional cases that cite the complexity of cultural services.

Results show that many papers discussing uncertainty use or conceptualize participation as a method to approach this. Uncertainty is also a fundamental factor in decision-making (Walker et al. 2003, Chisholm and Wintle 2012, Schlüter et al. 2012, Biggs et al. 2015).

2.4.8. Human wellbeing

Few articles have explicitly studied the role of socio-ecological system complexity in ES and HWB links, namely how complex socio-ecological processes determine HWB through access, social and individual conceptions of wellbeing, and spatial and temporal context. HWB and ES linkages need to be further studied in assessments of coastal ES, such as how different social groups conceptualize HWB and satisfy their HWB needs in coastal areas.

By using the Max-Neef matrix (Max-Neef et al. 1998), this review has identified the needs and satisfiers that are most commonly addressed by the reviewed articles; those that refer to having material aspects related to subsistence, protection and recreation, such as food, work, dwelling and recreation (Figure 8). The papers also mention interacting needs for subsistence, protection and recreation by addressing, from a materialistic perspective, satisfiers such as living space, dwelling, seascape and coastal landscapes. Contrarily, non-material aspects of subsistence, protection and recreation are not commonly addressed. In terms of subsistence, a fundamentally missing HWB aspect is adaptability. Humans need to develop adaptability and resilience to frequent and unexpected changes, especially taking into account the socio-ecological complexity and effects of climate change on coastal areas. Other fundamental but rather unexplored HWB dimensions of subsistence needs are physical and mental health and social setting. Social setting is also unexplored, but essential, as humans do not live as isolated individuals, but in socially interacting communities.

The protection of coastal areas is especially relevant for HWB. Although coastal areas are particularly vulnerable and affected by natural hazards, some strategic satisfiers are missing from the reviewed analysis: adaptability, insurance systems, cooperation and planning. Protection from hazards requires adaptability, insurance systems and the rights of those

affected and the need for cooperation, planning and help in order to cope with natural hazards. Similarly, recreation has become a key issue on coastal areas, as they are central spaces of recreation and leisure. The studied coastal ES literature has focused its attention on material satisfiers. However, the important dimensions of leisure and recreation are not only material, but also non-material, such as: curiosity, lack of worry, tranquillity, privacy. For example, the curiosity experienced by discovering new coastal cultural services, such as landscapes, or the tranquillity that might be experienced on a peaceful beach. The abovementioned aspects of HWB are frequently unexplored issues.

Furthermore, a remarkable gap regarding HWB is the absence of assessment of the needs of understanding, participation, creation, identity, affection and freedom (Figure 8). Even when these needs are researched, it is mostly to refer to material aspects of HWB. Understanding needs are approached through countable satisfiers (educational policies, schools and universities), while omitting being and doing from individual and collective cognitive processes (critical conscience, receptiveness, study), and omitting informal spaces for understanding (groups, communities, family). Participation needs and satisfiers are also rarely considered in scientific literature on coastal ES, although some exceptions are found. These articles mention having rights and responsibilities, or the integration of actors in organizations.

The literature on coastal ES proposes a somewhat restricted view of this by solely referring to creation through having skills and work, while other satisfiers are excluded, such as imagination or inventiveness. Likewise, the reviewed literature provides a partial vision of identity. It discusses identity components, such as symbols, language, religions and values. But some of the satisfiers that were found to be missing are related to acknowledging identity, such as sense of belonging, or differentiation. Finally, the revised scientific literature did not address the needs for affection and freedom. Affection refers to social bonding and cooperation, which are important within coastal spaces as multiple actors and social relations are at stake. Furthermore, freedom features such as autonomy and temporal/spatial plasticity are also significant but ignored satisfiers. Autonomy is a fundamental satisfier for coastal communities, as they must be able to control decision-making and management. Temporal and spatial plasticity is expressly relevant for coastal communities since coastal socio-ecological systems are highly reliant on temporal and spatial dynamics. Freedom and its satisfiers should not only be considered a means for coastal management, but also as individual and collective ends in themselves. Actors might hold different values and preferences, which may be conflicting, but all of them must have the freedom to defend what they stand for.

The review has also shown that satisfiers identified in the literature are generally material, while non-material satisfiers are overlooked. Logically, material satisfiers, such as food, may be considered vital for human subsistence. Coastal management and coastal ES literature have been characterised by addressing humans and their wellbeing as uniform elements. They have been approached commonly from materialistic perspectives, rather than from the more inclusive alternatives of human needs and dimensions of wellbeing; their interactions, their nested properties and constant transformation. Thus, important gaps are still present in the literature that hinder the basic understanding needed for sustainability.

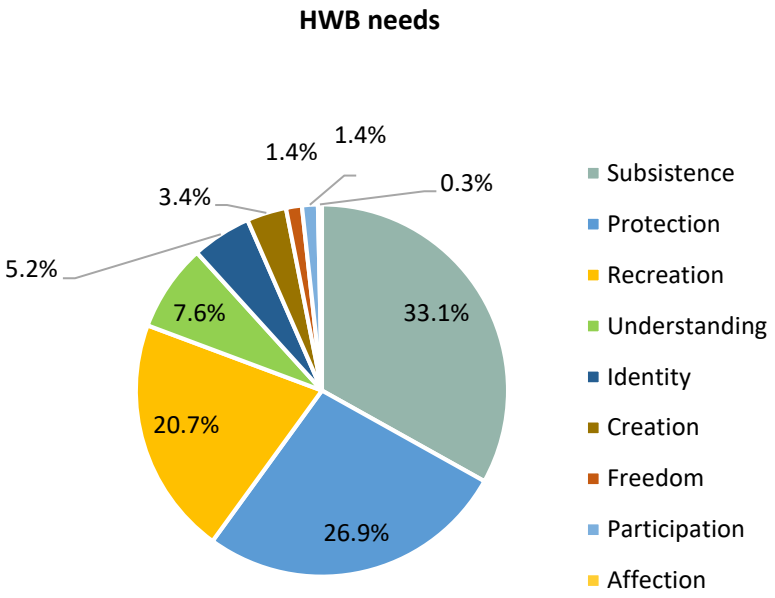


Figure 8. Percentage of human wellbeing needs assessed by 199 articles reviewed (1998-2017). The graph represents the number of manuscripts that address each human wellbeing (HWB) axiological need defined by Max-Neef et al. (1998): subsistence, protection, recreation, understanding, identity, creation, freedom, participation, and affection. Source: own elaboration.

2.5. Discussion

This literature review has identified important gaps in costal ES research (Figure 9). First, the lack of integration as regards ecological and social components; particularly, the analysis of cascade-model components shows that flow and demand are significantly missing components. Second, a partial understanding of coproduction as fundamental aspects of coproduction are not embraced (institutions and governance systems, knowledge, socio-historical legacies, social representations, technology and infrastructures). Third, how power underpins coproduction, trade-offs and access and distribution of ecosystem service benefits. Fourth, the lack of assessments that combine different scales, such as multi-scale and cross-scale assessments. Fifth, a gap concerning the intrinsic and relational dimensions of HWB, as well as an understanding of HWB distribution among social groups. Sixth and finally, a lack of uncertainty assessment, which receives only partial and superficial treatment in coastal ES research.

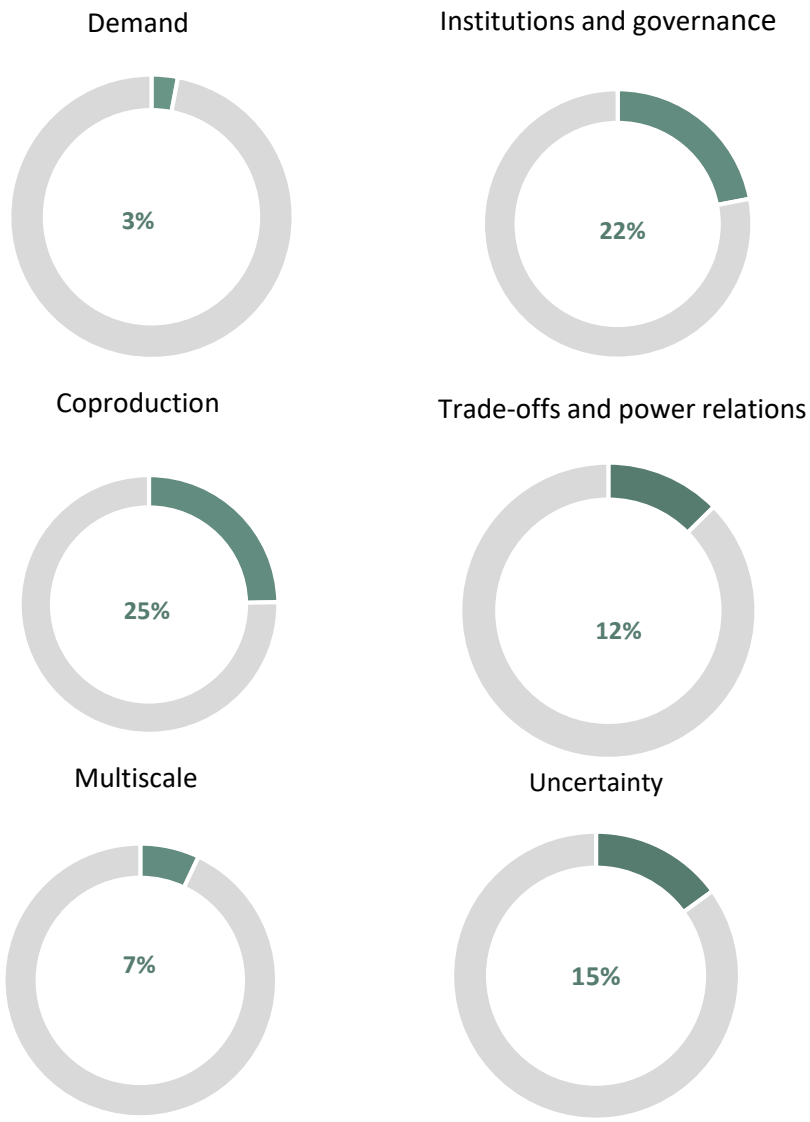


Figure 9. Percentage of reviewed articles (199) that assess socio-ecological aspects from 1998 to 2017. The figure shows the percentage of articles assessing demand, coproduction processes, institutions and governance, trade-offs and power, multi-scale (temporal and spatial) processes, and uncertainty. Source: own elaboration.

It is beyond the scope of this research to study whether these gaps exist in more general ES literature. Nevertheless, we found a number of contradictions and similarities with previous general ES literature reviews and critical reflective manuscripts. Some exisitng general ES literature reviews: Martínez-Harms and Balvanera (2012), Seppelt et al. (2012), Summers et al. (2012), Portman (2013), Bennett et al. (2015), Costanza et al. (2017), Hamel and Bryant (2017), Rieb et al. (2017) Wei et al. (2017).

Similar to coastal ES research, ES assessments have focused on economic valuation and the ecological assessment of the capacity of ecosystems (Seppelt et al. 2011, Wei et al. 2017), while flow and especially demand have been misrepresented. Nevertheless, in recent years, some authors have been working on ES capacity and flow models which seek to define the spatial distribution and assessment of capacity, flow and demand (such as, Kroll et al. 2012, Villamagna et al. 2013, Burkhard et al. 2014, Geijzendorffer et al. 2015, Baró et al. 2016). ES

coproduction still remains unclear (Bennett et al. 2015); to the authors' knowledge, coproduction is a rather unexplored aspect of ES, although frameworks such as the MEA and IPBES explicitly acknowledge the role of humans in the coproduction of ES. Some papers explore the issue of coproduction by recognizing how different social aspects (institutions, governance systems, social representations and values, technology and infrastructure, labour, financial capital and power relations) are linked to ES delivery. Such papers include those by Ernstson (2013), Huntsinger and Oviedo (2014), Spangenberg et al. (2014), Farhad et al. (2015), Felipe-Lucía et al. (2015), Fischer and Eastwood (2016), Palomo et al. (2016), Berbés-Blázquez et al. (2017) and Outeiro et al. (2017). Power is also an aspect that is left aside within ES literature (Felipe-Lucía et al. 2015, Berbés-Blázquez et al. 2016), which has not paid attention to the role that power plays in the coproduction of ES and in its benefits and costs distribution across socials groups. The literature review conducted by Hamel and Bryant (2017) shows that uncertainty has also been approached both superficially and partially.

Unlike ES coastal research, ES research increasingly acknowledges different scales (Schröter et al. 2018), a growing body of literature focuses on the spatial linkages between providing to benefiting areas (such as Kroll et al. 2012, Bagstad et al. 2013, García-Nieto et al. 2013, Serna-Chavez et al. 2014, Schröter et al. 2018). This body of literature conceptualizes and quantifies flow as the spatial movement of material, energy and information from the location that supplies ES to the location where benefits are enjoyed (Bagstad et al. 2013, Schröter et al. 2018). Such conceptualization serves to understand distributional spatial patterns and trade-offs. Nevertheless, temporal scales are rarely embraced.

In ES research there is an growing body of academic work on value pluralism and disaggregate analysis, although ecosystem-service research still fails to consider both aspects (Dawson and Martin 2015). Several authors—such as Dendoncker et al. (2013, 2018), Iniesta-Arandia et al. (2014), and Jacobs et al. (2016)—have made great efforts to develop and apply value pluralism. Additionally, relevant global science-policy interface initiatives, such as the IPBES, are embracing and supporting value pluralism ES valuations (Jacobs et al. 2018). Another growing research field is the disaggregated analysis of HWB among social groups, by authors such as Daw et al. (2011, 2016), Bennett et al. (2015), Dawson and Martin (2015), Horcea-Milcu et al. (2016), Hossain et al. (2017) Villamagna et al. (2017), Chaudhary et al. (2018) and initiatives such as IPBES and Ecosystem Services for Poverty Alleviation (ESPA).

Despite these efforts, the social dimension is still misrepresented in ES assessments. The lack of integration of social science in ES and in environmental interdisciplinary research is very well analysed by several authors (as, Norgaard 2010, Mooney et al. 2013, Castree 2014; Stojanovic et al. 2016, Stenseke and Larigauderie 2018). The integration between environmental and social science has proved to be challenging (Mooney et al. 2013, Milanez 2015, Stojanovic et al. 2016, Barthel and Seidl 2017), as these areas may have different and even opposing philosophical approaches; a differing use of the same or similar terminologies; existing uncertainties within present fields of knowledge; and different social and political positions of research. On this subject, Stojanovic et al. (2016) question whether all social science aspects can be approached under a general systems framework. System theory embraces complexity and provides a holistic framework. However, the social sciences are critical of the system conceptualization of certain aspects of society as this simplifies and undertheorizes social objects and processes (Stojanovic et al. 2016). Furthermore, certain authors have also stressed the issue of 'the hegemony of natural science', whose disciplines tend to be more valued than the social sciences (Ledford 2015). Consequently, the social

sciences are dismissed and social and environmental integration is asymmetrical in terms of power, funding, personnel, knowledge production and independence (Viseu 2015).

Social misrepresentation is even more aggravated in coastal ES research. An important reason behind coastal ES gaps is the fact that marine and costal research on ecosystem services have lagged behind terrestrial ES research (Barbier 2012, Liquete et al. 2013, Portman 2013) corresponding to a knowledge gap on marine ecosystems (see, Norse and Crowder 2005). Nevertheless, since MEA of 2005 added ES marine, ES research has been supported, but as a separate body of literature to that of terrestrial ES (Portman 2013). Consequently, the coastal— as a single landscape unit—has received little attention (Portman 2013). Land and sea systems are inextricably linked by flows of materials, energy and knowledge. Some coastal animals and plants spend their life between the land and the sea (Portman 2013). ES research needs to consider coastal areas as a single unit of analysis at multiple temporal and spatial scales.

In addition to the abovementioned aspects, the lack of social dimension in non-coastal and coastal ES research also responds to the dominance of ecologically-oriented scientists and economists; i.e. through a revision of the most influential authors (Kull et al. 2015), identifying a network of researchers from the subfields ecological economics, systems ecology, and conservation biology. The ES concept has been built on the consensus among those disciplines on how to approach society and environment relationships, while not including other perspectives. This consensus is not impartial, since ES is a political concept. Behind scientific objectivity, ES actually reflects specific ideas, values, power relations, and political-economic structures, which enable certain interventions and debates (Kull et al. 2015). The issue is, then, what interventions and debates do we want to support as scientists? In our opinion, coastal and non-coastal ES research should be informing the debates that societies face for resource management; who has or who controls access? Who are the winners and losers? What are the trade-offs?

2.6. Integral ecosystem service framework

Current coastal ES literature needs to embrace socio-ecological complexity and overcome the existing fragmentation of knowledge (which comes mostly from ecological and economic disciplines). To do so, we suggest five fundamental aspects to consider; First, coastal ES research should pay special attention to flows, studying the spatial and temporal pathways from ES production areas to demand or benefiting areas at different temporal and spatial scales. In this way, all cascade-model components could be covered, and multi-scale and cross-scale processes could be understood. Such information leads to more research on trade-offs and hence benefit and costs distribution. The tools and frames have already been developed by authors such as Bagstad et al. (2013) and Schröter et al. (2018). Second, the study of ES flows should be accompanied by coproduction assessment— Palomo et al. (2016), suggested a possible framework—as a means to understand natural and non-natural components that coproduce the ES along the flow pathway. Third, power should be included within ES analysis; i.e. how power mediates coproduction processes and benefit distribution. With such knowledge it will be possible to identify and understand the access or control of access of ecosystems services and their derived benefits, hence when, where, by who and how ecosystem service benefits are accessed. Fourth, all dimensions of HWB should be considered. In free and open spaces, participation stakeholders could express their values and trade-offs and conflicts would be exposed. Fifth, uncertainty needs to be evaluated and

communicated to stakeholders. Uncertainty assessments are relevant to decision making, as their results might shape a decision, but also they increase transparency and understanding of the issue at stake (Pappenberger and Beven 2006, Hamel and Bryant 2017). Including uncertainty in decision-making should also be considered a fundamental right, as decision makers and stakeholders involved have the right to know all knowledge limitations in order to make up their own minds (Pappenberger and Beven 2006, Hamel and Bryant 2017).

This research proposes a conceptual framework (Figure 10) that integrates the five abovementioned aspects: ES flows, coproduction, power relations, temporal and spatial scales, value pluralism and uncertainty. Its main contribution to the existing literature on coastal ES is to go further than the linear-cyclical approach of general ES frameworks by focusing on coproduction and power, as means to understand the assemblage of complex and non-linear interactions and feedback processes of coastal ES production, supply, demand and use processes; i.e. sorting out socio-ecological relations and feedback loops enabling ES processes. The suggested framework is not solely an analytical tool, but is also a normative tool, as it also seeks to guide coastal management debates and interventions towards environmental and social justice issues: control, access, trade-offs, benefit and costs distribution, i.e. winners and losers. Nevertheless, each coastal ES study has different needs and objectives, which might not fully cover all the elements and relations described in the framework.

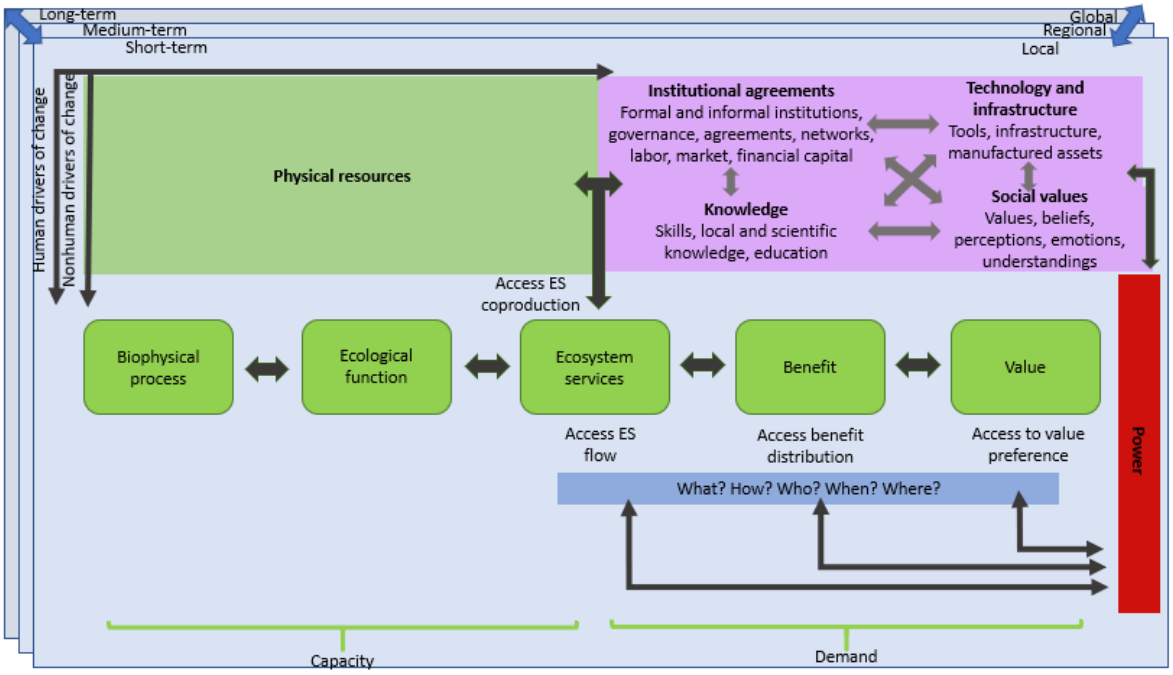


Figure 10. Conceptual framework that integrates the gaps identified during the review. The framework outlines coproduction and power relations as the core factors of assessments of coastal ecosystem services (ES). Relations of cascade-model components are bidirectional, not unidirectional. Cascade-model components are affected by human drivers of change (drivers that result from human decisions and interactions, such as institutions and governance, technology, market dynamics, etc.) and nonhuman drivers of change (drivers originated by natural dynamics, outside human control, such as natural climate phenomena). Note the mutual influence between human drivers of change, on the one hand, and institutions, governance, and other coproduction assets, on the other. ES services are not a free gift of nature, but are instead coproduced by human inputs. Although not all ES are coproduced equally, given that human contributions to ES might vary along the stages of ES

production (Fischer and Eastwood 2016, Guerry et al. 2015, Outeiro et al. 2017, Palomo et al. 2016, Reyers et al. 2013). Power relations underpin access to ES, distribution of benefits, and definition and preference of values. All abovementioned processes take place at different temporal and spatial scales and through interactions and feedback processes that operate at many scales. This complexity leads to high levels of uncertainty. Source: own elaboration.

Chapter III.

Cruise ship tourism and ecosystem services

3. Cruise ship tourism and ecosystem services

Tourism is a trillion-dollar global industry which represents 9% of the global gross domestic product (GDP) (UNWTO 2016) and 7% of global exports (Lenzen et al. 2018). It is a profitable industry and that is why many countries have made great efforts to develop touristic projects (Lenzen et al. 2018). Tourism activities, however, consume high amounts of energy and result in high carbon emissions (Rico et al. 2019).

Lenzen et al. (2018) have demonstrated that tourism has significant global environmental impacts in terms of carbon dioxide (CO_2) emissions, as it is more carbon-intensive than other economic activities. In fact, Lenzen et al. (2018) show that from 2009 to 2013 tourism's global carbon footprint[9,10] has grown from 3,9 to 4,5 $GtCO_2e$, and accounts for 8% of global greenhouse gas emissions (GHG). Greenhouse gas emissions from tourism would be equivalent to those emitted by the fifth largest polluting country worldwide (Lenzen et al. 2018, Rico et al. 2019). Moreover, tourism emissions are expected to double by 2035, and a great share of these emissions will come from air traffic (WTO, WMO, UNEP, 2008). Transportation is the main contributor to the tourism carbon footprint, especially air travel (Filimonau et al.2014, Gössling at al. 2015, Rico et al. 2019). Neither international aviation nor bunker shipping are part of the Paris agreement, however, and therefore both are excluded from greenhouse reduction targets. Lenzen et al. (2018) assert that 15% of global tourism-related emissions are not part of any international emissions reduction agreement

There is an extensive literature on the environmental impacts of tourism, which is basically centred on specific case studies (Pueyo-Ros 2018). The environmental impacts of urban tourism, which is a growing market segment[11], has received little attention. In fact, Rico et al. (2019) is the first study to calculate the carbon footprint of tourism in a city. The social impacts of urban tourism are also still understudied, although there has been an increasing interest in this in recent years. Authors such as Pinkster and Boterman (2017), Cocola-Gant (2018), and Fox Gotham and Kevin (2018) have studied the relationship between tourism and gentrification: the urban transformation process associated with tourism, and how this affects the lives of local residents, through the transformation of public space, and the expulsion of locals from those spaces, overcrowded infrastructure and increases in housing prices.

3.1. Ecosystem services and tourism

As Pueyo-Ros (2018) and Tengberg et al. (2012) assert, the tourism sector depends on ES to develop its activity; tourists need provisioning services such as those for food, energy or water. Regulating and maintenance services are also important, such as climate regulation or ES that mitigates natural risks through coastal protection or flood control, for example.

[9] Direct carbon emissions
from tourism activities (such as transport emissions) and the carbon internalized in the commodities purchased by tourists (as food, accommodation, shopping) should be considered when calculating the tourism carbon footprint. Methods to measure carbon footprints use the life cycles or supply chain emissions of goods and services linked to tourism activities (Lenzen et al. 2018).

[10] There are several criticisms of footprint indicators. Giampietro and Saltelli (2014) argue that the assumptions and simplifications established to estimate the carbon footprint result in multiple contradictions, and even contradict the main goal of the indicator, to calculate the overuse of planet resources.

[11] City trips and cruises where the fastest growing market segments in 2016, (ITB Berlin 2016) and the growth tendency continued in 2018 (ITB Berlin 2018).

Tourists also consume and enjoy cultural services as an aesthetic experience, leisure and recreation or as cultural heritage. In spite of the interdependence of ES and tourism, ES literature on tourism is scarce (Pueyo-Ros 2018). To the best of the author's knowledge, studies of cruise ship tourism are scarce. The only research that links ES and cruise ship tourism considers the negative effects of cruise ship tourism over more sustainable tourism practices or ecotourism (Seidl et al. 2014).

In the ES literature, tourism is conceptualised as a cultural ES (Milcu et al. 2013). For instance, the MEA (2005) classification conceives recreation and ecotourism as a cultural ES. This conceptualisation hides the fact that tourism is also an economic activity that provides economic benefits, consumes resources and has environmental and social impacts (Büscher and Fletcher 2017). This is why some authors have argued that in communities which strongly rely on tourism, it should be considered an ES provision (Rounsevell at al. 2010, Daw et al. 2011).

Pueyo-Ros (2018) argues that cultural ES is affected by the 'ecotourism bubble'. In critical tourism literature the 'tourist bubble' refers to the fact that tourists travel inside a 'bubble' that isolates them from some aspects (especially unpleasant ones) of their destinations (Jacobsen 2003, Jaakson 2004, Carrier and Macleod 2005). Along the same lines, the 'ecotourism bubble' refers to the disconnection between ecotourists and the context of their visit; ecotourism focuses on the relationship between nature and visitor in the visiting area, but it ignores the context of this visit (Carrier and Macleod 2005). For instance, it ignores all the necessary infrastructure required to allow visitors to arrive at a destination. In this way, the environmental impacts of ecotourism are ignored. Thus, from an ES perspective, tourism is simplified to ecotourism and detached from its environmental and social consequences.

The literature review carried out by Pueyo-Ros (2018) also shows that tourism is not solely understood as cultural ES in the ES literature, but also as an economic activity that consumes natural resources and has a significant environmental impact. Pueyo-Ros (2018) points out that although there is a double understanding of tourism in ES (as cultural ES and as economic activity), tourism is perceived in the ES literature as a positive factor for local development and environmental conservation. Tourism is seen as a valid alternative for promoting the local economy, with less environmental impact than other economic activities.

Pueyo-Ros (2018) also shows a disconnection between tourism research and the ES framework. This disconnection is mainly because tourism research community is composed of social scientists. Social scientists do not feel comfortable with the ES framework because of its systemic approach and the dominance of economic and natural science paradigms (Stojanovic et al. 2016), but social science perspectives are increasingly acknowledged in ES research. As a result, social scientists should feel more comfortable with the ES framework, hence tourism research community could be open to explore ES framework.

In fact, ES research from a tourist perspective could enhance the academic debate about how to integrate socio-ecological complexity into ES assessment. Tourism is a phenomenon that comprises multiple and complex social and environmental relationships which generate multiple trade-offs. Tourism thus constitutes an important field of exploration for socio-ecological research and ES. There are also important gaps in tourism research that could be addressed by the ES framework, such as the lack of environmental and social justice studies that go beyond case-study-based literature (Higgins-Desbiolles et al. 2019). Nevertheless, the weaknesses of the ES framework should be acknowledged and compensated for, as much as

possible. The ES frame should be complemented, with other conceptual frameworks, theories and worldviews. In such a way, the 'complexity blinder' problem described by Norgaard (2010) could be avoided. Tourism researchers should critically reflect on whether the underlying utilitarian worldview of ES metaphor fits the site or phenomenon of study before selecting ES as analytical framework. Researchers need to evaluate how the outcomes of the research could affect the site or phenomenon of study. For instance, the introduction of an ES framework and its utilitarian worldview could have significant effects on a community with a different worldview.

3.2. Cruise ship tourism

In recent years, the cruise tourism sector has increased globally (Wang at al. 2014, De Cantis et al. 2016, Weaver and Lawton 2017). Even during the global financial crisis of 2008 the cruise ship sector continued to grow (Rodrigue and Notteboom 2013, Pallis 2015). Since 1980, the annual rate of passenger growth has been 7,2% (FCCA 2014), expanding from 5.67 million passengers in 1995 (Dowling 2006) to 17.8 million in 2017, and is expected to hit 30 million in 2019 (CLIA 2018) and 39.57 million in 2027 (Cruise Industry News 2018a). Cruise ship tourism demand is increasing faster than land-based tourism; the global demand for cruise tourism in 2007-2017 increased by 70%, while land-based tourism increased by 47% (CLIA-Europe 2018). The Caribbean/Bahamas and the Mediterranean are the two main cruise regions worldwide, with 38,4% and 14,2% of global market share respectively (Cruise Industry News 2018a). Other regions, such as Northern Europe (9,4%), Asia (15,1%), Alaska (4%), Australia (4%) and South America (2,1%) are also important markets (Cruise Industry News 2018a).

The cruise ship sector has grown not only in numbers of passengers but also in destinations and the number and size of cruise ships (London and Lohmann 2014, Ros Chaos et al. 2018). In 2018, there were 386 ships in the world and expected to be 427 by 2027 (Cruise Industry News 2018b). In 2018, there were 132 cruise ships with 8.257.458 passengers in Europe, and there are expected to be 163 carrying 14.122.610 passengers by 2027 (Cruise Industry News 2018b).

Cruise ship trips generally last from three to twelve days, with an average length of 7,2 days (Pallis 2015). Generally, a typical cruise itinerary starts and ends at the same port, called the turnaround port, and stops at three to five different ports for between five to nine hours. These itineraries take place in specific regions, such as the Mediterranean. There are a few cruise itineraries that travel around the globe or in several regions, and can last for months or even a year.

3.2.1. The evolution of cruise ship sector

In its early stages, cruise ship travel was restricted to the elite, upper- and upper-middle-class citizens (World Monuments Fund 2013). The first cruise ship tourism trips took place in the 1930s, with trips from Hamburg (Germany) for upper-class families (Murias López 2002). In the mid-nineteenth century, ships were adjusted for passenger transport between continents, and the passengers different economic status (World Monuments Fund 2013). There were different facilities and accommodations within the same ship depending on the economic status of the passengers. The *Cunard Line* was founded in this period, offering trips between the USA and Europe, and especially the UK. Elite cruise companies began to grow, such as *Thomas Cook's* elite cruises to Egypt or those of the British *Peninsular and Oriental Steam Ship Navigation Company* (P&O) (Garay-Tamajón and Valiente 2012).

The situation changed after the First World War due to the decrease in transoceanic passenger transportation. Transatlantic ship companies transformed their ships into recreational ships, with touristic services and amenities (Murias López 2002). During the Second World War and post-war the cruise ship sector evolution stopped, as the context was not appropriate for developing touristic activities.

It was only in the 1960s that the situation started to change again. This change was especially motivated by the development of commercial air traffic and the first continuous air trips between USA and Europe. Marine passenger traffic was drastically reduced as a result. Transoceanic shipping companies had to reinvent themselves and find new markets to survive (Brida and Zapata 2010a). Initially the target population was high- and medium-income class citizens. With this target in mind, Carnival Cruise Lines, founded in 1972, created "Fun Ships" (Wood 2000). These ships offered the middle class multiple entertainment activities and amenities, accompanied by an image of luxury (Wood 2000, World Monuments Fund 2013). In this way, the ship itself become the attraction, rather than the ports of call (World Monuments Fund 2013).

The cruise ship sector grew moderately during the 1970s and 1980s (Brida and Zapata 2010a). Increasing access to air travel and television shows, such as "The Love Boat" in this period further promoted an increase in cruise ship tourism (Wood 2000, Weaver 2005, World Monuments Fund 2013), which intensified in the 1990s, expanding throughout Europe, Asia and Oceania (Brida and Zapata 2010a). During this period the strategy of cruise ship companies was to make their ships as important a factor as their destinations. Cruise companies developed bigger cruise ships to satisfy the increasing demand. Cruise ships became middle class mass market products which offered all-inclusive packages (Wood 2000).

The growth of the sector continued in the early 2000s, for a variety of reasons. The creation of technological developments in cruise ship building, the increase in the capacity of ships, the onboard amenities and services and the expansion of onshore tourism products and port infrastructure development (Peisley 2010, Lopes and Dredge 2018) were all decisive factors. This has all triggered the appearance of new cruise port infrastructures, new itineraries, new market products such as fly-cruise packages, and more diversified touristic products at cruise destinations (Klein 2008, 2011). Consequently, cruising is nowadays completely different from cruising in the 1970s. Cruise offerings are specialised, and adjusted to each market segment. Cruises have different categories: budget, contemporary, premium and luxury (Pallis 2015). 'Budget' involves the cheapest class of cruise ships, generally old ships with fewer services and amenities. 'Contemporary' is the most common class, including medium and big boats with good services. 'Premium' is the second most common class, similar to contemporary but with better services. Premium and contemporary cruises accounted for more than 70% of passenger capacity between 2006 and 2010 (UNWTO 2010). Luxury cruises are reserved for high income passengers, who travel on ships with excellent services.

Cruise lines have adapted to new vacation patterns, and integrated new target groups. The prices of cruise tickets have been greatly reduced and onboard sales and excursions represent the biggest share of cruise company profits (Lopes and Dredge 2018). The sector is thus far more complex than in its early days. The modern cruise sector is highly diversified, segmented and specialised. Rodrigue and Notteboom (2012) list the specific characteristics of cruise ship tourism as: 1) The offer of itineraries and cruise ships as the whole touristic product, so that the tourist product is the sum of the combination of sailing time inside the cruise and ports

of call; 2) A large share of the revenue in the cruise ship sector comes from onboard services and shore-based excursions; 3) Itineraries are adjusted to seasonal demand. Consequently, the Mediterranean and Caribbean market operate as complementary markets (e.g., global north summer cruise ships travel around the Mediterranean, while during global south summer cruise ships travel around the Caribbean); and 4) The cruise ship future growth strategy relies heavily on the supply side, rather than the demand. In this way, the saturation of the supply side will constrain future cruise developments, such as berth capacity, or the saturation of ports of call communities. As a result, the cruise ship sector will probably expand towards more involvement in terminal operations and port services, which is already an existing trend (Rodrigue and Notteboom 2012). In the future, cruise companies will probably develop adjacent touristic amenities such as resorts or hotels.

3.2.2. The cruise ship corporate landscape

Cruise ships have been increasing their capacity since 1970. Then, they could carry around 1.000 passengers, now they carry some 6.000 passengers or more (Figure 11). This increase in capacity has led to more economic profit, however, the construction of today's big cruise ships is only possible with high capital investments. The *Oasis,* with capacity for 6.000 passengers, had an overall construction cost of 1.24 billion American dollars (Rodrigue and Notteboom 2012). These investments are only viable for big companies. As a result, the cruise market tends to be concentrated in very few hands (Klein 2008, Rodrigue and Notteboom 2012, 2013). Four companies (Carnival Lines, Royal Caribbean, Norwegian Cruise Line and MSC Cruises) control 96% of the global cruise market (Rodrigue and Notteboom 2012). These companies have also bought other cruise companies, maintaining their original names (Figure 12).

Figure 11. The biggest cruise ship worldwide, Harmony of the Seas, in Barcelona. The cruise ship can host 9.000 people: 7.000 passengers and 2.000 crew. Source: Verdú (2016)

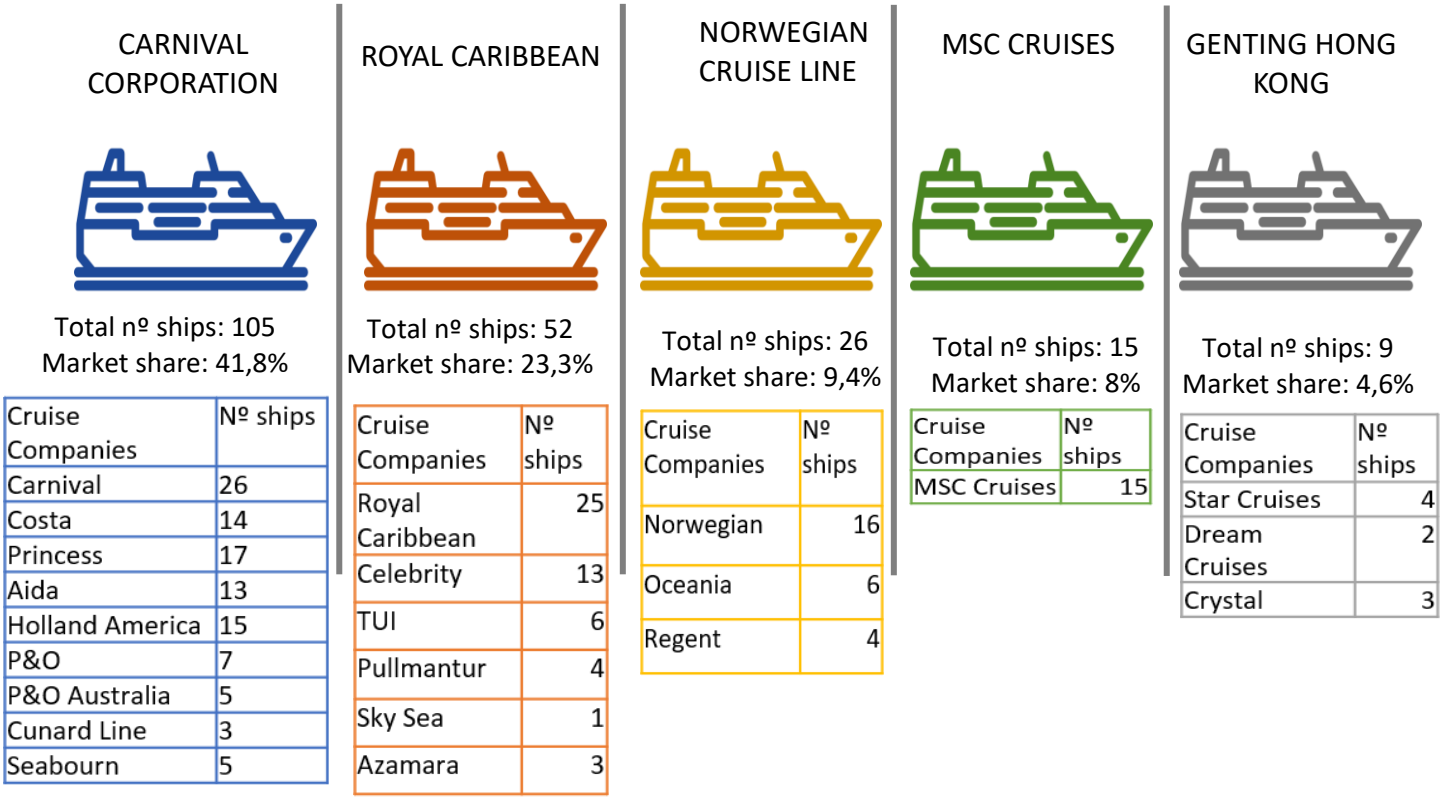


Figure 12. The structure of the cruise ship market. A few companies have the control of the market. Source: own elaboration based on Cruise Industry News (2018a).

In parallel to cruise ship growth and ownership concentration, regional cruise associations were created, such as the *Cruise Lines American International Association* or *the European Cruise Council (ECC) or Cruise Europe*. The role of these associations is to facilitate the relationship between ports and cruise companies, and lobby in the American congress or the European institutions in favour of cruise companies. In 2013, these regional organisations were merged into one international organisation, the Cruise Lines International Association (CLIA). A global cruise lobby with both continental branches, such as CLIA Europe, and national branches, such as CLIA Spain was created. CLIA Europe, with offices in Brussels, promotes the interest of cruise ship operators within European institutions and the CLIA national offices defend the cruise sector at a national level.

CLIA also works on cruise ship sector image and reputation as a critical element in reinforcing its political influence. The image of the sector is generally shaped by the media, internet and advertising (Klein 2005, 2008). CLIA promotes the image of the cruise sector and encourages the expansion of the sector by collaborating with the media and investing in advertising, as well as making investments in foundations and donations (Klein 2005, 2008). CLIA Europe is therefore a lobbing platform for cruise ship sector interests in Brussels, but also a platform that reinforces the image of the cruise ship sector.

3.2.3. The economic contribution of cruise ship sector

The cruise ship sector has a significant economic impact. CLIA (2018) reported that the total output[12] worldwide in 2016 was 126 billion American dollars, and 1.021.681 jobs were generated, paying 41.1 billion American dollars in wages and salaries. In Europe, the economic impact of the cruise sector has increased by 26% since 2009 (Pallis 2015). In 2017, direct expenditure by the cruise ship sector was €19.7 billion, with 403.621 jobs in cruise and cruise-related businesses. The European cruise ship building industry is a fundamental part of cruise ship direct expenditure. The most innovative and largest cruise ships are built in European shipyards. European cruise ship building represented an investment of €5.6 billion by cruise lines in 2017, especially in Italy, which is the leading country for cruise ship construction in Europe (CLIA-Europe 2018). Wages and other employee remuneration reached €12.77 billion. The total economic output of the cruise ship sector was €47.9 billion. Italy is also the leading country in the embarkation and destination market. Spain is in the second position, but is in fifth position regarding direct expenditure, with €1.48 billion (CLIA-Europe 2018).

The growth of the cruise ship sector in Europe is reflected in the increasing number of European cruise ship passengers, with an increase of 7,8 % from 2015 to 2017 (CLIA-Europe 2018). In total, in those years 6.96 million European residents travelled by cruise ship, especially from the UK and Ireland, which represents 26% of all cruise passengers worldwide (CLIA-Europe 2018). North Americans are still the major market source, at around 55% of the global share. A total 3.2 million of passengers came from other parts of the world (Pallis 2015). New markets are rising, such as those in Australasia and Asia (Pallis 2015).

Even though the economic impacts of cruise tourism are very significant, the benefit for local governments and communities is contested. Cruise ship companies control some of the related onshore services and the main passenger expenditures onboard (World Monuments Fund 2013). For instance, as Klein (2005, 2008) explains, cruise ship companies retain up to 70% of the price of shore excursions, while local businesses retain less than 30%. In a similar vein, Diedrich (2010) describes how the economic profits from the cruise ship sector in Belize are collected by international tour operators, rather than locals. Brida and Zapata (2008) concluded than more than 50% of land-based excursions are sold by cruise lines. Cruise companies thus manage to recirculate a big share of the economic gains from cruise ship tourism among themselves. Some passengers do not leave the cruise ship during port-calls, and so they do not interact with the destination at all (Lekakou et al. 2011). The number of passengers who do not visit a destination port might vary; according to Ros Chaos et al. (2018), 30% of passengers do not leave the cruise ship in Barcelona, although in Cartagena de Indias (Colombia) only 10% stay on the cruise ship (Brida and Bukstein 2010).

Economic contributions to the local economy are also reduced because local port authorities make great investments, such as new terminals, in order to transform the harbour infrastructure to accommodate cruise ships and passengers (Brida and Zapata 2010a, World Monuments Fund 2013). The increasing capacity of cruise ships requires considerable investments in infrastructure and implies high maintenance costs. The economic contribution is also reduced due to the bonifications and fiscal incentives that governments and port authorities implement to attract cruise companies (Klein 2005). Ports compete between each

[12] Total output encompasses all intermediate profits, taxes net of subsidies, net surplus and employee remuneration.

other to offer the best deal to cruise companies (e.g., bonifications, tax reductions, terminal ownership) (Klein 2005). This competition reduces the local ability to benefit economically.

Cruise companies save money by using flags of convenience, and registering their ships "offshore" in countries such as Panama, Malta, or the Bahamas, where fiscal, labour and environmental regulations are less strict (Brida and Zapata 2010a, World Monuments Fund 2013). Cruise companies that operate in countries as the UK, Spain, Italy, the USA, and Canada, among others, do not pay taxes in these countries because they are registered elsewhere. Ships can avoid obeying the environmental and labour regulations of the countries in which they operate, because they are governed under international regulations and the regulations of the country where they are registered (Klein 2005, 2008, Becker 2013). Carnival registers its fleet in Panama, and Royal Caribbean registers in Liberia and the Bahamas (Becker 2013). Becker (2013) explains the labour conditions of cruise crew, which include wages set for the developing world, no vacation, no extra pay for overtime and no health insurance. Most workers come from developing countries, such as the Philippines, Bangladesh, India or Turkey, and they receive equivalent salaries, as stated by the CEO of Royal Caribbean in Becker (2013, p.144) 'Typically, what they are able to earn from us is significantly greater than what they are earning if they would have stayed where they were.'

3.2.4. Waste outputs of cruise ships

Cruise ship activity generates several output flows, as wastewater, solid waste and air pollution. Cruises produce black, grey, bilge and ballast wastewaters (Figures 13 and 14). Black waters are sewage from toilets and medical services. Grey waters are produced by waste from sinks showers, baths, washing machines, swimming pools, etc. Bilge waters are collected in the bilge area of vessels, the lowest part of vessels, and can contain the residues of fuel, oil, cleaning chemicals, metals, bacteria and invasive species. Ballast water is used to stabilise a cruise ship, and can contain marine microbes, plants and animals, transported around the world. Ballast waters are normally loaded in coastal areas after the ship discharges wastewater or cargo, and then discharged in the next port of call.

Cruise ships are required to have marine sanitation devices in order to treat sewage on board, such as Type II Marine Sanitation Devices (MSDs) and Advanced Wastewater Treatment Systems (AWTS). Type II MSDs are onboard treatment systems that break swage using biological or aerobic digestion processes. In recent years, cruise ship water treatment has been improved by the implementation of Advanced Wastewater Treatment Systems (AWTS). AWTs provide better biological treatment, solids separation and disinfection (Koboević and Kurtela, 2011), however, wastewater treated by AWTS still has high levels of nitrogen and phosphorous, and metals such as zinc or copper, among others (Klein 2009).

Once sewage has been treated, water can be discharged into the sea within a specific distance of the coast (generally three nautical miles). If water is only broken up and disinfected, it can only be discharged from three miles to twelve miles offshore. Very few ships disinfect the swage, as most of cruise ships have treatment plants on board (CE Delft 2016). Untreated water can only be discharged more than twelve miles from shore. Most Type II MSDs and AWTS extract solids from sewage. In some cases, dewatered sewage is incinerated by incinerator plants inside the cruise ship. Other options are to discharge the sewage sludge further than twelve miles offshore or to collect it and discharge it at harbour for treatment. As Klein (2009) explains, discharging sewage sludge in the open sea requires large amounts of oxygen-creating eutrophication and algal blooms, which deteriorates sea water quality and

biodiversity. The bacteria present in black and grey water can also endanger vulnerable species and habitats. Similarly, invasive species contained in ballast water can also disturb vulnerable species and habitats.

Oil or oily water, such as bilge water, can be treated onboard by an oil water separator (OWS), which removes oil from water and discharges the water into the open sea, while the oil sludge is typically disposed of at a harbour (CE Delft 2016). Bilge water is generally collected and disposed of at harbours for treatment under the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex I. MARPOL is the international convention for the prevention of marine pollution due to habitual operations or accidents, such as spill overs. The convention includes six technical annexes that regulate six waste typologies.

Cruise ships also generate solid waste, such as organic waste, glass, paper, plastic, etc. Solid waste is regulated under MARPOL Annex V. Solid waste can be non-hazardous or hazardous. Non-hazardous waste can be incinerated onboard, however, there is non-organic waste that cannot be incinerated, such as plastic or glass. In these cases, non-organic waste is discharged at harbour facilities under MARPOL Annex V. Organic food waste can be ground up and then discharged into the open sea, at twelve miles (CE Delft 2016), or it can be stored and disposed of at harbour facilities. Ashes from incineration are collected and disposed of at harbour facilities according to MARPOL Annex VI. Cruise ships do not produce much hazardous waste, on average less than 1.000 litres per week per boat (Klein 2009). Laundry, general maintenance, and medical services are sources of hazardous waste. This waste is collected and delivered to harbours.

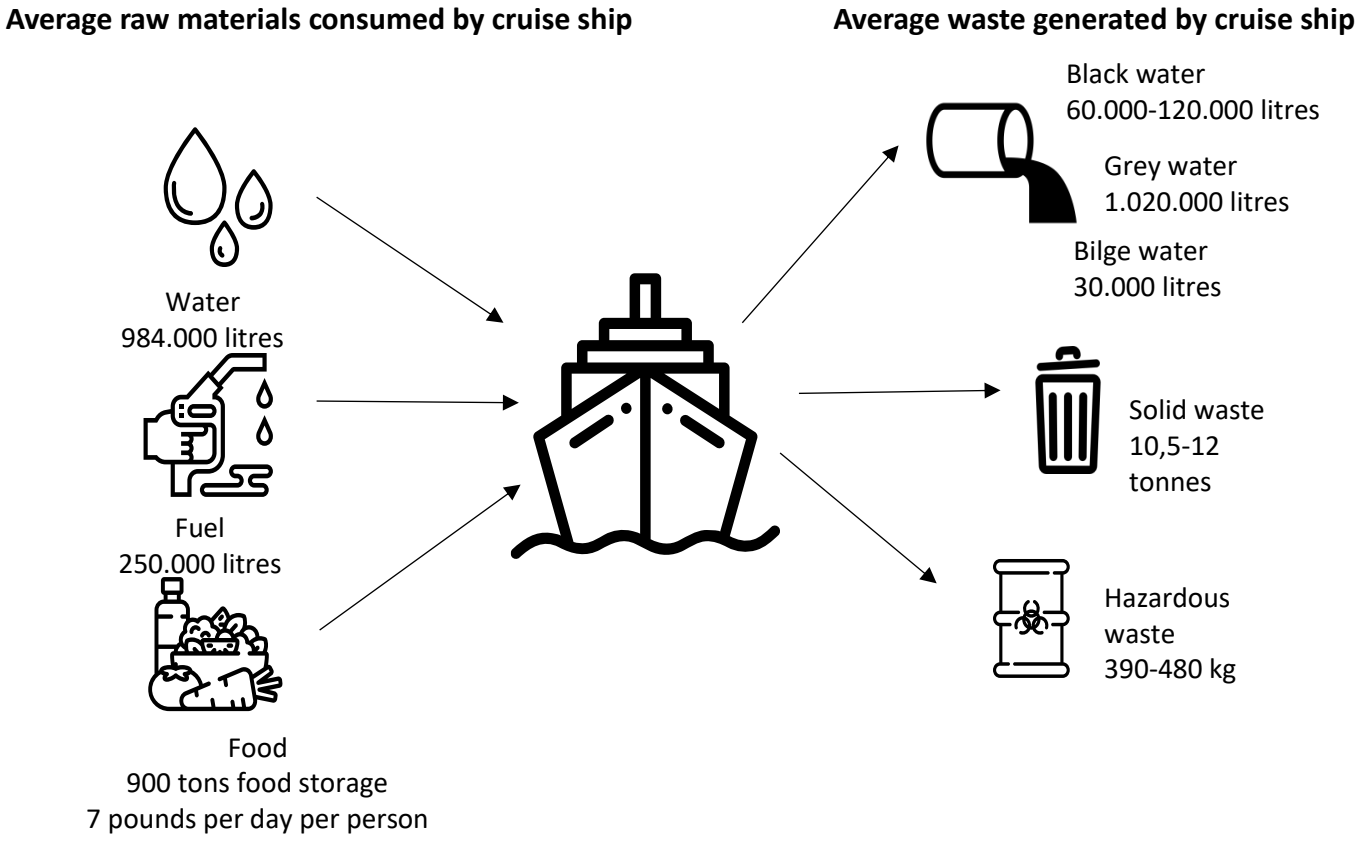


Figure 13. Cruise ship consumption and waste generated per day. Source: own elaboration based on Commoy et al. (2000), Klein (2005) and Carić (2013)

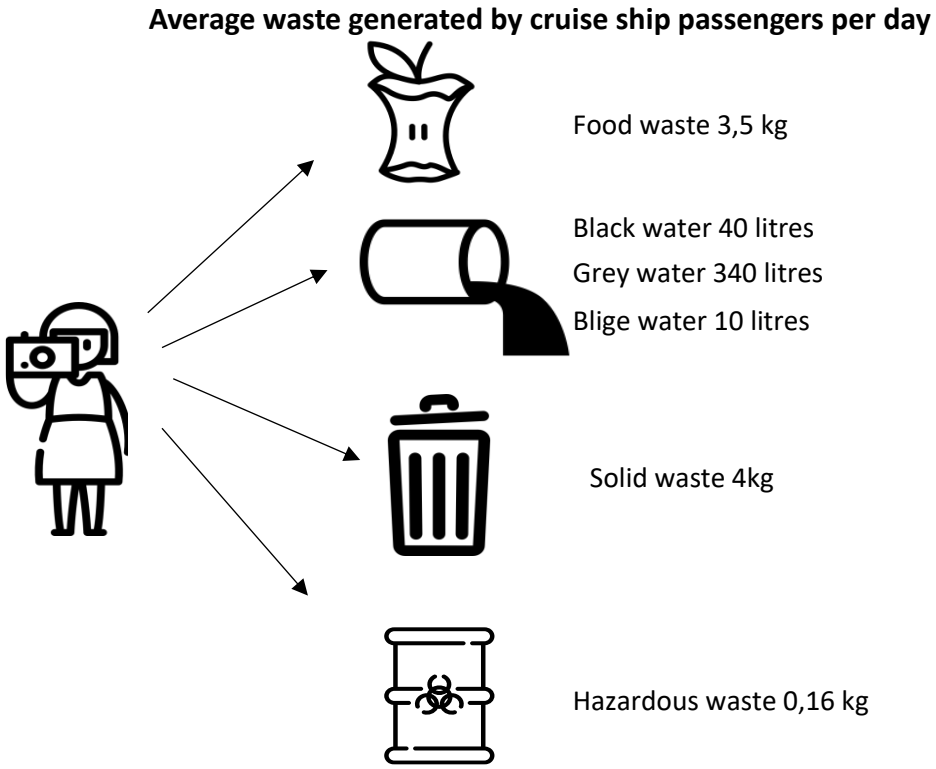


Figure 14. Cruise ship passenger consumption and waste per day. Source: own elaboration based on Commoy et al. (2000), Klein (2005) and Carić (2013)

3.2.5. Air emissions of cruise ships

Air emissions depend on the type of vessel, travel speed, manoeuvring and hotelling among other things. Although the quantity of emissions can differ, cruise ship emissions consist largely of nitrogen oxides (NO_x), sulphur oxides (SO_x) and carbon oxides (CO_x) gases, and suspended particles, such as black carbon. Air pollution from ships results from diesel engines that burn high sulphur content fuel (EEA 2013). The sulphur concentration in marine fuel is much higher than in land vehicle diesel, however, new regulations are in place to reduce sulphur emissions. MARPOL Annex VI, states that once in a harbour, ships have to switch to low sulphur content fuel, maximum 0,1%. Outside a harbour, the maximum sulphur content is 3,50%, and from 2020, it will be reduced to 0,50%.

Ship emissions deteriorate air quality in coastal areas (almost 70% of ship emissions take place within 400 km of coastlines) as they result in nitrogen dioxide (NO_2), ground-level ozone (O_3) formation, sulphur emissions that generate acid rain and particulate matter (PM) emissions (EEA 2013). Ship emissions interact with other air components and generate secondary pollutants, such as O_3 or acid sulphuric. Secondary pollutants are transported and can affect air quality further inland (Eyring et al. 2010).

Faig Abbasov et al. (2019) published a report showing that in 2017, 203 cruise ships in Europe emitted about 62 kilotons (kt) of SO_x, 155 kt of NO_x, 10 kt of PM and more than 10 megatons (Mt) of CO_2. Most of the emissions were in the Mediterranean Sea, as it is the major cruise destination in Europe. The study also shows that the Spanish coast is the most affected by cruise ship air pollution. Cruise ship emitted fifty times more of SO_x than Spain's twenty-three million passenger vehicles in 2017.

Ship emissions are higher at open sea than in harbour. In open sea cruise ships can use high sulphur fuel and they increase their travelling speed, which generates more emissions (Policy Research Corporation 2009). Emissions in the open sea are therefore higher, although they have less impact on populated areas. They have an impact, however, on GHG emissions, and air pollutants contribute to the modification of the terrestrial sun radiation reflection balance (EEA 2013). Since shipping takes place mostly in open sea, cloud formation in the open sea can be modified by shipping emissions. The alteration of cloud formation and their characteristics can alter the reflection of the incoming sun radiation. Black carbon (BC) particles deposited on ice and snow areas can also alter the albedo of these surfaces. Air pollution derived from ships also contributes to ocean acidification and eutrophication because of the deposition of sulphur and nitrogen compounds (Derwent et al. 2005, EEA 2013), thus negatively impacting sea life. Similarly, shipping activity can have significant negative impacts on marine habitats due to shipping disasters, oil spills, (Ng and Song 2010) or underwater marine noise.

Substantial scientific literature shows the relationship between air pollution caused by diesel exhaust gasses and damage to human health, such as cardiovascular and respiratory conditions, and even death (Corbett et al. 2007, EEA 2013). Epidemiological studies show that short exposure to exhaust gases and PM are associated with health effects such as headaches, dizziness, nausea, coughing, and laboured breathing, while long-term exposure is related to chronic diseases, including lung cancer and increased mortality (Corbett et al. 2007, EEA 2013). In spite of these findings, the total extent of the effects of air pollution on human health are still uncertain, as they continue to be discovered (Yau et al. 2013, Tichavska and Tovar 2015).

PM affects human health differentially. Coarse PM (PM_{10}) (e.g., diameter ≤ 10 micrometre, μm) is deposited in the nasal region (Policy Research Corporation 2009, WHO Europe 2013). Fine PM ($PM_{2,5}$) (e.g., diameter ≤ 2,5 μm) reaches the alveoli and might enter the blood system (WHO Europe 2013). Ultrafine particulate matter (UFPs) (PMc_1) (e.g., diameter ≤ 1 μm) might enter the nervous system and other organs, such as the liver and the heart (WHO Europe 2013). Current literature shows that UFPs account for 80% to 90% of urban air particles (Rodríguez et al. 2007, Mejía at al. 2008, González et al. 2011). There are multiple uncertainties related to monitoring UFPs, however, as most air quality monitoring networks do not monitor UFPs, but rather PM_{10} and $PM_{2,5}$. The composition of UFPs and their spatial/temporal progress therefore remains uncertain (Baldauf et al. 2016). There are also significant knowledge gaps regarding the impacts of UPFs on human health and their synergies with other pollutants (Baldauf et al. 2016). Most studies have addressed UFPs from land vehicle exhaust emissions, obviating ship emissions and cruise ship emissions. González et al. (2011) conclude that ship emissions may source more UPFs than vehicle exhaust emissions. In a similar vein, they argue that the increase in ship emissions is dominated by UFPs.

Other environmental impacts related to cruise ship activity are associated with the transformations of coastal areas to enable cruise ship traffic, such as cruise ship terminals, and the pressure and disturbance generated by the derived recreational activities regarding wildlife (Brida and Zapata 2010a). The increase in air traffic due to the transport of passengers to departure harbours also produces important GHG emissions (Brida and Zapata 2010a). There are also environmental impacts, such as GHG emissions, derived from food supply to cruise ships. Cruise ship activities also have social impacts, such as the competition for space

in tourist destinations, especially in small island destinations, where there are large ratios of cruise tourists per resident. Cruise tourist crowds also disturb resident routines as Klein (2005) reports for a Nova Scotia village (Canada), where tourist crowds congest road traffic and public spaces.

3.3. Academic approach to cruise tourism

Although the cruise ship sector is growing, academic literature on the cruise ship sector and its impacts is limited (World Monuments Fund 2013). The existing cruise ship literature is fragmented and lacks unifying theoretical perspectives (Papathanassis and Beckmann 2011). Some aspects of the cruise ship sector have been researched further than others, such as the managerial and operational aspects of the ship and passenger experience (World Monuments Fund 2013, Weaver and Lawton 2017). Research has been carried out on marketing (e.g., Hwang and Han 2014), market fragmentation (e.g., Hung and Petrick 2011, Rodrigue and Notteboom 2013), and passenger experiences onboard and onshore (e.g., Kwortnik 2008, Andriotis and Agiomirgianakis 2010, Cruz-Ruiz 2014). There is also cruise research related to supply chain logistics (e.g., Véronneau and Roy 2011, Véronneau et al. 2015), and studies concerning safety and medical issues onboard (e.g., Isakbaeva et al. 2005). Similarly, literature concerning the impacts of cruise ships on port structures is centred on infrastructure requirements, such as sanitation, berths or security (World Monuments Fund 2013). There is a clear emphasis on scholarly research focused on improving business efficiency and profitability. This tendency shows the dominance of economic profit-driven research (World Monuments Fund 2013, Weaver and Lawton 2017). Several studies have also analysed the economic impact of cruise ships (e.g., McCarthy 2003, Stefanidaki and Lekakou 2012, Pallis 2015, Vayá et al. 2016)

Economic profit-driven research is confronted by a growing critical literature on the environmental and sociocultural impacts of cruise ship sector (e.g., Johnson 2002, Klein 2007, 2010, 2012, Brida and Zapata 2010a, Brida et al. 2012, Carić and Mackelworth 2014, Tamajón 2015, Brida and Lanzilotta 2017, Ros Chaos et al. 2018). Similarly, there is a growing interest in cruise industry structures and predatory practices involving local and regional institutions and actors (e.g., Wood 2000, Gui and Russo 2011, Font at al. 2016, Weaver and Lawton 2017). Some authors aim to quantify passenger expenditure onshore (e.g., Brida et al. 2013, Lopes and Dredge 2018) and to demonstrate how cruise lines manage to keep the greatest share of these expenditures (e.g., Weaver and Lawton 2017). Scholars also study the perceptions of residents (Dredge 2010, Brida et al. 2012), and carry out critical analyses of working conditions in cruise ships (Terry 2009). There is also incipient research into environmental and social activism against cruise ship environmental impacts (e.g., Klein 2007).

Last but not least, papers and scholarship based in the Caribbean, the leading cruise ship market worldwide (Garay-Tamajon and Canoves-Valiente 2012), dominate the field, and very few consider the Mediterranean, which has become the second largest cruise ship tourism market. This research intends to contribute to both critical cruise literature, and Mediterranean cruise research.

3.4. Cruise ship tourism in Barcelona

Barcelona has become a tourist city. In 1990, the city received just over one and a half million tourists (1.732.902), and in 2017, more than eight and a half million (8.884.550) tourists visited the city, which has a resident population of 1.6 million (Ajuntament de Barcelona 2017a). The total number of visitors, including day-trip visitors and tourists staying overnight,

rises to thirty-three million which are concentrated in specific areas of the city, mainly the city centre, called the Ciutat Vella district (Figure 15) (RBD Consulting Group 2017). As such, Barcelona is one of the world's top destinations, ranked the twelfth most visited city worldwide by the Global Destination Cities Index 2017, and the fourth most visited European city, after London, Paris and Istanbul (Mastercard 2017).

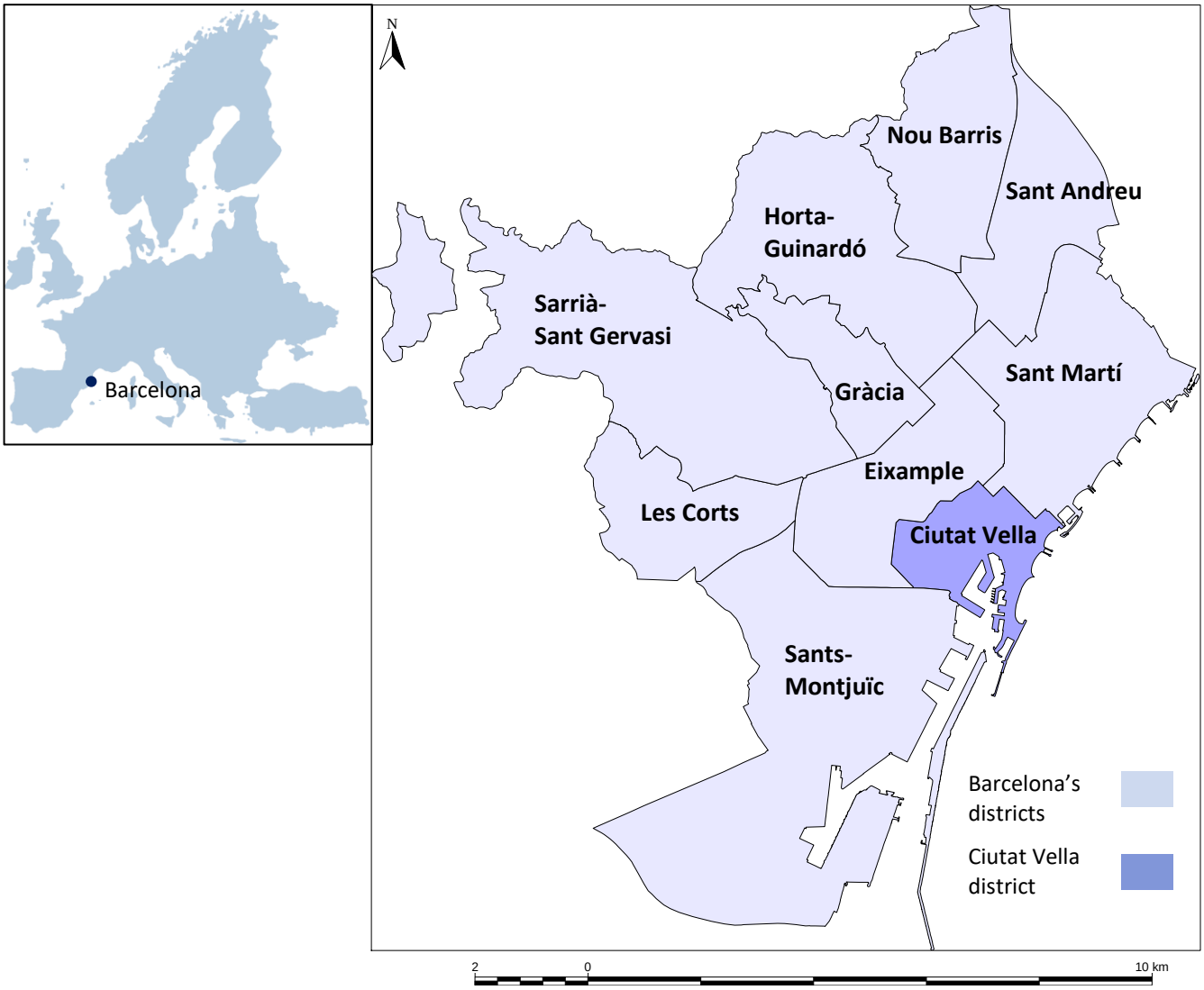


Figure 15. Location of Barcelona, Barcelona's districts and the Ciutat Vella district highlighted (in darker blue). The Ciutat Vella district concentrates most of the touristic activity of the city. Source: own elaboration.

The success of Barcelona as a tourist destination is, in part, caused by the growing tendency to practice urban tourism among national and international citizens. The development of urban tourism is related to the increase in low-cost airline companies. Low-cost airline companies have proliferated in Europe in recent years. In 2017, slightly more than forty-four million passengers arrived/left to/from Barcelona's airport (El Prat-Josep Tarradelles) (Observatori del Turisme a Barcelona 2017). The city is an example of the current touristic trend in Europe for short urban trips, as the average stay in Barcelona is 2,7 overnights (Ajuntament de Barcelona 2017d). The city also received more than 2.7 million cruise ship passengers in 2017 (Observatori del Turisme a Barcelona 2017).

The tourist sector makes a very important economic contribution to the city. It represents 14% of Barcelona's GDP (Ajuntament de Barcelona 2015). However, the tourist sector in the city also has important environmental impacts. In Barcelona tourism contributes to 9.578.359 tonnes CO_2eq., which is 96,93 kg CO_2 eq/visitor·day (Rico et al. 2019). 95,9% of these emissions are caused by arrival and departure transport, especially air traffic (89,3% of arrival and departure transport GHG emissions) (Rico et al. 2019). Cruise ship passengers can arrive to the city by cruise ship and visit the city for few hours, known as 'transiting'. They are counted as day visitors to Barcelona, as they are not staying overnight in the city. Transit passengers generate 66,1 kg CO_2 eq/cruise day-tripper·day, the largest amount of emissions of all tourist day visitors (Rico et al. 2019). Cruise passengers can also start or finish their trip in the city (turnaround passengers), and 16% of them do so by using transoceanic flights (average of 135,4 kg CO_2 eq/visitor·day), which is 0,9% of the total arrival and departure transport GHG emissions of cruise sector (Rico et al. 2019).

3.4.1. How did Barcelona become a touristic city?

The celebration of the Olympic Games in the city was a turning point in the development of today's tourism sector in Barcelona. The preparation of the city for the event, involved various urban and waterfront regeneration projects that added value to the cultural heritage of the city and improved the tourism infrastructure and its associated services. The touristic tradition of the city had started much earlier than this, however. In 1859, a city expansion plan called *Pla Cerdà* was approved. This plan involved new urban organisation intended to improve habitability for the residents of the city, in terms of hygiene, public health and urban traffic (Oficina Coordinació Any Cerdà 2009). The plan envisioned the creation of multiple centres, and strengthening the capital position of Barcelona. The city thus started its expansion and modern urban transformation. Its commercial and industrial character also inspired the city to host the International Exhibition in 1888. The idea behind the International Exhibition of 1888 was to renew the city through the coordination of public institutions and private actors (Palou Rubio 2011). The exhibition was used to provide the city with public infrastructure, monumental elements and hotels and services, such as those in other western cities of the time. By the end of nineteenth and beginning of twentieth centuries, Barcelona had the necessary elements (such as, hotels, services, urban dynamism and emblematic spaces like Les Rambles and Colom statue) to develop a tourist industry in the city (Palou Rubio 2011). These two historical events meant the profound urban transformation of the city and the beginning of its international promotion.

In 1906, the city council created the first entity to promote Barcelona's tourism activity, called *Comisión de Atracción de Forasteros y Turistas* (CAFT) (Commission of Attraction of Foreigners and Tourist). The CAFT created the first tourist office in Barcelona and the first tourist poster and slogan of the city, "*Barcelona ciudad de invierno*" (Barcelona, a winter city) (Figure 16). The CAFT objective was to make Barcelona a tourist destination and to use tourism as a tool to modernise the city (Palou Rubio 2011).

The *Sociedad de Atracción de Forasteros (SAF)* (Society for Foreigners Attraction) was created in 1908. The two tourist entities coexisted and collaborated until 1909, as they had a very similar objective, the touristic development of the city (Palou Rubio 2011). The CAFT was soon replaced by the SAF. SAF integrated members of the municipality and the private sector, and members of the main cultural associations and institutions of the city (INSETUR 2014). The main objective of the SAF was the touristic promotion of the city, and a city model based on tourism (Palou Rubio 2011). SAF was financed by public institutions and private donations.

This public-private touristic promotion model became a reference for other Spanish and European cities(INSETUR 2014) .

Figure 16. Poster with the Barcelona's first slogan 'Barcelona ciudad de invierno' (Barcelona a winter city). Source: Museu Nacional d'Art de Catalunya (2014)

In the first half of the twentieth century, Barcelona experimented with a new urban transformation, the construction of the *Gòtic* quarter in the city centre and *Pueblo Español* in Montjuïc. The urban transformation was motivated by another international exhibition, the *Exposición Internacional de las Industrias Eléctricas* (INSETUR 2014). This event was used to reinforce the international projection of the city and provide modern infrastructure and emblematic and monumental elements, as found in other European capitals. During this period SAF projected the international image of the city in the European market and supported the development of a rich cultural offering. Barcelona became one of the preferred destinations of the time (INSETUR 2014). The touristic development of the city then stopped due to the civil war (1936-1939). Tourist activity was stopped during the Spanish Civil war and dictatorship period (1939-1975). All public institutions, including those for tourists, were given over to the control and interest of the Francoist government. The Francoist government did not support the touristic development of the city during this period.

The situation started to change after the end of the dictatorship. In 1979, Spain celebrated the first democratic elections since the dictatorship. The first democratic municipal government created the *Patronato Municipal de Turismo de Barcelona* (Municipal Tourist Board of Barcelona) which aimed to promote Barcelona as a touristic destination (INSETUR 2014). At the same time, the city was becoming a post-industrial city. The announcement that it would host the Olympic Games in 1992 accelerated the urban transformation. The layout of the railway along the coast (Figure 17), which served as a barrier between the city and the sea, was changed and moved inland through a tunnel, reconnecting the city to the sea. The old industrial waterfront areas were transformed into urban and recreational spaces, such as a recreational port in the old port (named Port Vell), beaches and promenades. The city also reorganised the drainage system as a means to improve coastal water quality. Water

collectors were installed, as were water treatment plants to reduce direct sewage into the sea. At the same time the cultural elements of the city were promoted as touristic attractions, such as its modernist architecture. This urban regeneration process was framed within the Barcelona Model, which was seen as a successful model for urban regeneration that combined cultural strategies and urban regeneration to tackle social difficulties (Degen and Garcia 2009).

Figure 17. Barcelona coastline circa 1980-90. The train lines (in red) along the coast of Barcelona acted as a barrier between the city and the sea. The exact date of the picture is unknown. Source: Villares (2015)

Barcelona's urban regeneration process took place within a shifting tourist paradigm; the sun and beach model was in decline, and urban tourism was emerging. The liberalisation of air traffic led to cheaper flight tickets, which created new touristic destinations and demands (INSETUR 2014). Transformed urban centres recovered their cultural and touristic centrality, as in Barcelona. Tourism development also reinforced the international role of cities and strengthened the competitive capacity of cities in a global world (Palomeque 2015). Urban tourism expansion served as basis on which to define new urban production and consumption relationships and public space functions (Palomeque 2015).

In this context, and especially because of the Olympic Games celebration in 1992, the municipality of Barcelona started a process of reflection and transformation of the city, where tourism was a key factor in future development (Bové and Guim 2013). The first meeting between the municipality of Barcelona, represented by the Municipal Tourism Board and the Tourism Committee of the Chamber of Commerce, Industry and Navigation of Barcelona took place in 1987 (Duran 2002, Bové and Guim 2013). A partnership was built that resulted in the elaboration of a Strategic Tourism Plan, approved in 1993. The main objective of the plan was to evaluate the potential of the city to become an international touristic destination by taking advantage of the Olympic Games (Garay-Tamajon and Canoves-Valiente 2012). The plan aimed to promote the image of Barcelona, position the image of Barcelona and its tourist offer in the international context, expand to new markets and increase the expenditure by visitors, consolidate the existing tourist activity, monetise the public and private investment from the Olympic Games and to reinforce economic sectors linked to tourism (Bové and Guim 2013).

The Strategic Tourism Plan of 1993 represented the beginning of a strong collaboration between the public and private sector for urban and tourism development (INSETUR 2014). The plan represented the convergence of interests between public and private institutions in the city. A new tourism promotion entity was created on 1993, called *Consorci de Turisme de Barcelon*a (Barcelona's Tourism Consortium). The consortium is composed of public and private sector representatives. In this way, the private sector can participate in the touristic promotion of the city, while partially financing it. The creation of the consortium also meant a complete shift in the tourism promotion model of the city. Tourism promotion moved from the general promotion of the city, to market specific and specialised touristic promotion by identifying touristic market segments, such as cruise market (Garay-Tamajon and Canoves-Valiente 2012). The objective was to identify and attract new market segments into the city. For that reason, the consortium developed market actions and campaigns intended to focus on new market segments in concordance with their origin, profile and motivation (INSETUR 2014).

The number of tourists travelling to the city started to grow significantly after the Olympic Games (Palomeque 2015). The increasing supply and demand, the location of the city and its environmental conditions greatly contributed to this growth. After many decades of abandonment of the city's natural and cultural heritage, especially its waterfront and beaches, they were restored so as to make them attractive for international visitors (Garay-Tamajon and Canoves-Valiente 2012) (Figures 18 and 19). The location of Barcelona also contributed to its touristic development. Barcelona is located close to major European markets, and in the Mediterranean basin, close to other Mediterranean tourist destinations. The city is a Mediterranean metropolis and the capital of a traditional sun-and-beach regional destination (Catalonia).

Figure 18. Somorrostro beach circa 1950. vs. nowadays. Source: (Quitian 2017)

Figure 19. Marina Street in 1988 vs. nowadays. In 1988, the area was marginal and abandoned. The beach was inaccessible. An industrial area was demolished in 1987 and its inhabitants were relocated (García 2017). A team of architects led by Oriol Bohigas, Josep Martorell, David Mackay and Albert Puigdomènech designed the Vila Olimpica, where international athletes were hosted during the Olympics. Nowadays this is one of the areas in Barcelona where with a higher average income of residents (Ajuntament de Barcelona 2017c). Source: (Ramos no date) and Google Maps.

Today, there is no doubt that the Olympic Games of 1992 meant a profound transformation of Barcelona, however, Barcelona had been a historical tourist destination since the beginnings of the twentieth century, when the basis of the touristic model of the city was established: public-private partnerships for touristic promotion and culture as a central element of urban tourism (INSETUR 2014). The results of the Olympic Games and the Barcelona model encouraged many critical reflections, and authors such as Delgado Ruiz (2007) argues that the Olympic Games and the supposed success of the Barcelona model served to create and consolidate Barcelona as a brand and product that could be commercialised.

3.4.2. The rise of cruise ship tourism in Barcelona

Barcelona became the first cruise ship harbour in the Mediterranean, and the fourth worldwide, surpassed only by Miami, Port Canaveral and Port Everglades, all in Florida (USA) (Garay-Tamajón 2015). The number of cruise ship passengers arriving in the city has increased since 2001. In 2001, around half a million passengers visited the city. In 2018, three million cruise ship passengers visited Barcelona in 830 cruise ships (Autoritat Portuària de Barcelona 2017, Ajuntament de Barcelona 2018). This represents 37,8% of the tourists who visited the city (not including day visitors). In 2001, the percentage of cruise tourists was 19,4%, and therefore the percentage of cruise tourists is also increasing in relation to the total number of non-cruise ship tourists (Figure 20).

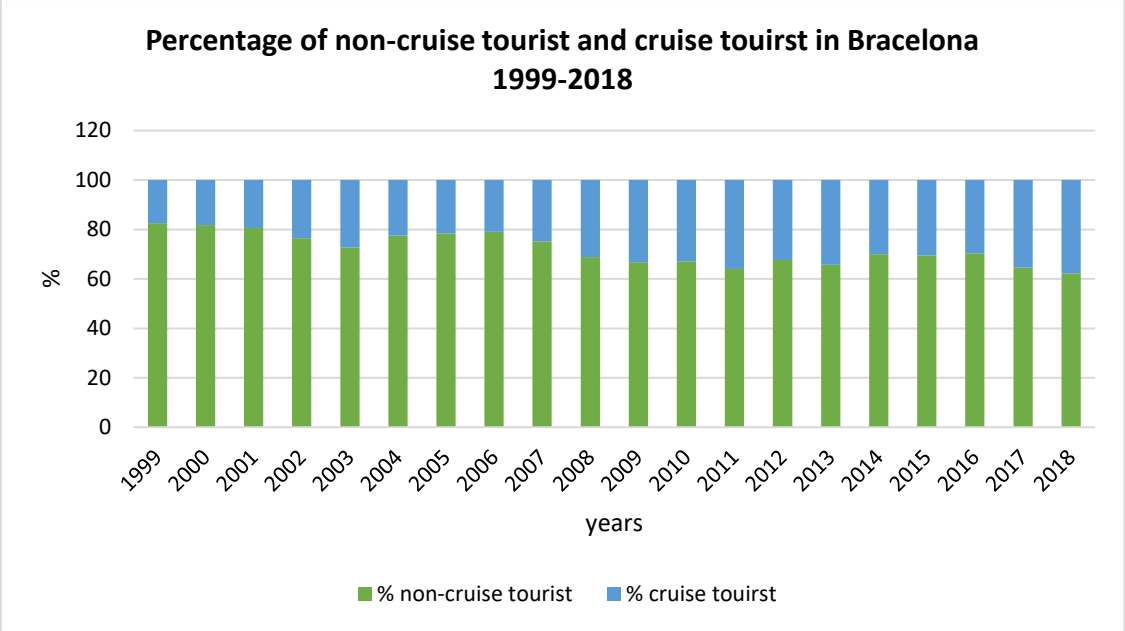


Figure 20. Percentage of non-cruise tourists and tourists in Barcelona between 1999-2018. The number of cruise ship tourists has been growing, but it still represents a small proportion of the total tourists visiting Barcelona. Source: own elaboration based on Autoritat Portuària de Barcelona (2017) and Ajuntament de Barcelona (2017d)

The boost to Barcelona as a cruise ship destination is rather novel, but the history of cruise ship tourism in Barcelona and in Spain can be traced to many years ago. The first cruises that operated in Spain did so during early nineteenth century. Some companies that operated in Barcelona's harbour shipped products and travellers, mostly emigrants travelling from Spain to the Spanish colonies and South America (Garay-Tamajon and Canoves-Valiente 2012, Cerchiello 2017). The harbour in Barcelona was expanded at the end of the nineteenth century, when the first transversal dock was built in 1882 thanks to Barcelona's *Junta de Obras del Puerto* (Board of Port Construction) (Alemany 2002). As a result, companies such as Transatlantic and Transmediterránea started transporting travellers to and from the harbour. Tourists were still a small percentage of travellers, mostly a few high income travellers who crossed the Atlantic as a touristic experience (Garay-Tamajón and Valiente 2012, Garay-Tamajón 2015).

The situation remained stable in the first half of the twentieth century, unlike in other European countries. The number of tourists travelling by cruise ship in Spanish harbours was very small. The Civil War and later the dictatorship prevented any significant change. Barcelona's harbour continued to be an industrial harbour. In the 1960s, the political context started to change in Spain. The autarchy period supported by the Franco's dictatorship finished, and a process of openness to international trade began, in which tourism was a key factor. An incipient cruise culture emerged in the country, but was still associated with high income tourists. Only 20.000 Spaniards took cruise ship holidays (Garay-Tamajón 2015).

Between the 1970s and 1980s new cruise companies were created in Spain, such as *Unión Lloyd* and the *Central de Cruceros Company* (Garay-Tamajón 2015). The amount of cruise passengers began to increase in the 1990s due to the celebration of the Olympic Games in the city. The creation of the Barcelona Tourism Consortium and the elaboration of the Strategic Tourism Plan in 1993 transformed the cruise tourism sector in the city. In fact, the

Strategic Tourism Plan saw cruise tourism as a crucially important market segment for tourism development in Barcelona (Garay-Tamajon and Canoves-Valiente 2012). Eleven cruise ships were used as hotel accommodation during the Olympic Games. This experience tested the capacity of Barcelona's harbour to host large cruise ships. It was a successful experience that proved the operational capacity of the harbour's managers and showed the potential of the city to host cruises (Garay-Tamajon and Canoves-Valiente 2012).

This experience was later used, together with other factors, to boost the cruise ship tourism sector in Barcelona. Garay-Tamajon and Cannoves-Valiente (2012) explain the factors that contribute to the consolidation of the city as leading cruise ship harbour in the Mediterranean. The main one is the synergistic relationship between Barcelona's harbour authority and the public-private institution in charge of tourism promotion in the city, the Barcelona Tourism Consortium. Since 1992, the harbour authority has collaborated with cruise ship companies, built safe embarkation facilities and infrastructures for cruise ships and has promoted Barcelona as a cruise ship tourist destination. At the same time, the Barcelona Tourism Consortium has created a successful touristic image for the city. Other factors were the competitive prices, the location of the city close to European markets and other tourist destinations within the Mediterranean basin, the location of the harbour and the short distance from the city centre, the existence of infrastructure for leisure pursuits, the development of new products to fulfil the demands of cruise ship tourism, good and safe port infrastructure and connections with other means of transport, especially Barcelona's El Prat airport. All these factors evolved while the European cruise ship market was growing, and the Mediterranean was becoming a cruise ship destination.

3.4.3. Current cruise ship tourism in Barcelona

The above resulted in the launch and consolidation of cruise tourism in Barcelona. The harbour and cruise ship infrastructure have been adjusted for new needs since then. At the end of the 1990s the harbour had occupied all the available land for expansion because it had reached the old mouth of the river Llobregat, however, the port activity continued to grow and demanded more land. The port envisioned a plan to build a new logistics area (named ZAL-2) and a large dyke by expanding the harbour southwards. This plan was part of *Pla Delta*[13] and required deviation of the Llobregat's flow (Figure 21). In 2004, the last section of the River Llobregat was diverted and the plan was carried out. To compensate for the deviation of the river a 'natural' area was created around the new mouth of river. In 2008, the construction of the big dyke southwards was finished, as was the extension of the already existing east dock.

[13] Pla Delta was signed in 1994. The plan blueprinted a series of transformations around Llobregat's delta. Different public administrations with interests in the area - such as the municipality of Prat del Llobregat, the airport and the harbour - signed an agreement to develop infrastructure based on the expansion of the port and the airport (Margenet 2009).

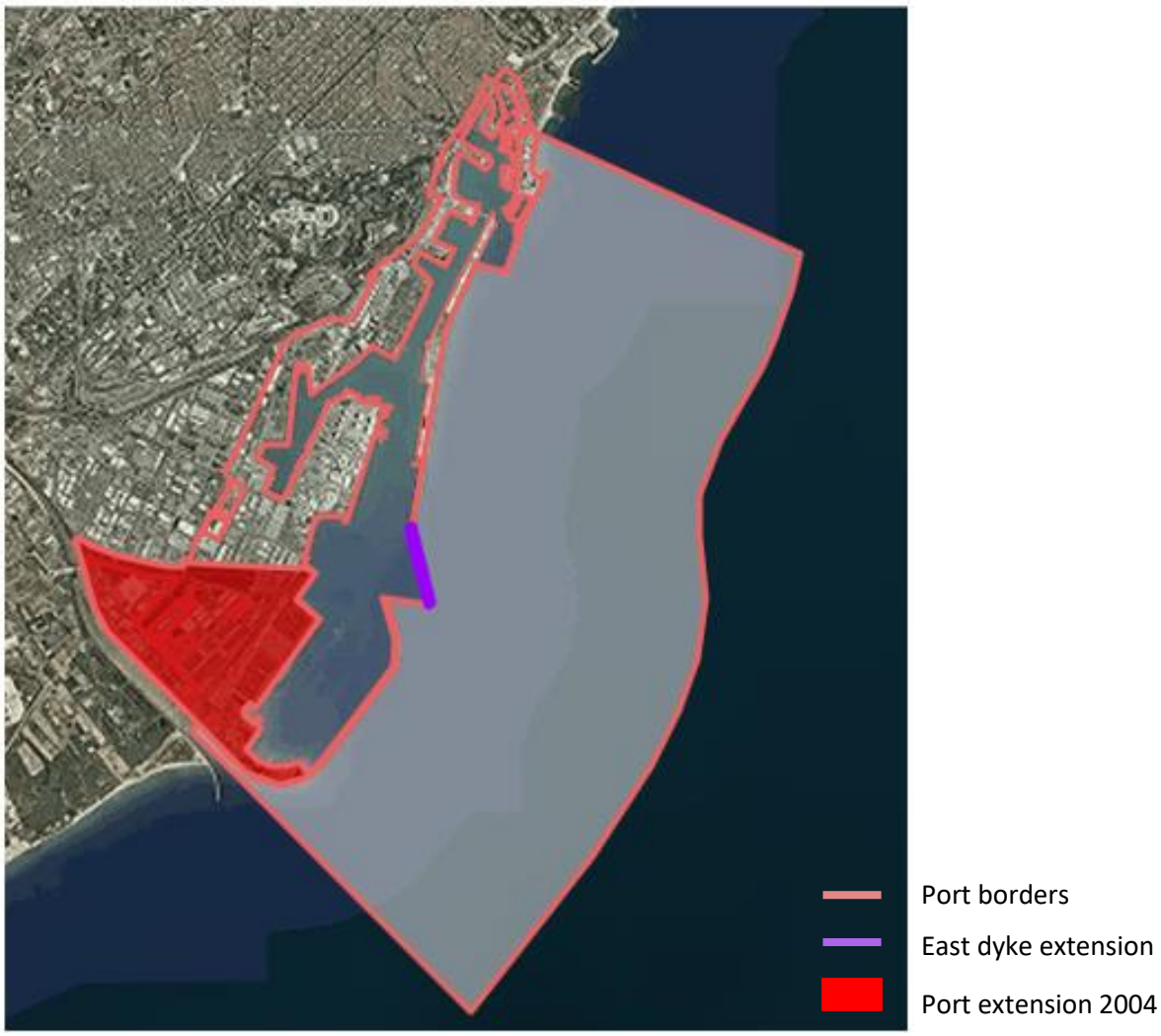


Figure 21. Barcelona's harbour borders and extensions. In red, the harbour area gained for land and sea through deviation of the River Llobregat in 2004. In purple, the east dock extension was completed in 2008, measuring 2.170 meters long. Source: own elaboration.

There are currently eight cruise ship terminals. In the main cruise ship dock (East dock or Moll Adossat) there are five terminals, A, B, C, D, E (Figure 22, 24 and 25). There are three smaller terminals in the Old Port: Terminal South, Terminal North and Terminal Maremàgnum (Figure 22 and 23). According to the agreement signed between Barcelona's harbour authority and Barcelona's municipality in 2018, South, North and Maremàgnum the terminals will be closed when the current concession agreement finishes. In exchange two more terminals will be built in the east dock, one of them is already planned, Terminal F. Similarly, one of the ferry terminals, that is currently located closer to the city centre, will be moved to east dock (Figure 22).

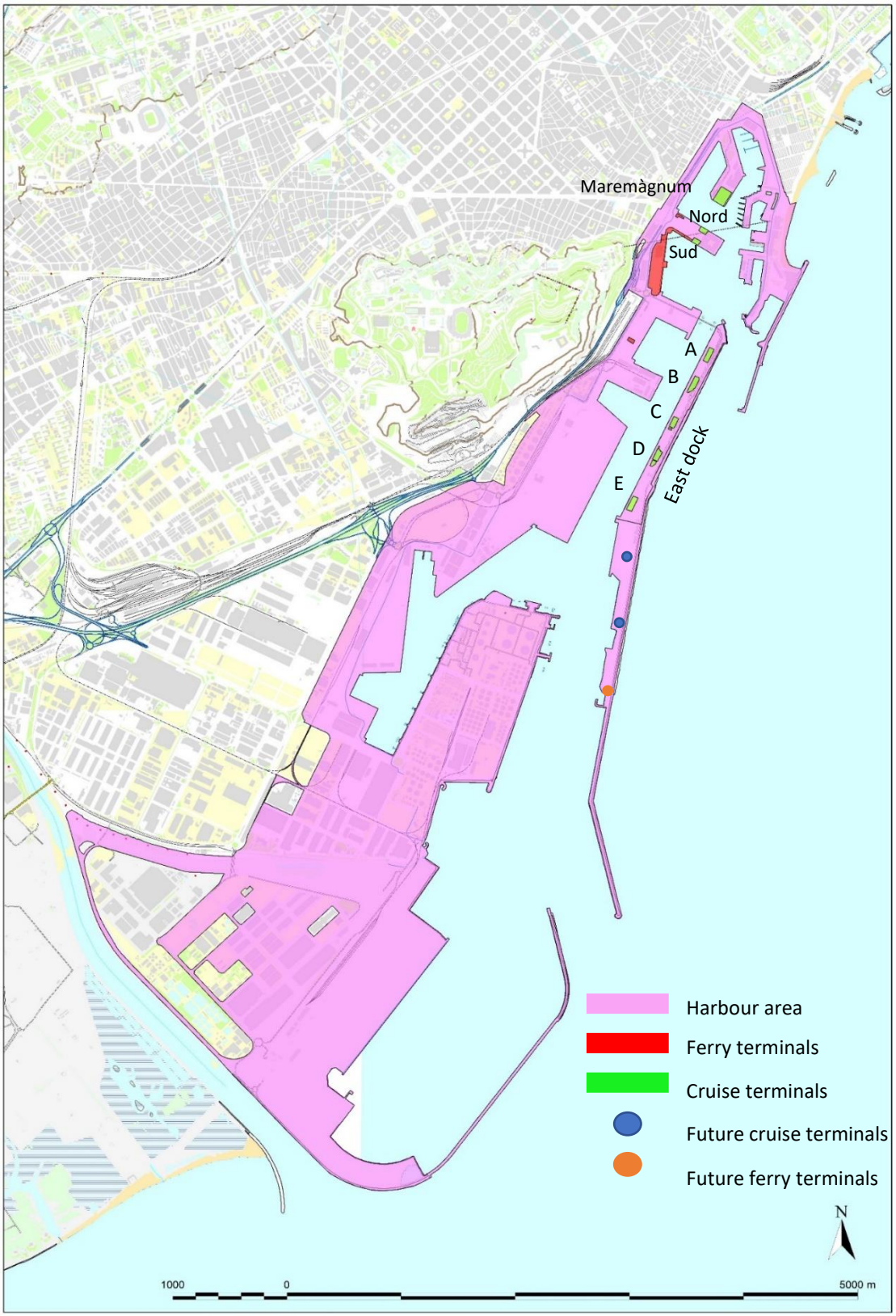


Figure 22. Barcelona's harbour location and limits from left to right. Location map of Barcelona in Catalonia and location map of Barcelona's harbour. Source: own elaboration.

Figure 23. View of North and South terminals. These terminals, according to the agreement of 2018, will be dismantled once the concession finishes. Source: (AQR-Lab Universitat de Barcelona 2016).

Figure 24. View of the east dock with four cruise ships. Source: Estrada (2019).

Figure 25. General view of Barcelona's harbour. Four cruise ship are berthed in front if the east dock and there are two more cruise ships berthed at the back, at the South and North terminals. Source: Europa-Press (2017).

Cruise ship passengers, crews and cruise lines have made direct contributions to the local and regional economy, which has been studied by Vayá et al. (2016). Their total contribution to the Catalan economy is 1.083.000 million € (Figure 26). The direct spending of passengers, crew and cruise lines is distributed between different sectors (Figure 27 and 28).

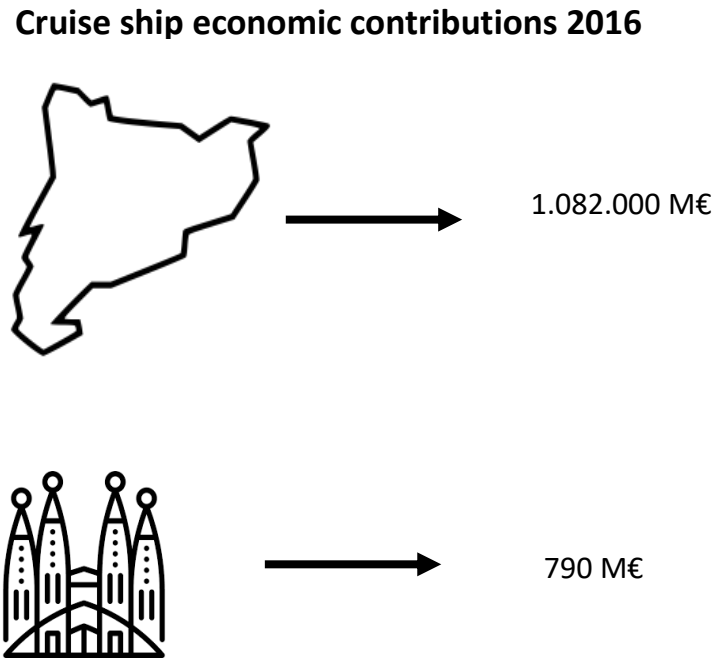


Figure 26. Regional and local economic contribution of the cruise ship sector. The direct contribution to the regional economy is 619 M€ by direct spending. Indirect and induced contributions rise to 467 M€, in total 1.082.000 M€ (three M€ per day). Of these economic contributions, 73% stays in the city of Barcelona, 790 M€. Source: own elaboration based on Vayá et al. (2016).

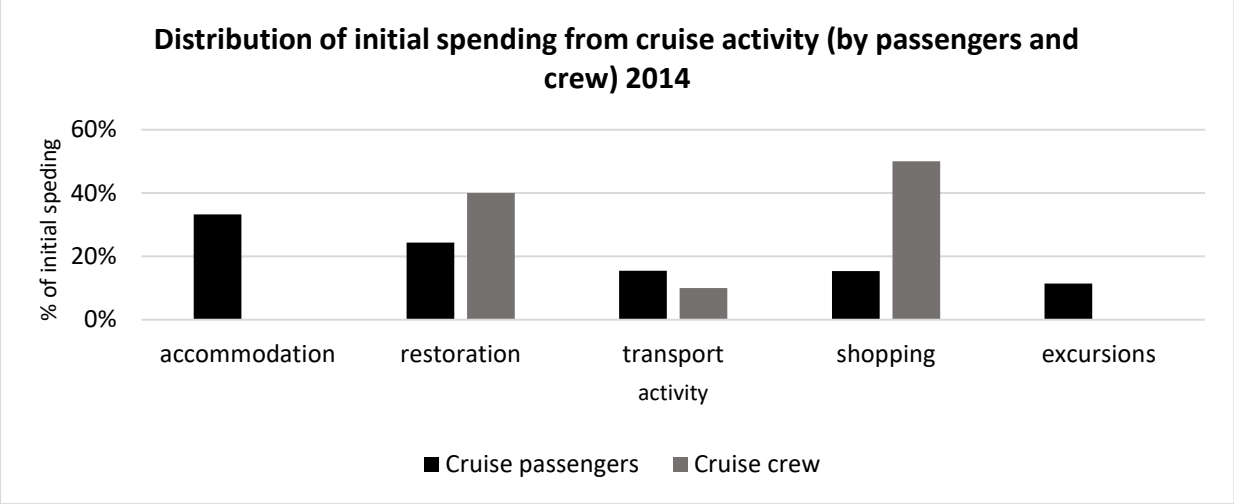


Figure 27. Cruise ship sector economic distribution of initial spending among sectors by passengers, crew and cruise lines. Direct spending of passengers and crew is distributed between different sectors. Most passenger expenditure is on accommodation and catering. The crew mostly spends on catering and shopping. Source: own elaboration based on Vayá et al. (2016).

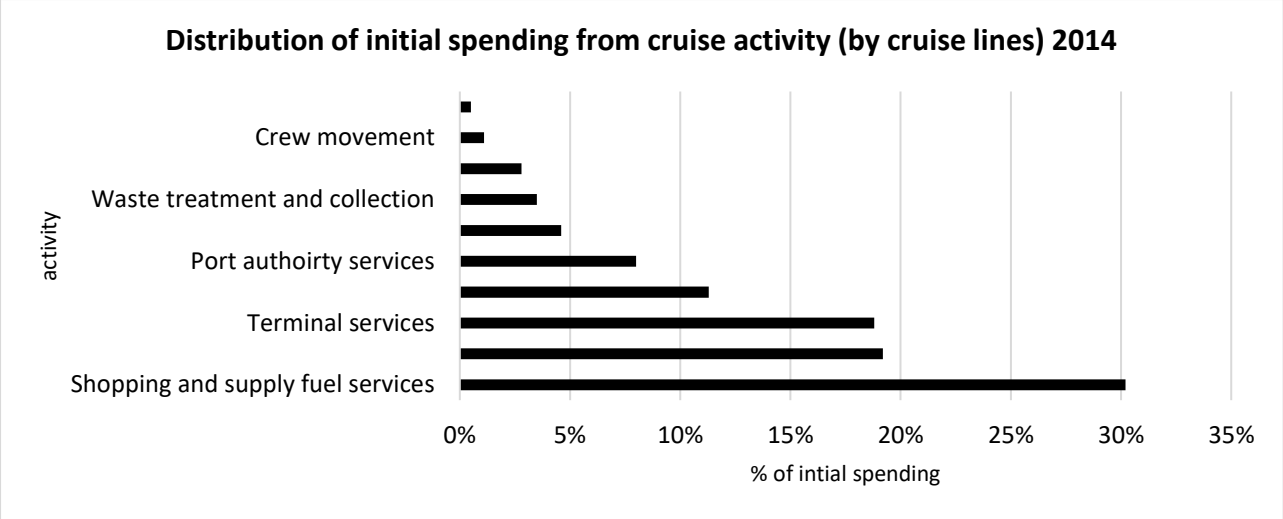


Figure 28. Distribution of initial spending by cruise lines in 2014. Direct cruise lines spending is focused on the supply of fuel services, provision of food and beverages, terminal services, travel agents and tours. Source: own elaboration based on Vayá et al. (2016).

Thanks to the connections with other transport, especially Barcelona's airport, many cruise lines use Barcelona as turn-around port, where passengers embark and disembark. The number of turnaround passengers varies between years (Figure 29). On average, 55% of Barcelona cruise passengers were turn-around passengers in 2007-2018 (24% visited the city before or after the cruise trip). On average, they stayed 2,6 days in the city and they spent 202€ per day in the city (Figure 30). Nineteen percent of turn-around passengers do not stayed overnight in the city, however, as they travel directly from or to the airport to the cruise ship. The economic contribution made by turn around passengers to the local economy is higher than that of cruise day-visitors.

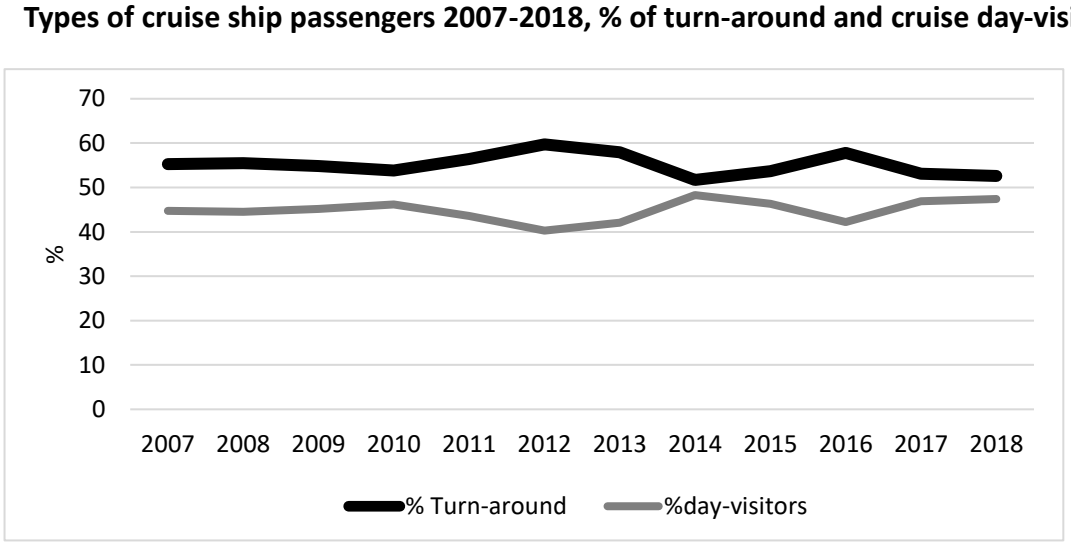


Figure 29. Typology of cruise ship passengers 2007-2018, % of turn-around and 1-day visitors. The percentage of turn-around and 1-day visitors (also called transit passengers) from 2007- 2018 has remained stable. Source: own elaboration based on data provided by the Harbour Authority of Barcelona.

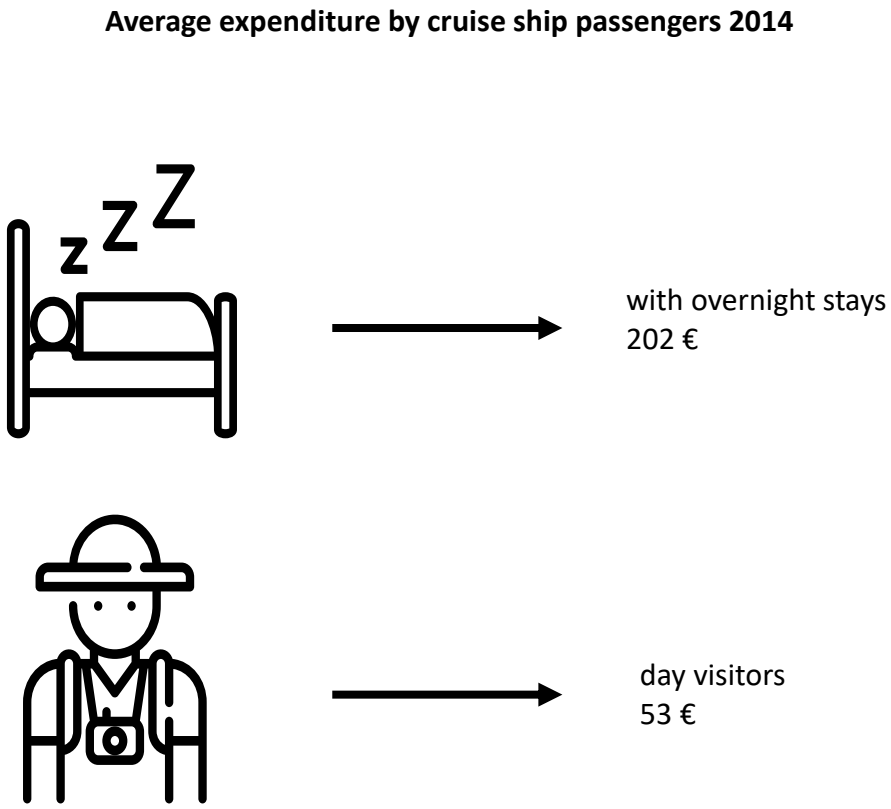


Figure 30. Average expenditure by type of cruise ship passengers. The average daily expenditure of turn around passengers is higher than that of cruise ship day visitors. Source: own elaboration based on AQR-Lab Universitat de Barcelona and DYM Instituto (2014).

Tourism development strategies in Barcelona have resulted in unlimited tourism growth since the 1990s. Local civic and political organisations have recently started questioning the positive impacts of such growth, requesting a shift towards tourism reduction and sustainability (Figure 31). Cruise ships are part of these criticisms, although they represent a small proportion of tourism. In 2016, during the diagnosis phase of the Strategic Tourist Plan 2020 of Barcelona (Ajuntament de Barcelona-Direcció de Turisme 2017), the municipality of Barcelona organised thirteen thematic participation sessions with different actors related to tourist-specific issues in the city – such as the employment and labour market in the tourist sector, planning and urban development management tools around tourism and marketing for a sustainable and responsible destination. Two of these sessions were 'The effect of cruises on destination Barcelona'. These two sessions showed two radically opposed positions; actors that defended the positive impacts of cruise ship tourism, especially economic impacts, and actors that questioned these positive impacts and condemned the social and environmental impacts of cruise ships.

Figure 31. Protest against cruise ships in Barcelona in April 2018. Source: Europa-Press (2018)

In spite of the existing confrontation between the two positions, both agree on the lack of data about the phenomenon, and the deficit of rigour and reliability in the data of existing studies, whether economically or environmentally. The existing published reports generate distrust among the parties, as their origin and intentions are unclear. Vayá et al. (2016), the first and only analysis of the economic impact of the sector, did not account for social and environmental costs. This dissertation aims to provide rigorous and reliable data on the cruise ship phenomenon through a case study of Barcelona and to shed some light on its environmental and social costs.

3.5. Case study research design and methods

Section 1.10. presented and justified the general research design and methodology of the case study, the combination of a case study and GT. The combination of these two methodologies has been applied to Research Objectives Two and Three of this dissertation: Objective 2) To identify and characterise ES demanded by cruise ships (ships and passengers); Objective 3) To understand how power relationships condition: a) access to ES, and b) the distribution of externalities derived from the use of ES. Objectives Two and Three also shared data collection methods. The following research strategy has thus been followed (Figure 32).

The research strategy combines qualitative and quantitative techniques. A mixed method approach has been followed by combining semi-structured interviews, reviews of official documents and reports, and a survey to cruise ship passengers. The researcher has triangulated the data obtained, which improves the validity of the research, and ensures that the research is verifiable and can be extrapolated. Triangulation is used as a means to avoid research bias (Creswell 1994, Beeton 2009).

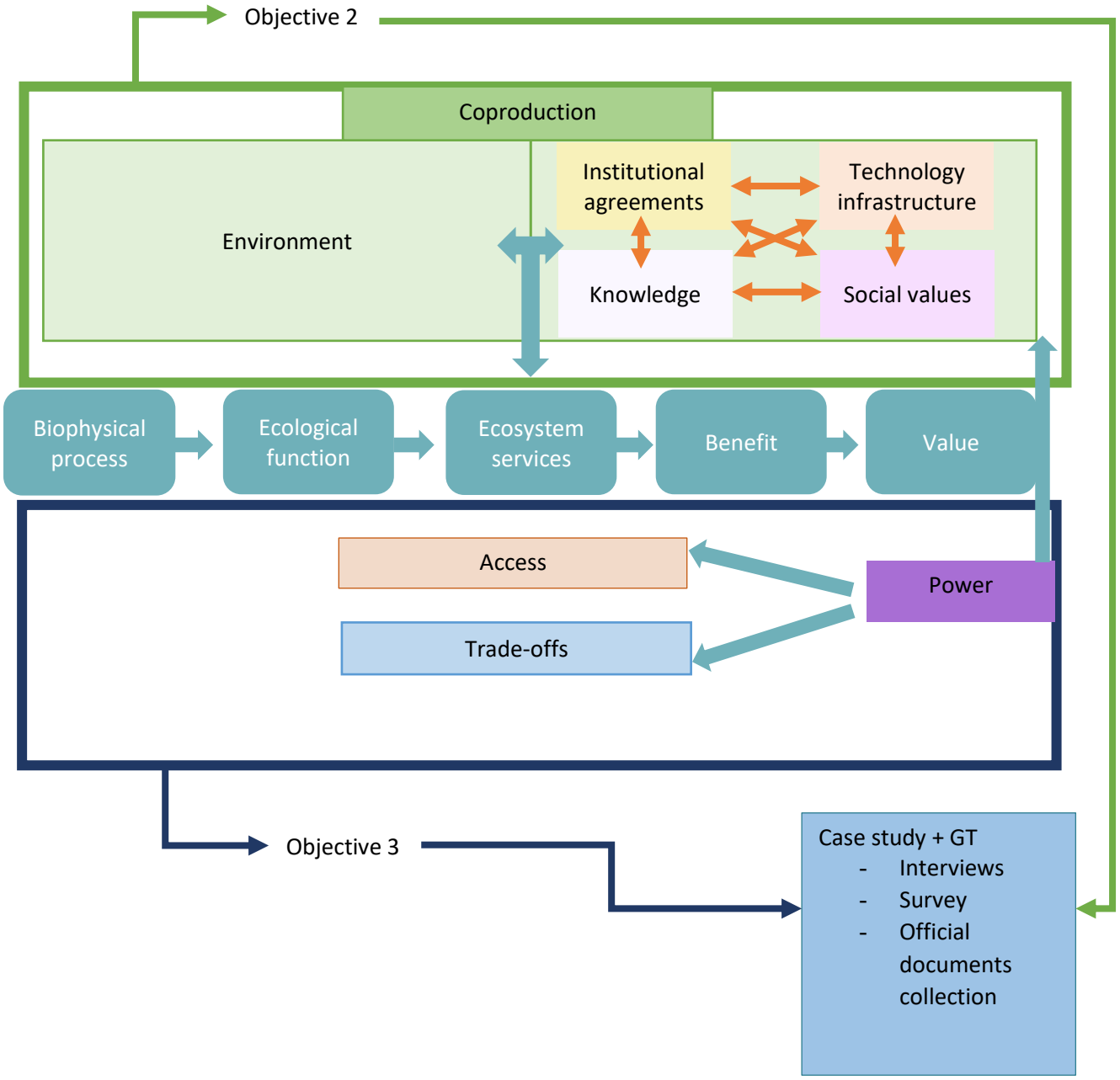


Figure 32. Research strategy case study. Source: own elaboration

3.5.1. Data collection

Data collection for both objectives was carried out simultaneously in different field work periods. The field work was divided into two different rounds due to theoretical sampling requirements, as the sampling of new data for qualitative research needed to be supported by an analysis of the previous data collected (Table 3) (Charmaz 2006, Halaweh and Kim 2012). The survey data were collected in two different seasons (winter and summer) with the objective of capturing seasonal differences in cruise ship passengers.

Table 3. Field work methods and periods

Data collection method	**1st round**	**2nd round**
Semi-structured interviews	October 2017 - December 2017 20 Interviews	June 2018 - September 2018 22 Interviews
Survey	January 2018 234 questionnaires	June 2018 521 questionnaires

The semi-structured interviews were structured in five main blocks. First interviewees were asked about the ES demanded by cruise ships, second about the coproduction process of these ES, third about actors and relationships involving ES, fourth about access mechanisms to ES, and fifth about exclusion to ES and trade-offs (see interview protocol in Appendix D).

In total, forty-two interviews were conducted with different respondents, with a stratified approach to cover each of the major stakeholder groups identified: twelve with local and international academics (expertise on tourism, environmental science, air pollution, water management, ecosystem services and cruise ship sector), five with local activists, eleven with political and administrative authorities (from the municipality of Barcelona, Barcelona's Harbour Authority, Barcelona's Tourism Consortium), one with a cruise ship company officer, four with ship agency officers, two with ship's chandlers officers, one Cruise Line International Association officer in Spain, two with tourist guides, one with a bus company spokesperson, two with waste management officers and one with a docker's union representative.

During the interviews, respondents commented on existing official documents and/or reports. These official documents and reports were reviewed and analysed. Quantitative data found in these official documents or reports was used to support qualitative analysis. Secondary data therefore served as means to reinforce the analysis and provide more validity for the research, and thus to triangulate the results.

The survey conducted with cruise ship passengers was structured in three different blocks (Appendix C)

1) Arrival and visit basic information: how did they travel to Barcelona, how long did they stay in the city, and how did they move around?
1) Demand of ES: what did they visit and why, and which ES did they require during their visit?
2) Passenger profile: country of origin, age, gender, and with whom they were travelling.

A purposely developed questionnaire was tested on December 2017 with 15 respondents. The questionnaire was designed based on information collected through the literature review on ES and the case study and four exploratory interviews. The final survey was conducted in two different seasons (winter and summer), with 756 respondents in total.

The researcher worked with officers of the harbour authority to develop a cruise ship passenger profile: high, medium and low socio-economic levels. The sample was thus stratified by cruise ship category[14] (Table 4).

Table 4. Cruise ship passengers profile and number of surveys

Passenger profile	Number respondents
Luxury (winter)	45
Luxury (summer)	100
Premium income (winter)	135
Premium income (summer)	300
Standard income (winter)	55
Standard income (summer)	121
Total	756

Data collection dates were selected in accordance with the cruise ship profiles arriving each day. On these days the researcher administered questionnaires to cruise ship passengers after they had visited the city, just before departing from Barcelona. The cruise ships that arrive in Barcelona and the exact hour of arrival and departure can be found on the Barcelona Harbour Authority's website. The time of data collection was planned in accordance with the cruise ship schedule. Generally, cruise ships arrive into the harbour early in the morning, between 7 to 9am. Organised excursions start between 9 and 10 am. From 11 until 1pm, responses were collected randomly in specific touristic spots where cruise ship passengers have some free time. These locations had been previously identified with the help of local tourist guides (such as Barcelona's Cathedral and Museu Marítim). Cruise ship passengers on organised excursions can be identified because they use a tag with the name of the cruise ship they are travelling. In order to collect responses from cruise passengers visiting the city without an organised excursion, responses were also collected randomly inside harbour limits, and specifically inside shuttle buses (Figure 33 and 34) from Barcelona city centre to cruise ship terminals.

The survey sample was limited due to restrictions imposed by terminal operators and cruise companies, as the researcher was not able to enter cruise ship terminals, nor excursion or transfer buses. These limitations reduced the representation of the sampling, because it was only possible to access cruise passengers outside the terminals, once they were visiting the city or when inside the shuttle bus. In this way, the researcher only had access to passengers who visited the city by organised tours or passengers that visited the city freely and took the

[14] Such as the stratified sampling developed by AQR-Lab Universitat de Barcelona and DYM Instituto (2014). This classification differs from Pallis (2015) as it only includes three categories (luxury, premium and standard), instead of four (luxury, premium, contemporary and budget). Pallis' (2015) classification includes a budget category, however the traffic of budget cruise ships is not relevant to Barcelona.

shuttle bus to return to the cruise ship. The researcher did not have access to passengers who returned to the cruise ship by taxi, cruise company transfer bus, by foot or other means of transport. It was also not possible to access turnaround passengers who travelled directly from the airport to the cruise ship or vice versa, or turnaround passengers who arrived at the cruise ship by taxi, by private vehicle or by foot. In some cases, this lack of representation is significant, as according to Ros Chaos et al. (2018) 48% of turnaround passengers arrive at cruise terminals by taxi and 25% by transfer bus. Consequently, transit passengers are better represented in the sampling than turnaround passengers. This lack of representation is difficult to overcome, as the permission to enter cruise terminals does not depend on the harbour authority, but on each terminal operator and cruise company.

Figure 33. Field work data collection. Shuttle bus where survey responses were collected. Source: own elaboration

Figure 34. Field work data collection. Area where excursions buses and shuttle buses stop before and/or after visiting the city. Source: own elaboration

3.5.2. Data analysis

The transcription of the interviews was made manually. In some cases, if the audio of the interview was very clear, I used an automatic transcription tool (HappyScribe). This automatic transcription tool transcribed around 50% of the interview, and the rest I did manually.

After transcribing all the interviews, the texts were analysed and managed in NVivo11 (QSR International Inc., Burlington, Massachusetts, USA). Following the grounded theory systematic process, I first applied an initial coding process sentence by sentence (Figure 35). In this stage of the process, I tried to use codes (in NVivo called nodes) as close to the text as possible. As suggested by Charmaz (2006), I looked closely actions on the data and I made as much effort as possible to code the data as actions. In some cases, a quotation had more than one code. It is important to stay open minded during initial coding (Charmaz 2006). Every time new ideas or hypothesis emerged; I wrote a memo. I also captured reflections on each transcribed and coded interview in memos. The second coding step was the definition of focused codes. I aggregated the most relevant and repeated initial codes as broader codes. For instance, when different global food flows were mentioned, I merged them into a more general code called global flows.

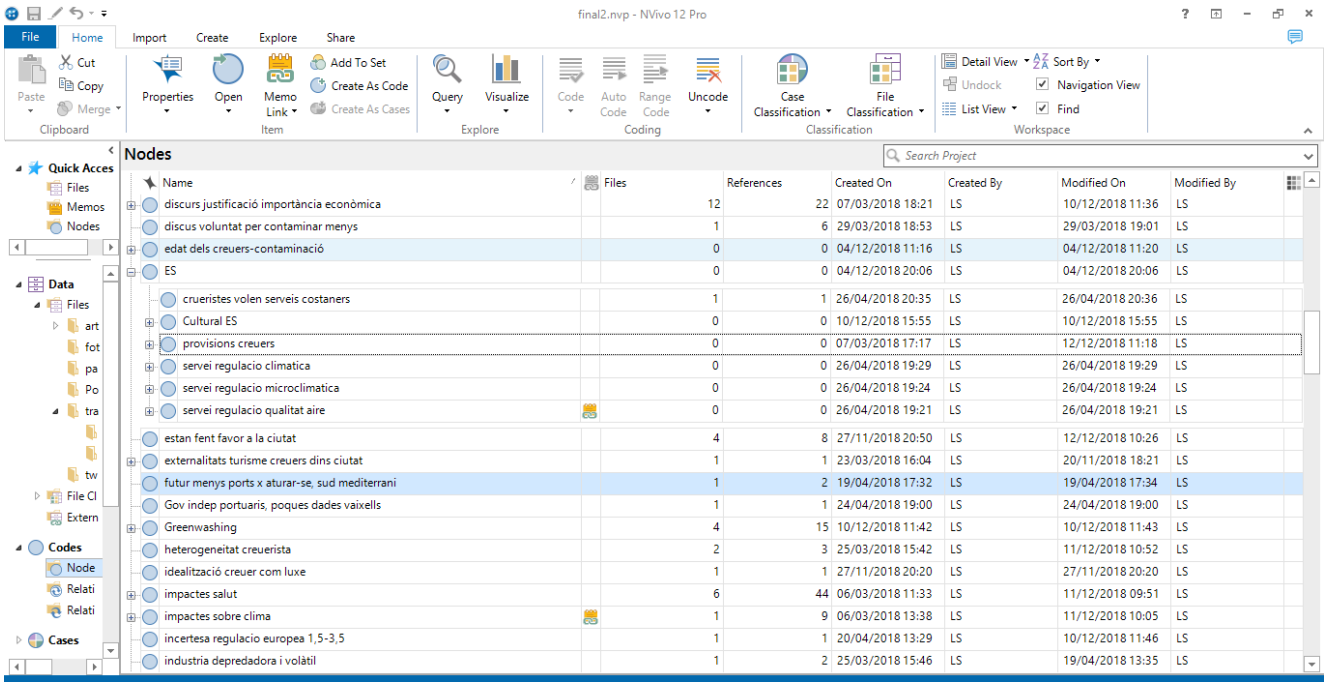


Figure 35. Example of initial coding phase.

The results of focused coding were a codebook for each research objective. The codebook used to address Objective 2 consisted of 21 codes (Table 6). Similarly, the codebook applied to analysing Objective 3 contained 21 codes (Table 8). Both codebooks were created using an iterative process: if new codes emerged, they were added to the codebook. I wrote new memos during the focused coding phase (Figure 36). I also identified some relationships between codes and memos. At the end of the focused coding phase I reviewed all memos, which helped me to start the last coding step, the theoretical coding.

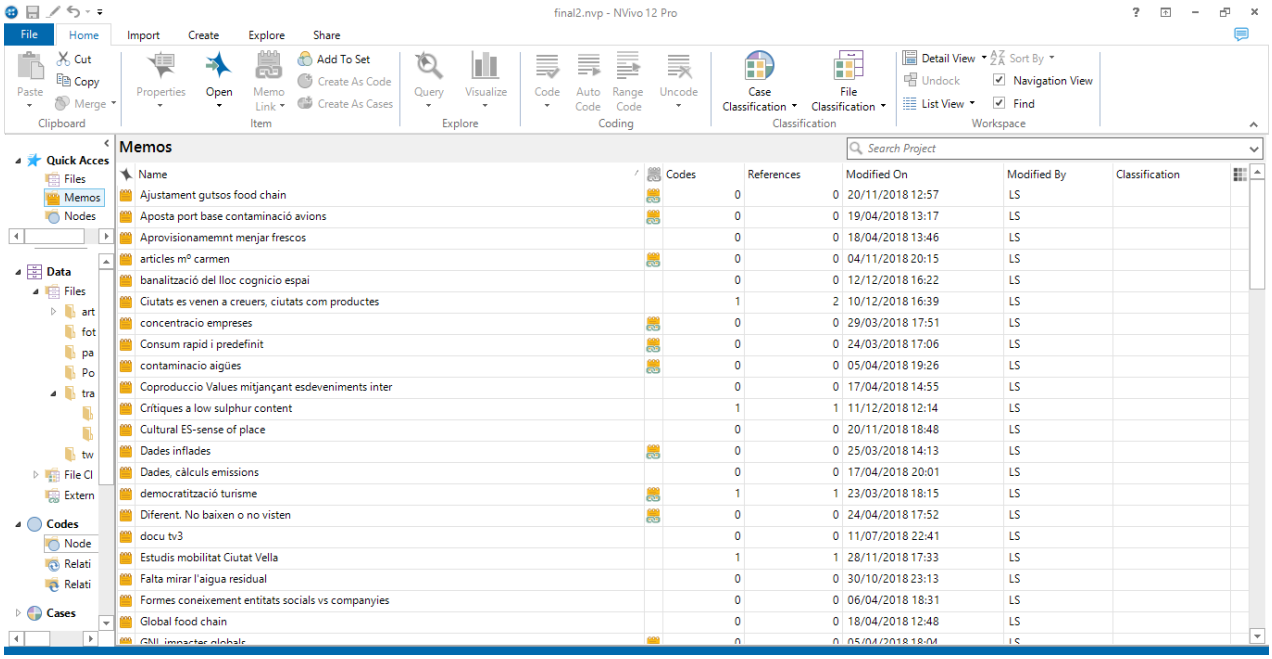


Figure 36. Example of memos written during data analysis.

In the theoretical coding stage, I looked for relationships among the codes. From these relationships, I built models that explained the phenomena studied (Figure 37). These models were created using NVivo software tool for mapping. The conceptual data mapping and visualisation functions in NVivo are limited to a few tools, however, especially to show relationships between nodes and concepts. That is why the models were complemented and finished in more complete software, such as GIMP or Power Point. The comparison and combination of nodes, memos and models allowed me to build arguments and theory.

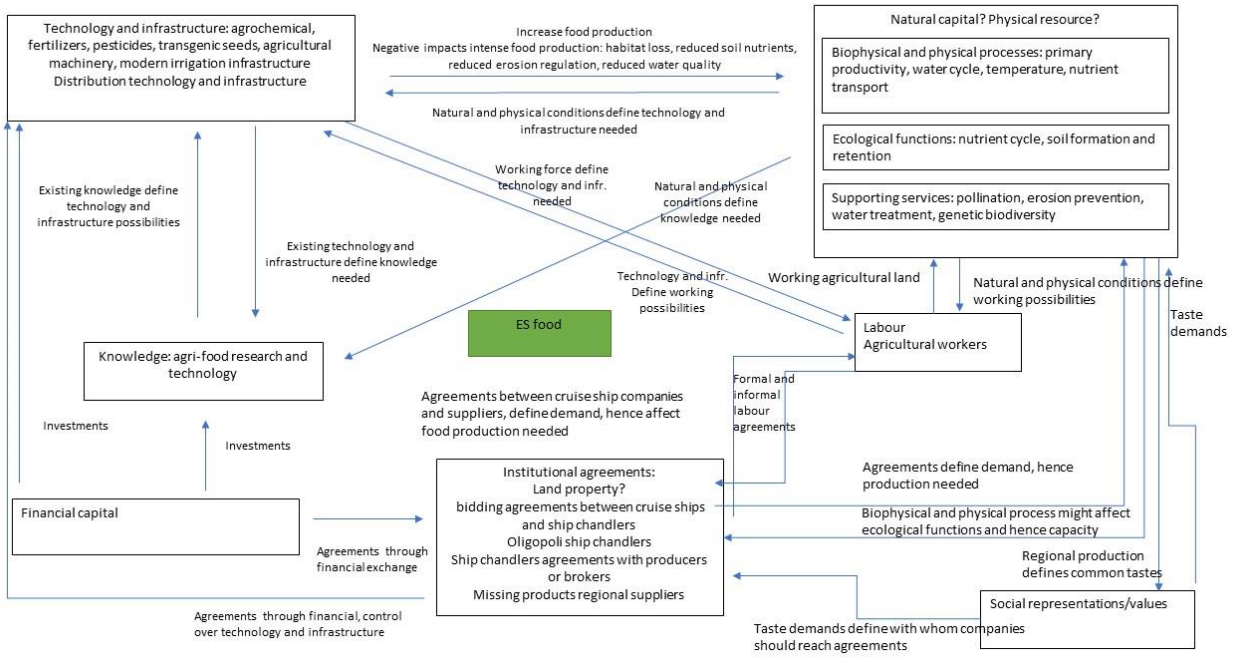


Figure 37. Example of a GT model. Source: own elaboration

Following the iterative GT loop, I used the existing literature to explain and understand emerging nodes, relationships and theories throughout the coding process. When necessary, I even complemented nodes, relationships and theories with existing literature. The analysis of the semi-structured interviews was complemented with the analysis of official documents and reports. The data collected through these materials reinforced categories that emerged through theoretical coding. Last but not least, the data collected through the survey of cruise ship passengers was transferred to a data base created with SPSS software. After transferring, the data was analysed using descriptive statistics, such as sums, absolute frequency, central tendency, arithmetic mean and standard deviation.

Chapter IV.

Transcalar coproduction processes of ecosystem services

4. Transcalar coproduction processes of ecosystem services[15]

4.1. Introduction

The results presented in Section 2.4. conclude that coastal ES research acknowledges the importance of socio-ecological systems, but that the social dimension is still under-studied. As in general ES research, the role of humans as co-producers at different ES stages is still ambiguous in coastal ES literature. The results show that flow and scale are still an often-misrepresented aspect. Even though ES research increasingly acknowledges scale effects on ES and scalar feedbacks (Hein et al. 2006, Martín-López et al. 2009, Scholes et al. 2013, Malinga et al. 2014, Andersson et al. 2015, Raudsepp-Hearne and Peterson 2016), but scale is still an often misrepresented aspect. A growing body of literature focuses on the spatial flows and scales at which services are provided and at which benefits arise (Kroll et al. 2012, Bagstad et al. 2013, García-Nieto et al. 2013, Scholes et al. 2013, Serna-Chavez et al. 2014, Schröter et al. 2018). Nevertheless, these spatial connections have been studied at regional or local spatial scales (Kroll et al. 2012, García-Nieto et al. 2013), but global flows have been ignored (Koellner et al. 2018).

The research presented here aims to contribute to the integration of socio-ecological systems complexity into ES research by addressing the gaps in understanding about flows, scales and coproduction. The aim is to understand different relations and interdependencies between sending and receiving systems, whilst also to study the embedded multi-scalar and cross-scalar coproduction processes and feedbacks. To this purpose this research has evaluated a socio-ecological complex system, centred on a harbour, and the visiting cruise ships.

4.1.1. The pathway of ecosystem services

As mentioned in Section 1.7., ES flows are conceptualized here as ‘spatial and temporal connections from providing to benefiting areas’ (Serna-Chavez et al. 2014, p.24), hence adding to ES flow time and space dynamics. Provisioning areas refer to the origin of ES flow, and the benefiting areas are where the ES is finally enjoyed (Bagstad et al. 2013, Serna-Chavez et al. 2014, Schröter et al. 2018). Provisioning and benefiting areas are connected by decisions in one system that can have impacts on the other one, or elsewhere (Koellner et al. 2018, Schröter et al. 2018).

To date, ES flow research has been characterized by theoretical contributions of ES flow (Bagstad et al. 2013, Serna-Chavez et al. 2014), and empirical analysis of ES flow at local or regional scale (Kroll et al. 2012, García-Nieto et al. 2013), neglecting the analysis of interactions and interchanges between distant telecoupled systems. There are some exceptions, as López-Hoffman et al. (2010), Yu et al. (2013), Liu et al. (2016). Moreover, in June 2018 the journal Ecosystem Service published a special issue called ‘Global flows of ES’, with authored publications by: Drakou et al. (2018), Koellner et al. (2018), Quatrini and Crossman (2018) Schröter et al. (2018) and Semmens et al. (2018). All these publications provide empirical and conceptual approaches to ES global and telecoupled ES flows. The authors study ES flows and the interdependencies between providing and benefiting systems, holding to the premise that to study system interconnections is necessary for sustainable governance, as this helps scientists and policy-makers to understand potential feedbacks between systems, hence allows to address trade-offs and synergies across different systems.

[15] The collaboration and supervision of Tim Stojanovic was very important to write this chapter. Soon a paper with the results of this chapter will be published.

Moreover, unequal relations among telecoupled systems emerge, as Yu et al.(2013) argue, where rich countries' consumption transforms and displaces traditional local land-use of poorer countries. However, rarely ES research analyses these unequal relationships. As well, there is a lack of attention on cross-scalar effects over coproduction processes and feedbacks.

4.1.2. The coproduction of ecosystem services

ES are co-produced by social and ecological components (natural resources, knowledge, infrastructures, technology, institutional arrangements, governance systems and social representations) at multiple (and across)-scales. Coproduction can be understood as production which necessitates both biophysical entities and processes (operating according to flows of energy and metabolism), interacting with sociocultural systems of (operating according to money, power, values and meaning-making) to constitute ES, at the point in time where choices are made to consume. A key tenet of the coproduction conceptualization is that these processes are not reducible to one another. However, neither do they operate separately, they are intertwined and derived from pre-existing socio-ecological systems. Socio-environmental transformations embody current and past social and ecological component's evolution. Over time each socio-ecological component and the relations among them change, while they evolve (Norgaard 1994). New institutional agreements transform environments, as changed environments lead to new institutional agreements. Thus, socio-ecological components interact and transform each other, they co-evolve.

Coproduction is fundamental to ES research –(MEA 2005, Tallis et al. 2012, Yamanaka et al. 2013, Burkhard et al. 2014, Jones et al. 2016)-. Nevertheless, existing coproduction studies lack an understanding of spatial and temporal multi-scale and cross-scale coproduction interactions and feedbacks. That is to say, understanding coproduction as a multi-scale and cross-scale coevolutionary process, where ecological and social transformations codetermine one another in space and time (Norgaard 1994), at multiple scales and across scales.

4.1.3. Scale

Processes operate across scale dimensions from the local to the global. Local may refer to social or ecological community, such as those within the borders of a municipality. Both sub-national and supranational regional scales can refer to parts of a country with similar social or ecological features. International processes operate at beyond national boundaries or planetary levels.

The relations between scale and socio-ecological systems has captured the attention of many scientists, especially in interdisciplinary research (Kok and Valdkamp 2011). According to this argument, the integration of scale perspectives into socio-ecological research and management, has to face fundamental challenges; the plurality of systems to represent scales, and associated uncertainty about solutions at one specific scale, which might create trade-offs at other scales (Cash et al. 2006).

Socio-ecological processes and actors might operate at different scales, or emergent properties can take place at different scales, hence in a multi-scalar form (Scholes et al. 2013). For example, the degradation of coastal ecosystems might happen at local, regional and global level simultaneously. Moreover, the socio-ecological processes at larger or small scales interact across scales and lead to unexpected outcomes, hence cross-scalar relations and interdependencies (Scholes et al. 2013). For instance, the effects of regional climate disasters, such as droughts, into global food prices. Therefore, multi-scale and cross-scale relations and

processes are part of complex socio-ecological phenomena. From now on, multi-scale and cross-scale relations and processes are included under a single concept 'scalar relations'.

As means to achieve a more holistic assessment, address complexity and integrate ES plurality, ES assessments need to approach phenomena by scalar relations analysis. That is to say multi-scalar analysis and cross-scalar analysis. Multi-scale analysis refers to parallel assessments at multiple scales (Scholes et al. 2013). Cross-scalar analysis are a form of multi-scale analysis, but the focus is on the interactions among different scales (Cash et al. 2006, Scholes et al. 2013), in order to deal with uncertainty and understand how cross-scalar interactions create ES trade-offs and synergies at other scales.

ES flow research is currently moving towards a broader frame, expanding conceptual and physical frontiers to understand the global pathways from provisioning and receiving systems, and the interdependencies among these systems. The definition of the scale or scales of ES production and benefit allows comprehensive identification and analysis of socio-ecological components that coproduce ES (Raudsepp-Hearne and Peterson 2016). Still, ES flow research rarely embraces coproduction processes and overlooks scalar relations. To the knowledge of the authors only few exceptions integrate scalar relations assessments into coproduction (Drakou et al. 2018, Fridman and Kissinger 2018, Schröter et al. 2018).

4.1.4. Cruise ships

Few studies address cruise ship research from a scalar relations perspective, such as; Gui and Russo (2011) who develop a framework to connect global structure of cruise value chains to local and regional generation of value. London and Lohmann (2014) and van Bets et al. (2017) who analyse unequal power relations between local and international actors of cruise ship industry. Also Clancy (2008) and Font et al. (2016) study conflicts between local stakeholders and cruise industry practices. Still, cruise ship research lacks an understanding of the interconnections of phenomena associated to cruise ships, as scalar relations; i.e, multi-scalar and cross-scalar processes and flows.

As principal cruise ship port in the region, Barcelona is an obvious case to identify and analyse ES flows enjoyed by cruise ships activities and their passengers in within socio-ecological complexity frame. Therefore, this research studies ES flows, how are these coproduced and their scalar relations in the case of the port of Barcelona. To sustain complex interconnected socio-ecological systems, social and environmental policies need to consider feedbacks and impacts beyond direct region of management (Pascual et al. 2017). In this context, scale has a prominent role, as there is a growing consensus that scale is fundamental to govern environmental problems, because socio-environmental management is about dealing with cross-scale phenomena (Cash et al. 2006).

4.2. Methods

As explained in Section 3.5, this research follows a mixed method approach combining semi-structured interviews, the documentary analysis of official documents and reports and surveys of cruise ship passengers. The semi-structured interviews were structured in five main blocks, where the first two blocks corresponded to data collected for this chapter; the ES required by cruise ships and the coproduction processes of these ES. Similarly, the survey conducted with cruise ship passengers asked about the ES required by cruise ship passengers. If respondents in the interviews commented on existing official documents and/or reports, these official documents and reports were reviewed and analysed.

The identification of ES demanded by cruise ships was based on an ES classification developed by myself, based on: Atkins et al. (2011), Barragán-Muñoz and Borja Barrera (2012), Böhnke-Henrichs et al. (2013), Liquete et al. (2013), Sousa et al. (2016) and Charles et al. (2018). Any classification involves decisions that include or exclude ES or some of their elements. The suggested ES classification in this dissertation tries to be as inclusive as possible. I have reviewed a total of seventeen existing classifications. Finally, bearing in mind the objectives of the research, I selected six of them with which to develop my own classification. These six classifications were selected because they included coastal ES, which is important for this research. According to the GT iterative process and the inclusive spirit of this research, the classification was modified and adapted during the data collection process. If I identified new ES during the data collection process, these were therefore added to the classification. The final classification is composed of twenty-three ES (Table 5).

Table 5. Own ES classification, based on Atkins et al. (2011), Barragán-Muñoz and Borja Barrera (2012), Böhnke-Henrichs et al. (2013), Liquete et al. (2013), Sousa et al. (2016) and Charles et al. (2018)

Category	*Ecosystem service*	*Description*
Provisioning	Food	Available flora and fauna for the specific purpose of human consumption as food
	Raw materials	Mineral mining and organisms not for human consumption
	Freshwater	Water that is extracted for use in human industry and economic activity
	Energy	Non-consumer use of the environment for energy generation
	Biotic materials and biofuels	Medicinal, ornamental and other resources; biomass to produce energy
Regulation	Water purification	Removal of pollutants by ecosystems
	Air quality regulation	Absorption by vegetal or water bodies of air pollutants
	Climate regulation (regional and local)	Sequestration by the greenhouse and climate active gases ecosystems
	Microclimate regulation	Regulation by green spaces and water bodies of local climate
	Coastal protection	Ability to reduce energy from the coastal environment in episodes of high energy concentration, such as storm floods, tsunamis, and hurricanes
	Erosion regulation	Capacity to control erosion processes by coastal flora, habitats or morpho-dynamic structures

(continuation Table 5)

	Biological Control	Control of pathogens, biological control on the spread of vector borne human diseases
	Lifecycle maintenance	The maintenance of key habitats that act as nurseries, spawning areas or migratory routes
	Ocean nourishment	Natural cycling processes leading to the availability of nutrients in seawater for the production of organic matter
	Nutrient cycling	Storage, cycling and maintenance of nutrients by ecosystems
Cultural	Recreation and leisure and tourism	Human activities linked to leisure time
	Aesthetic experience	Sensations that produce well-being and inner peace derived from the active enjoyment and contemplation of different landscapes
	Inspiration for culture, art and design	The existence of environmental features that inspire elements of culture, art, and/or design
	Spiritual and symbolic experience	The contributions that ecosystems make to formal religious experiences
	Cognitive effects	The contribution that ecosystems makes to education, research, etc.
	Cultural heritage and identity	Spatial bonding of inhabitants and/or visitors with their environments (excluding aesthetic, symbolic and religious experiences). Also includes the significance of environments in cultural traditions and folklore and the appreciation of a community for local environments and ecosystems
	Local ecological knowledge	Knowledge related to local ecosystem and human activities
	Environmental education	Ecosystems provide elements, scenery and didactic resources for sustainability learning

The interviews were transcribed and later codified following Charmaz (2006), that is to say first initial coding, next focused coding and finally theoretical coding. The outcome of focused coding was a codebook to operationalise and group the codes (Table 6).

Table 6. Code book Research Objective 2

Nodes	**Definition**	**Nodes inside**
International flows	Any ES flow sourced from around the world and is demanded or consumed in Barcelona	e.g. IT-products, USA-products
Regional flows	Any ES flow that is sourced regionally and is required or consumed in Barcelona	e.g. R-products, ESP-products
Local flows	Any ES flow that is sourced locally and is required or consumed in Barcelona	e.g. CAT-products, BCN-products
ES- food provision	Food for human consumption in cruise ships. Food comes from managed agro-ecosystems, marine, freshwater systems and forests (cultivated crops, reared animals, fishing, aquaculture, wild animals, wild plants, algae)	e.g. ES-F-supply, ES-F-flow, ES-F-production
ES- water	Surface water, groundwater and seawater for drinking and non-drinking in cruise ships	e.g. ES-W-flow, ES-W-production, ES-W-demand
ES-energy	Energy sources (oil and gas) for cruise ships	e.g. ES-E-flow, ES-E-production, ES-E-demand
ES-air quality regulation	Absorption by vegetal or water bodies of air pollutants like particulate matter, ozone or sulphur dioxide in the Barcelona region	e.g. ES-AQ-flow, ES-AQ-production, ES-AQ-demand
ES-climate regulation	The contribution of ecosystems to the maintenance of a favourable global climate through impacts on the hydrological cycle, temperature regulation, and the contribution to climate-influencing substances in the atmosphere in the Barcelona region	e.g. ES-CR-flow, ES-CR-production, ES-CR-demand
ES-microclimate regulation	The contribution of ecosystems to the maintenance of favourable local climate conditions	e.g. ES-MC-flow, ES-MC-production, ES-MC-demand
ES-Leisure, recreation, tourism	The contribution of ecosystems to the provision of opportunities for recreation and leisure in the Barcelona region	e.g. ES-LER-flow, ES-LER-production, ES-LER-demand
ES-cultural heritage and identity	Contribution of ecosystems to identity and cultural heritage	ES-HER-flow, ES-HER-production, ES-HER-demand
ES-Aesthetic experience	The contribution that ecosystems make to the existence of a landscape that generates a noticeable emotional response within the individual observer	ES-AE-flow, ES-AE-production, ES-AE-demand

(continuation Table 6)

ES-Inspiration for culture, art and design	The existence of environmental features that inspire elements of culture, art, and/or design	ES-INSP-flow, ES- INSP - production, ES- INSP - demand
ES-Spiritual and symbolic experience	Contribution that ecosystems make to formal religious and symbolic experiences	ES-SSE-flow, ES-SSE-production, ES-SSE-demand
ES-Cognitive effects	The contribution that ecosystems make to education, research, and individual and cognitive collective cognitive development	ES-CE-flow, ES-CE-production, ES-CE-demand
Co-production	ES result of nature-human interaction	Coproduction-Env, Coproduction-IT, Coproduction-SV
Environment	Natural resources, biophysical processes and ecological functions which contribute to the production process of 'nature'	Coproduction-Env-sea, Coproduction-Env-Urban green
Technology and infrastructure	Physical assets which contribute to the production process of services, e.g. tools, machines, infrastructure, buildings and other manufactured capital	Coproduction- IT-internet, Coproduction-IT social network
Social values	Intangible assets associated with individual and collective values and beliefs which contribute to the production process of services, e.g. values, visions, beliefs, perceptions and emotions	Coproduction-SV-image, Coproduction-SV-beliefs
Institutional agreements	Intangible assets associated with formal and informal social relationships which contribute to the production process of services, e.g. formal and informal agreements, social networks, institutions, legislative frameworks, economic and financial markets and labour	Coproduction-IA-formal-Coproduction- IA-concession
Knowledge	Intangible assets associated with individual and collective skills and knowledge which contribute to the production process of services, e.g. skills, scientific knowledge, local knowledge and education	Coproduction-K-data-, Coproduction-K-Info

After coding and memo-writing, the relationships among codes were identified. These relationships serve to build models to explain coproduction. The results are presented in the following sections, with exemplar quotations. Behind the exemplar quotations presented in this text are repeated examples of the same kind, under the same code. One exemplar quotation is used to show the results, but this quotation does not represent a single

experience or process, but rather is an example of the same experience or process found across different respondents and contexts.

4.2.1. Case study: Barcelona's cruise ship[16]

Ports transformations respond to international market flows and technological changes (Ducruet and Lee 2006), such as the increasing need for bigger cargo-handling spaces and the growing size of ships (Notteboom and Rodrigue 2005). The expansion of Barcelona's harbour in the 1960s responded to both more space and bigger ships. An industrial harbour was built away from the city's waterfront towards the south. As a result, the beaches located southward suffered serious erosion problems. This expansion caused the salinisation of the aquifer and the disappearance of the agricultural land around adjacent towns (Margenet 2009). Due to the sustained growth of the harbour there was new expansion in the mid-1990s. Nevertheless, the Llobregat River acted as a physical barrier for southwards expansion. The river was diverted 2km southward. The river diversion has had serious environmental and social impacts in the region. Agricultural land and its connected landscape and cultural legacy disappeared (Margenet 2009). Erosion problems at the southern beaches, and the salinisation of the aquifer worsened. The aquifer received a massive influx of water from the sea. As compensation, a new delta and wetland area were constructed, again using agriculture land (Margenet 2009).

Harbour expansions take place away from the original ports, generally located close to downtown areas (Notteboom and Rodrigue 2005). Original ports become out-of-date due to the new infrastructure and technological needs of shipping sector. As a result, original ports are left behind, but at the same time the industrial abandonment of these ports opens the door for other uses, such as waterfront development, housing and commercial activities (Notteboom and Rodrigue 2005). Barcelona's original port, or the Old Port, and waterfront were renewed during late 1980s and 1990s, following the international trend of post-industrial waterfront transformation[17] (Desfor et al. 2011, Desfor and Vesalon 2008, and Laidley 2011), and using the Olympic Games nomination as a catalyst. The Olympic Games and the urban regeneration of the outdated waterfront were also used as a catalyst for creating new infrastructure for cruise ships.

4.3. Results

Cruise ship and their passengers demand multiple ES, as water cruise ship uses 984.000 litres of water per day (Krile 2016). One of the biggest cruise ships in the world, the Harmony of the Seas consumes 250.000 litters of fuel per day (Vidal2016). Also, every day a cruise ship of 3.000 people needs around 45.000 kg of food (Becker 2013), on average cruise ships have on stock three kg per day per passenger (Escoffier 1995). In the case of Barcelona cruise ship and its passengers also demand multiple ES, such as provision services, especially energy (Figure 39) and food provision. Freshwater demand has been reduced over the last ten years (Figure 38), as cruise ship applied technology for water production onboard. Regulating and maintenance services are also demanded, such as microclimate regulation and air quality regulation (Figure 39). Cultural services are also demanded by cruise passengers, especially leisure, recreation and tourism, aesthetic experiences and cultural heritage and identity

[16] A description of the case study can be found in section 3.5.

[17] Very similar to Baltimore (David 2001), Boston (Desfor and Laidley 2011) or Toronto (Desfor and Vesalon 2008).

(Figure 39). Provision, regulating/maintenance and cultural ES demanded by cruise ships and their passengers originate from international, regional or local flows.

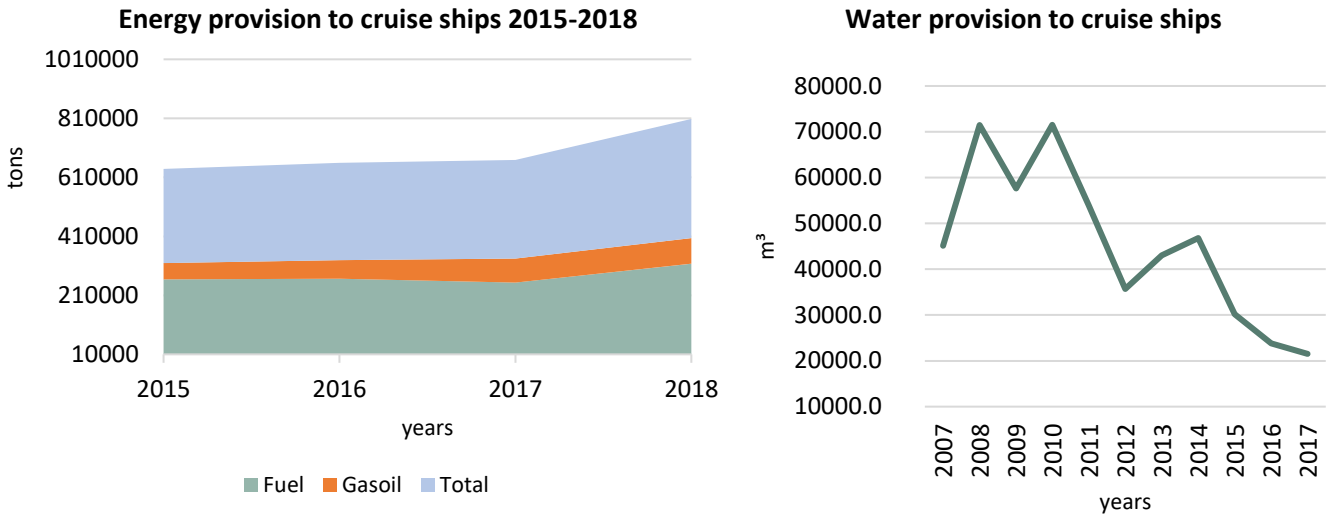


Figure 38. Provision ES demand by cruise ships: energy and water. The left graph shows energy provision to cruise ships between 2015-2018. The right left describes water provision to cruise ships between 2007-2017. Cruise ship energy demand has increased in Barcelona's harbour from 2015-2018. Cruise ship energy demand has increased in Barcelona's harbour from 2015-2018. Conversely, water demand has been reduced over the last 10 years. Source: own elaboration based on data provided by Barcelona Harbour Authority.

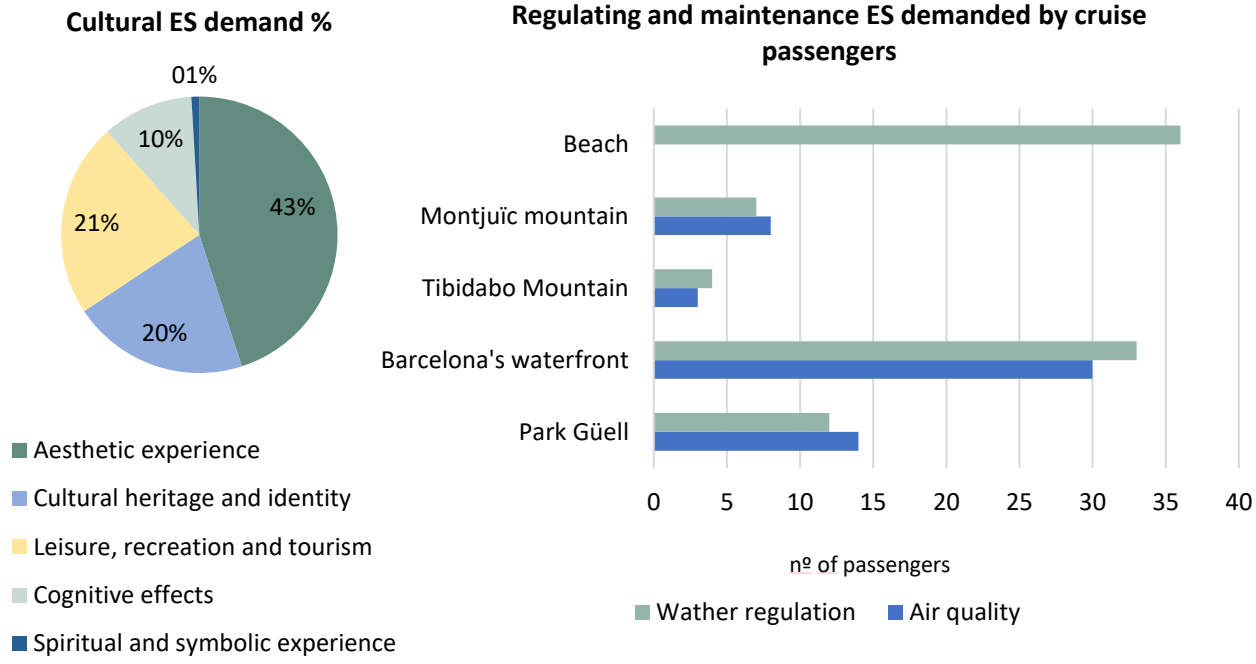


Figure 39. Regulating and maintenance and cultural ES demanded by cruise ships and passengers. Air quality and microclimate regulation are especially important in Barcelona waterfront. Most demanded cultural ES are aesthetic experience, leisure, recreation and tourism and cultural heritage and identity. Source: own elaboration based on data obtained by a cruise passenger survey carried out in January 2018 and June 2018. Sample of 756 cruise passengers.

4.3.1. International ecosystem services flows

International flows of ES to cruise ships are energy and food flows. Food and energy are generally supplied to cruise ships through a single worldwide supplier. In the case of food and energy provision, cruise ship companies reach agreements with multi-national ship chandlers to cover needs of each ship worldwide (single source supply). This idea appears repeatedly during the interviews, as a ship chandler officer explained very well:

When a shipping company closes an agreement normally the closure is worldwide because it negotiates a much lower price. Personal interview 01/11/2017.

Ship chandlers establish agreements with energy or food producers, or with intermediaries (brokers) (Figure 40, via 1). In some cases, cruise ship companies reach direct agreements with food producers, without ship chandlers and brokers, for very specific products or big companies (Figure 40, via 2).

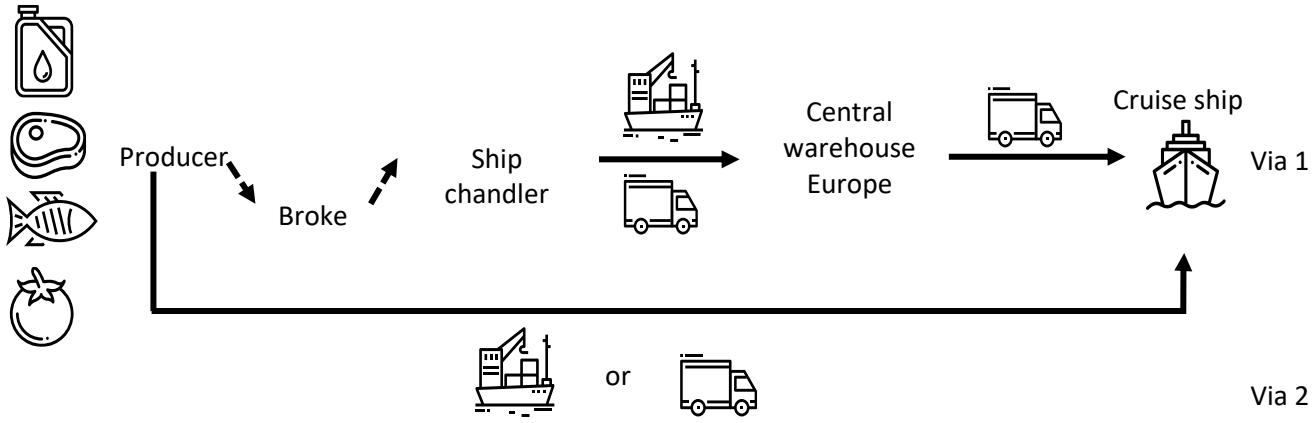


Figure 40. Food supply chain to cruise ships. Via 1; The pathway of provision ES to cruise ships is mediated via ship chandlers, and in some cases brokers. Provisioning ES travel from production areas to main ship chandlers warehouse in Europe then transported to a harbour chosen by the cruise ship company where products are loaded into the ship. Via 2; There are no intermediaries, the pathway of provision ES to cruise ships goes from production areas to cruise ships. Source: own elaboration.

Three cruise ship companies dominate the global cruise ship market: Carnival Corporation, Royal Caribbean and Norwegian Cruise Line and MSC Cruises (part of the Mediterranean Shipping Company). Big corporations have more power of negotiation, which has meant important changes in food and energy supply in Barcelona; the sector has transitioned from regional and local suppliers, at the end of the 1990s, to international ship chandlers. In terms of food provision four ship-chandler companies dominate the European market: B&S (Dordrecht, The Netherlands), Gebr. Schoemaker (Bremen, Germany), Barcelona Europe Supply (BES) (Barcelona, Spain) as subsidiary company of Appollo Group (Florida, USA); and Kuehne + Nagel (Rotterdam, The Netherlands).

Ship chandlers provide 90% of food products to cruise ships. In spite of the difficulty of precisely tracking the origin of the products (they are part of complex global food supply chain), there are some general recognized trends. Cruise ships with a high percentage of American passengers ship products from USA, and those with European passengers, from Europe.

Fresh products, such as vegetables and fruits, come from European food markets. The country of shipping especially depends on the location of the ship chandler's central office and warehouse in Europe, generally The Netherlands and Germany. However, the origin of the product might be different as the European food chain is complex and characterised by international flows[18]. Along the route there is at least one harbour where fresh-food products, coming from global markets, are loaded into cruise ships. In west-Mediterranean routes the main loading harbour is Civitavecchia (Rome), or other Italian harbours, due to logistic facilities and low loading costs.

In spite of the fact that Barcelona has higher loading costs due to national regulations on dockers salary and labour conditions, some cruise ships use Barcelona as main loading harbour. In 2017, 39251 tonnes of food and beverage were loaded in Barcelona's harbour, and 50922 tonnes in 2018. The origin of these products is diverse (Figure 41), using a real cruise ship as example[19]. ES flow might come from the central warehouse to the cruise ship, as German and Dutch warehouses, or might refer to the direct flow from producer to cruise ship. The average traveling distance of food to the example cruise ship is 1.670,25km. However, the exact origin of the food supplied to a cruise ship remains unknown, as there is missing information of the flow from ES production to central warehouse.

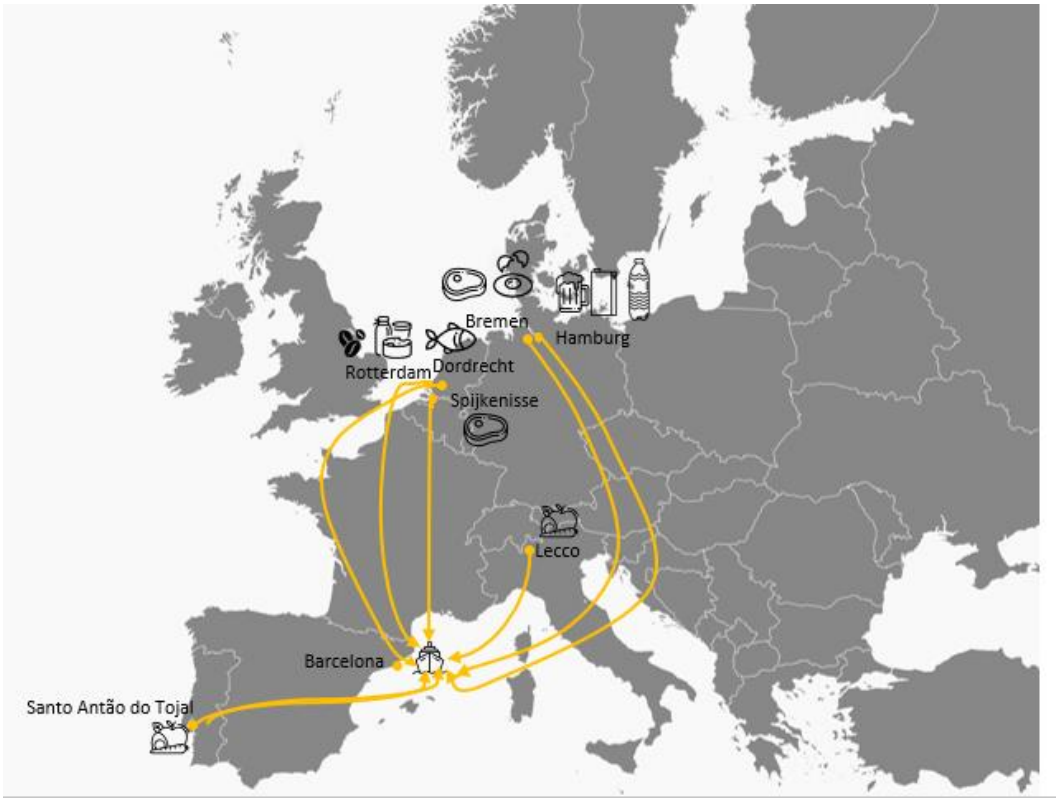


Figure 41. Food flows to a cruise ship in Barcelona's harbour. Origin of the products of cruise ship X. Food products come from ship chandlers' central warehouse to the cruise ship, in German and Dutch warehouses, or direct flow from producer to cruise ship. Some examples of food product are vegetables and fruits that come mainly from Portugal and Italy. From Germany beer, water, eggs, meat and processed food as juices. From the Netherlands lactic products, coffee, fish and meat. Source: own elaboration based on data provided by a ship agency located in Barcelona.

[18] See the case of , as in the case of tomatoes Gamboa et al. (2006) and Vargas and Chantry (2014).
[19] The name of the cruise ship and company cannot be revealed.

Furthermore, 10% of food products, named by cruise ship companies as missing products (emergencies due to shortages of products or very specific local products), might be loaded in Barcelona or in any other harbour according to the needs of the cruise ship. Cruise ship companies purchase them through local or regional ship agencies, or directly connecting regional ship chandlers or food providers.

4.3.2. Regional ecosystem services flows

Fresh water supply comes from regional sources. In the case of Barcelona's surface water, 40% comes from reservoirs located along Ter river basin and 51,5% along River Llobregat. Groundwater sources from Llobregat river basin provide 7% of water resources, and Besòs river basin 0,5%. Furthermore, a desalination plant located in El Prat del Llobregat also provides 1% of potable water (Agbar 2011). On average, use of the drinking water on cruise ships is more than 984200 litters per day (Krile 2016). In Barcelona, from 2015, there is a clear tendency for water supply reduction (Figure 38). The reason might be that cruise ships increasingly have their own water desalination plants. The improvement of water production technologies on board through evaporators or reverse osmosis, has increased cruise ship capacities to produce their own drinking water. According to the Cruise Line International Association (CLIA), onboard water production did not significantly increase energy consumption, since evaporators produced most of the water onboard. The average energy consumption of reverse osmosis in cruise ships is 10,96 kilowatt hour (Guler et al. 2015).

The demand of cultural ES extends beyond Barcelona's city borders in a limited way. Regional institutions (*Diputació de Barcelona and Turisme de Catalunya*) promote touristic attractions outside city borders and offer them to cruise ship companies, which are used by only approximately 3% of the passengers. A specific initiative promoted by Barcelona's regional government (Diputació de Barcelona) is aiming at Barcelona's region city brand through Touristic Marketing Plan of Barcelona's regions 2017-2020 (*Pla de màrqueting turístic de les comarques de Barcelona 2017-2020*). This plan intends to increase the number of visitors in Barcelona's region, promote tourist mobility around the region and consolidate the region as multiproduct touristic destination.

4.3.3. Local ecosystem services flows

In spite of institutional efforts to promote regional touristic activity outside the city, cruise ships cultural ES demand remains basically within city border (Figure 42 and 43). As many respondents highlight cruise ship passengers, especially cruise day-visitors visit main city highlights in very short time.

The aim of cruise lines is that passengers do short tours, to visit many things but very fast. The common route is Les Rambles until Plaça Catalunya, then they visit the Cathedral, the Gòtic area and waterfront. Some also go to Sagrada Família. Personal interview 2/07/2018.

Figure 42. Barcelona's map touristic spots. In red most visited areas by cruise ship passengers: Les Rambles, Gòtic neighbourhood and Sagrada Familia. Source: own elaboration.

Cruise ship companies sell organized tours that generally last around four to five hours, as they are interested in keeping passengers inside cruise ship as long as possible to increase their expenditure inside the boat. In this very short time cruise passengers demand and use cultural ES of the city, through an intense experience, and in a rather superficial manner. Hence, to visit and experience as many things as possible in very short time, as is pointed out repeatedly during the interviews. An incoming agency officer exemplifies how cruise organized tours aim to show main city highlights, as customized and predefined experiences in a very short time:

Most common tours are to go to Sagrada Faimilia, take few pictures, then to Les Rambles, walking a bit around the Gòtic neighbourhood and then some tapas tasting in a restaurant while watching a flamenco performance, to kill two birds with one stone, and then go back to the boat again (...) Tours last just few, four or five, hours, so they can go back to the boat for lunch. Personal interview 30/11/2017.

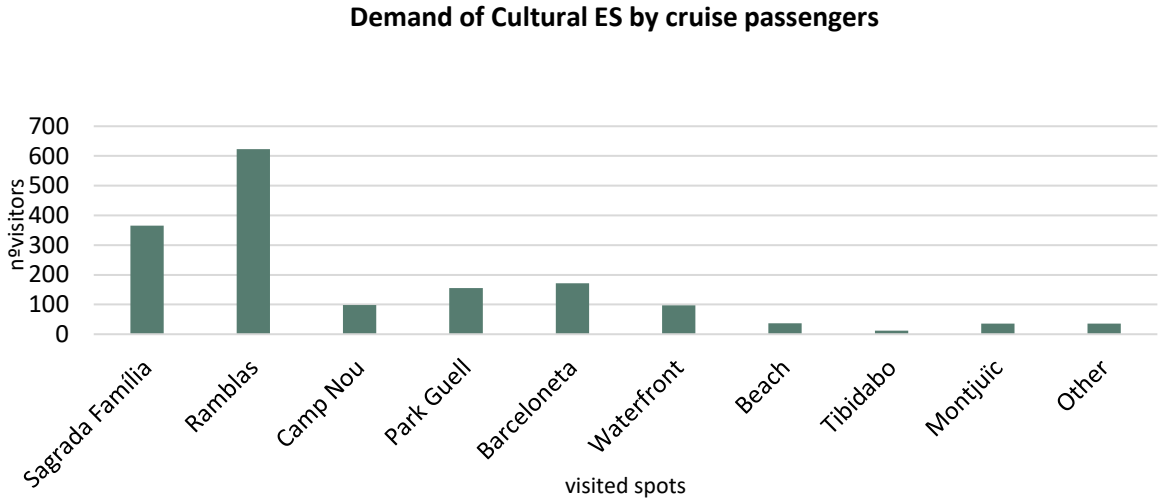


Figure 43.Demand of Cultural ES by cruise passengers. Cruise ship passengers most visited places in the city are Sagrada Familia and Ramblas. Source: own elaboration based on data obtained by a cruise passenger survey carried out in January 2018 and June 2018. Sample of 756 cruise passengers.

4.3.4. Ecosystem service coproduction

Natural and social processes are inherently linked and current socio-natural conditions are the result of previous conditions that are intrinsically natural and social (Swyngedouw 1999). Hence, present socio-natural environments are the result of coproduction processes supported by pre-existing socio-natural environments. Four key coproduction processes have been identified; a) Technology and infrastructure as a means to physically transform current socio-natures; b) Institutional agreements used to guide and transform socio-natures; c) Different knowledges and skills support socio-nature changes; and d) Social values and representations underpin socio-nature transformations and agreements.

4.3.4.1. The role of technology/infrastructure

Technology and infrastructure increase ES capacity to provide for demand (in some cases distant), by **transforming** existing socio-natures. For instance, in the case of food provision service technology such as, agrochemicals, transgenic seeds, agricultural machinery or modern irrigation infrastructure increase ES capacity by **substituting** biophysical process. Nevertheless, food production based on intense use of technology and infrastructure, has negative impacts on existing socio-ecological milieu[20]; such as increased soil degradation, water eutrophication, greenhouse emissions, land use change, deforestation and decrease of biodiversity. Furthermore, food supply impacts are not only limited to provisioning areas.

In general terms, food supply is supported by international supply chain, food travels long distances from production areas to benefiting areas, often passing through central and regional warehouses and later distributed to benefit areas. As ship agency officers and academic experts on food trading argue during the interviews, food global supply chain results in an increase in food travel distance, energy consumption and gas emissions. An academic expert on food trading issues summarizes this reality:

[20] Authors as Fridman and Kissinger (2018), Sun et al. (2018), O'Mara (2011), Inskip and Zimmermann (2009), Etter et al. (2006) have studied negative impacts of intense farming.

The entire model is associated with high consumption of resources and energy, food must travel many km, therefore its footprint is much larger, they produce many emissions. Personal interview 20/06/2018.

Land food supply is also characterized by large footprint, imported products to Spain travel on average approximately 4.000km (Pérez Neira et al. 2016). Transport from production sites to distribution centres causes 8,4% of food emissions of $CO2_e$ footprint, and from distribution centres to stores 0,2% (Berners-Lee 2011). Nevertheless, global food trade represents only 9% of all food products worldwide, most food trade takes place in local, national or international communities, as European Union (EU). Therefore, most of the food consumed within EU comes from inside EU borders. There are some exceptions, as typical 'tropical' products, as coffee, cacao, tea and tropical fruit, for instance in 2002, 83% of the coffee and 75% of cacao were traded in from a global market (Montagut and Dogliotti 2006).

In the interviews different respondents show, that in the case of cruise ships the main characteristic is that food supply to cruise ship can be to any port worldwide, frequently passing by warehouses (Figure 40) as an academic expert on food trading issues explains:

Cruises have large distributors that provide food at any port. (…). Food products travel around the world to end in a cruise ship. Personal interview 20/06/2018.

Furthermore, the transport footprint in cruise ships might be larger in some cases, such as when American cruise lines operate at the Mediterranean (as Azamara Club Cruises, Carnival Cruise Line, Celebrity Cruises, Crystal Cruises, Norwegian Cruise Lines or Royal Caribbean International, operate). As mentioned above, if most passengers are Americans, non-fresh products are imported from USA by ship. Nevertheless, ship agency officers, political and administrative authorities and academic experts agree that there is a lack of data of the exact food route from production sites to demand sites. The food flow can be tracked up until the European regional warehouse, as an expert an academic expert on food trading argues:

You can find information, but there is a time when you lose the route, in my opinion this is intentionally done. Personal interview 25/07/2018.

The increasing internationalization of food supply has meant land-use change in demand areas that previously have been producer areas. Their agriculture land has been reduced because local and regional producers cannot compete with cheaper prices at global level. For example in France in the last ten years a quarter of agriculture productions have disappeared (Le Monde 2011, Vargas and Chantry 2014). Likewise, in Catalonia between 60% of the farms disappeared between 1962 to 1999 (Majoral 2006, Badal et al. 2011). An officer of Barcelona's food-trading market, named Mercabarna, argues this fact:

We eat beans from Ecuador, or asparagus from China. And Gavà (a city near Barcelona), who was a great producer of asparagus, no longer produces anything, it could not compete. Here (Catalonia region) we are not food producers; we now import food. Personal interview 12/06/2018.

Another example is the use of infrastructure and technology to collect surface water and sea water increase fresh water supply. Water reservoirs collect surface water, which is cleaned in treatment plants, stored and distributed through a complex pipeline network and loaded in cruise ships through a hosepipe. Surface water infrastructure has impacts on socio-ecological systems, as the infrastructure requires land and energy. Moreover, supplying ES to cruise ships **requires** certain logistics infrastructure and technology; docks, loading machinery,

roads, tracks, barge and/or hosepipe are needed to load food, water and fuel into cruise ships. Labour human force is also fundamental, as dockers work force load cruise ships.

Infrastructure and technology are also applied as means to coproduce harbour socio-natures and ES**.** Barcelona's obsolete waterfront and harbour were renewed during the '90s, the old industrial harbour areas were **transformed** into urban public and private spaces: recreational port, promenades and beaches. While, the city recovered waterfront spaces, the industrial harbour moved and expanded southwards, extending to the south Llobregat River and transforming terrestrial and marine space. In 2008, the east dock was enlarged to accommodate cruise ship terminals. The materials **needed** for the construction of the dock were port dredging materials, excavation of port works and residues from other works or activities (Ministerio de Medio Ambiente 2000). Hence, reducing the travelling distance of the materials. Also, materials were extracted from quarries and transported, preferably, by train or ship to limit the number of trucks in the area (Ministerio de Medio Ambiente 2000).

The dock extension meant the transformation of marine space into terrestrial industrial spaces and lead to important environmental impacts in the surrounding marine environment; as changes in sediment morpho-dynamics lead worse beach erosion southwards, underwater noise pollution, the elimination of benthic community within the area of the dock, the replacement of soft-bottom macrofauna for hard-bottom macrofauna, as the granulometry of marine soils was modified due to extra dredged soils that fill soft-bottom soils (Ministerio de Medio Ambiente 2000, Tribunal de Cuentas 2007). The dock expansion created new socio-natures spaces that serve as cruise ship terminals, and as habitat for hard-bottom fauna and nesting areas of *Larus audouinii*, a gull endangered species (El periodico 2017).

In fact, repeatedly in the interviews the respondents emphasise that the waterfront transformation has been a very important element of Barcelona's touristic development, as part of the touristic attraction and image of the city, as a municipal technical officer argues:

With the Olympic Games and the whole change of the waterfront everything started (the rise of tourism. Personal interview 4/06/2018.

Several respondents also assert that the waterfront supplies new cultural ES, such as leisure, recreation and tourism and aesthetic experience, as a municipal technical officer recalls:

(the waterfront) is a new space for Barcelona that tourists like a lot, to walk around, the beach… Personal interview 04/06/2018.

Another, frequent idea during the interviews is that new ES capacities and demands linked to touristic activities led to new infrastructure development, to adjust to visitors needs and provide new touristic attractions. Hence, new socio-natures **define** and **demand** new infrastructure and technology development, as a ship agency technical officer explains:

Harbours keep growing, they have to modify their infrastructure to adapt to cruise needs and sell themselves to cruise companies. Personal interview 12/12/2017.

ICT, can also be used to promote new touristic spots using social media, or new ICT technologies and applications to enhance tourism experience. In such a manner, photography in social media are a coproduction component, cruise ship tourists share their experiences, photos and other contents related to cultural ES. Taking photos is considered as fundamental part of the visiting experience. On average 11% of cruise ship passengers considered taking photos as a reason of visiting a place. In most iconic places this percentage increases, Ramblas

and Sagrada Família, but also in Barcelona's waterfront. While cruise ship tourist share content on social media, they are reflecting their use of ES and influencing others demands. Hence, as explain by tourist guides and tourist technical officers, ICT transforms ES cultural demand of cruise ship passengers, hence **changes** tourist interests and social imaginaries of the city, as a tourist technical officer exemplifies:

We invite influencers to visit the city, so they show the city to their followers. In this way, we massively move people though internet. If we tell them about the secret square somewhere, then they will all go. Personal interview 19/12/2017.

In the same line, tourist guides and tourist technical officers explain that through internet cruise ship passengers can be fully informed, decide what to visit and how and pre-plan or pre-book online every step of the trip, as exemplified by a tourist guide:

There are also more and more people going freely, there is internet... (…) They (cruise passengers) can check online Barcelona visiting information. For example, there is a company that offers cheaper tours around the city, than tours offered by cruise ships. Personal interview 5/06/2018.

Furthermore, in several occasions the interviewees indicate that Barcelona has a well-structured and functional infrastructure, which allows the cruise ship tourist to move easily and safely around the city and visit the city without any pre-arranged tourist tour, 79% of cruise ship visitors. An incoming agency technical officer states:

Barcelona is a safe city, quite easy to move around and with very good public transport. Tourists can visit the city without needing an organized tour. Personal interview 23/10/2017.

Cruise ship visitors transform city public space. Municipal technical officers, local activists and academic experts argue that public space occupation is especially intense within the city centre and during a short period of time, hence creating a perception for residents of invasion and saturation of space. This is aggravated further, when cruise ship passengers move around the city in big groups (Figure 44), as a municipal technical officer exemplifies:

One day with the mayor of Amsterdam we were walking around the Ciutat Vella area, and suddenly a group of 50 tourist appear, we had to put ourselves against the wall so they could pass. This happens quite frequently in this area (Ciutat Vella) (…) This is impact in the case of cruise ships is more aggravated, because they are groups of 40 or 50 people. The problem of Ciutat Vella is very related with space, big groups and very narrow streets that is the problem. The problem are the big groups. Personal interview 11/06/2018.

Figure 44. A group of cruise ship tourist walking by a narrow street in the city centre. Source: own elaboration

Furthermore an academic expert mention a significant idea, since cruise ship passengers, in big or small groups, visit the city during few hours their **understanding** of the space is very limited, thus their movements through urban space are also limited and thus disturbing residents mobilities, as a tourist academic expert argues:

In the case of the cruise, I think that the cognitive gap is bigger than other visitors. The fact that they are not staying in the city and have a short visit but very organized makes their previous knowledge of space and their capacity for autonomous movement in space very limited. This is a cognitive approach that is most likely to have effects on the use of space. Not knowing where you are is going to engage space in a way you would not do if you had the knowledge. Personal interview 14/06/2018.

4.3.4.2. The role of institutional agreements

Institutional agreements can define the **control** of access to ES through contracts between private agents and/or private and public agents, intermediated by financial capital. Cruise ship companies bid for fuel and food provision globally via an exchange of financial capital. In the case of water, institutional agreements take the form of public-private partnerships that manage necessary technology and infrastructure for water collection, treatment and distribution. These agreements are shaped by financial capital, as the Catalan public administrations initiated a bidding process in 2012-2013 to privatize water management and infrastructure, which was previously financed by public funds (March 2014).

Institutional agreements also **regulate** ES supply and demand. For example, formal institutional agreements, such as local and regional Barcelona urban plans, define the location and design of urban green areas and their associated ES, especially Barcelona General Metropolitan Plan (GMP). Institutional agreements regulate which ES are enhanced, their location and the beneficiaries of these services. These might be based on formal agreements, as urban planning and regulations, or might be based on non-formal arrangements.

A formal agreement was developed after the nomination of the city to host the Olympic Games in 1992. Local authorities envisioned a great urban renewal project, that has been

named as Barcelona model (Capel Sáez 2005, Casellas 2006). In this context, a model of cooperation between private and public administration was built (Casellas 2006), taking form as a strategic plan. The development of these plans depends on private capital and resources. Through time, this cooperation model has led to an increasing influence of the private sector on local urban planning decisions.

In Barcelona, institutional agreements affecting harbour waterfront socio-nature transformation are not regulated by urban planning. Harbour land development can be done outside the urban planning system, as an academic urban planning expert explains:

In the harbour there is an exception that allows for projects to be developed. In terms of planning the port area does not have to comply with the regulations defined by the historic centre. Personal interview 16/06/2018.

Harbour land **development** is based on arrangements between the municipality and the Harbour Authority. In 1988, the municipality and the harbour authority developed a strategy to open the city to the sea and recover harbour land for citizens. As explain by several interviewees, a public-private partnership, named *Gerencia Urbanística Port Vell 2000*, was in charge of this waterfront development, characterized by new public spaces, but also commercial and private activities. Commenting on this, an academic urban planning expert explains:

Ports have modified their internal regulations to allow this type of urban and commercial uses within the port land. We saw this process in '92, the idea of opening the port to the city (to create new spaces for city residents). It was a conflicting process, as it meant the privatization of a great share of the waterfront land to accommodate commercial and private activities. Personal interview 16/06/2018.

Similarly, in 2018 the municipality and the harbour authority have reached a new agreement to transform harbour land into public use and relocate the east dock, the commercial harbour (2 cruise ships terminals and 1 ferries terminal) further south. This agreement also defines new public spaces, and some land to commercial and other private activities. Both agreements **regulate** the transformation and creation of new socio-natures and thus new ES, especially cultural ES (aesthetic, cognitive and recreational). Thus, as different interviewees refer, these institutional agreements supported by new infrastructure development regulate new socio-natures, as a municipality officer claims:

(talking about the 2008 agreement) The objective is to make a redevelopment project to create space for sports, leisure, family or neighbourhood activities. Personal interview 24/10/2017.

The cooperation between private and public organizations is characterised by the investment of public funds. Especially, from 1988 to 1992, public funds were invested in the waterfront **development**. Harbour land development is seen as a highly profitable investment opportunity for private investors; with less legal restrictions than urban land and public investments aid finance waterfront development, as academic urban planning expert explains:

Harbour land provides a privileged location with, a surplus value 4 times higher than any existing land elsewhere (we are talking about 4000, 8000% of profits, there are very few legal opportunities that good). Is an empty land, where is possible to build without urban

regulations. This is already a benefit. Furthermore, these projects are supported by public investments. Personal interview 16/06/2018.

Public funds, as European Regional Development Funds (ERDF), were also invested to build the east dock extension (Generalitat de Catalunya 2011), and new cruise terminals. The harbour authority created a public-private partnership as cruise terminal operator, named *Creuers del Port*. After the initial investment, the harbour authority sold its share to private investors (as Royal Caribbean, Ltd and Global Liman Isletmeleri SA).

Barcelona's Tourism Consortium, also partially financed by public funds, creates and promotes new touristic attractions within the city that cruise ship companies can sell on board. Due to the saturation of specific touristic icons of Barcelona, the municipality and Barcelona's Tourism Consortium aim to modify touristic highlights of the city. As frequently described by several participants, current saturation of spaces **frames** new institutional agreements between Barcelona's Tourism Consortium and the municipality, or within the municipality, as municipal officer explains:

One of the issues that we (the municipality) are thinking about in the frame of the mobility plan of Ciutat Vella is to change the cruise ships shuttle bus stops. We would like to create more stops, now there is only one at the end of Les Rambles, so more stops in other places around the centre could reduce the congestion of Les Rambles. Personal interview 19/06/2018.

They aim to promote less typical attractions, or even promoting touristic spots outside the borders of city, collaborating with regional administrations, as described by a Barcelona's Tourism Consortium officer:

We no longer use the Sagrada Família, Parc Güell, or the Ramblas, or the Gothic Quarter (most saturated areas). We try to value other resources. For example, Montserrat, other buildings of Gaudí, Montjuïc, Catalan National Art Museum... these are resources that have a lot of potential to grow and thus decongest other touristic spots.

The creation and promotion of new destinations as means to decongest saturated spaces, has controversial results, as retold in different interviews. Tourist visit places that were not touristic and bring with them the impacts related to tourism intensification: public space congestion, mobility disturbance, public transport saturation, transformation of commercial activities and exclusion of residents. In some cases, these new touristic spots lack touristic infrastructure, or they are underdeveloped. The lack of infrastructure can aggravate tourism impacts and create conflict with residents, as an academic expert academic expert on tourism describes:

A very typical example is the case of Turó de la Rovira, the bunkers. They have become a touristic attraction, but there is no infrastructure to answer tourist demands. The buses to go there became very crowded, there are no toilets and noise…Neighbours complain. Personal interview 15/06/2018.

Furthermore, interviewees also retold that the distribution of touristic flows less saturated areas of the city did not contribute to distribute the economic benefits to these areas, due to the lack of lack touristic infrastructure to answer tourist demands, as described by an academic expert on tourism:

I do not see any economic distribution. They (the municipality) send the tourist there (Turó

de la Rovira) to reduce the saturation of other city touristic areas. However, if tourist plan to spend money there, there is nowhere to do it. What kind of economic distribution are (the municipality) doing then? (The municipality) distribute the impact not the benefits! Personal interview 15/06/2018.

4.3.4.3. The role of knowledge

Local and scientific knowledge is increasingly being used as means to **inform decisions** related to ES capacity and demand. For instance, Barcelona's new biodiversity plan explicitly recognizes the need of new scientific knowledge production related to plant and trees ecological functions as means to maximize ES capacity.

Likewise, interviewees recurrently highlight that the knowledge and data on cruise ship tourist behaviour can be important to aid and improve management and ES capacity and demand mismatches, as a municipal officer describes:

Many actors agreed that there was a lack of information about the behaviour of the passengers (what they visit and what they demand) and that complicates Barcelona's management (of cruise passengers flows). Personal interview 22/06/2018.

In this regard, the municipality has made efforts to enhance participation and communication among different actors related to cruise ship tourism and its management: CLIA, the city council, Barcelona's regional government (*Diputació de Barcelona*), neighbourhoods councils (closer to the harbour), cruise ship companies, among others. The municipality has created working groups where different actors share information and knowledge on cruise ships in order to better frame current cruise ship passenger management flows, adjust or **develop** new infrastructure to minimize impacts on the public; such as new bus stops for touristic buses, adaptive services by civic agents to control overcrowded touristic spots and limit the number of people of touristic tours.

Nevertheless, the results reveal conflicting views on knowledge **validity**, especially in terms of air pollution derived from cruise ship activities. Social organizations, private actors and experts have converged in demanding more objective and scientific knowledge, as they report that current studies might be biased by actors' interests; i.e. Environmental NGOs argue that the harbour authority and cruise ship lobby, CLIA, publish biased studies, and vice versa. Interviewees, especially local activist remark in several interviews, that the lack of trust regarding knowledge validity is based on who oversees or finances the study, and the lack of a neutral agent supervising the study. As explained by the argument of a local activist:

Who is doing these studies and who pays for them? Basically, the port decides who does them, so probably not necessarily reliable institutions. Personal interview 10/10/2017 .

Although, there are multiple uncertainties and knowledge gaps regarding harbour emissions and emissions, since air quality **demands** highly complex methods and models, is well established that cruise ship emissions contribute to worsen Barcelona's air quality. Cruise ships are responsible of 12% of total harbour emissions, but their contribution to Barcelona's air quality is 0,23% for coarse Particulate Matter (PM_{10}) and 1,2% Nitrogen dioxide (NO_2).

Moreover, local information and knowledge of the city that cruise ship passengers might **acquire** online, contributes to their **prioritization** of interests and hence their use and demands of ES. Cruise ship passengers do not only depend on official tourist channels or cruise ship companies' tours. As retold in many interviews, in a touristic city, as Barcelona,

there is great amount of information provided online, cruise ship tourist can be very well-informed and based their decisions on online information and reviews, as pointed out by a tourist guide:

Barcelona is a very iconic place. People will want to visit iconic places. Also the media, Internet… affect what they do (…) TripAdvisor reviews, google reviews all the information is online. Personal interview 25/10/2017.

4.3.4.4. The role of social values

Values, beliefs, ideas, individual or collective worldviews determine our **understanding** of socio-natures and how these are transformed and managed, hence social values effect ES, their capacity and demand. In Barcelona, using city's landscape, features and heritage, municipal authorities and private actors have **built** an international and touristic city image and brand. During the last decades of 20th century, Barcelona's authorities built a city image: cultural, open, lively Mediterranean and modern metropolis (Benach 1993).

The construction of the city image has been **supported** by public and private actors, as Barcelona's Touristic Consortium, through fairs and congresses, but also by using commercials, movies and media supported by the Barcelona-Catalunya film commission.

The construction of Barcelona's touristic image has been accompanied by urban regeneration projects and touristic infrastructure development. Hence, urban socio-nature have been transformed to adjust to touristic sector **demands**. There is a synergic relation between city branding, private investments and infrastructure development, as stated by different participants. City brand gives value to private investments, and vice versa, as described by Barcelona's Touristic Consortium officer:

Barcelona is very well positioned in many international rankings; people want to come here and invest here, also cruise companies to build terminals (…) The position of Barcelona in international rankings comes from several factors, such as the attraction of start-ups, artists, companies of technological sector, congresses and fairs…cruise sector is one more. Personal interview 12/06/2018.

The synergic relation between city branding and urban investment projects has been studied by Sutton (2015) through the case study of the renovation and transformation of the old city harbour, Port Vell, to a private luxury marina, he states the following:

The brand adds value to a project (the luxury marina) to create a space of exclusivity in the heart of the city and, in turn, that exclusivity space enhances the brand(Sutton 2015 pag.41)

Cruise ship companies invest in Barcelona due to the international significance of its brand. At the same time, their investments give value to the city; i.e. new terminal buildings, especially iconic architecture as the new terminal D and future terminal F.

This relation has been **reinforced** by the following social discourses: 1) Narratives related to conceptualization of 'nature'. As means to influence and transform specific socio-natures, such as waterfronts or urban parks, certain understandings of urban 'nature' are presented. Barcelona's waterfront reconstruction was linked to discourses about opening the city to the sea, to reconnect the city to the sea as means to improve Barcelona's quality of life and environment. Similar, the agreement between the harbour authority and the municipality of Barcelona signed in 2018, frames future actions around the environmental sustainability of cruise ship sector, aiming to reduce air emissions of cruise ships in the city.; 2) Discourses of

universalism (Desfor et al. 2011, Desfor and Laidley 2011); i.e. narratives that aim to create uncritical devotion to strategies or projects based on ideas of common good and visualizing the future of the city, 'what is good for cruise ship sector is good for the city'. Along these lines, CLIA Spain has created a communication platform to improve cruise ship sector image in the city, named Escala BCN, which promotes values related to exclusiveness such as authenticity, good gastronomy, and uniqueness.; 3) Furthermore, some interviews indicate that cruise ship companies and private tourism actors have built discourse and attitudes characterised by the idea of providing a service to the city, as a municipality officer points out:

*Once I listened to the CEO of Carnival saying, 'cities must be proud of receiving cruise passengers, they (cities) are lucky to receive the passengers', so for him cities are the lucky ones, not the passengers who have the chance to visit the city(...).*Personal interview 18/07/2018.

Nevertheless, results show changing trends on social values regarding tourism and cruise ship tourism. Some voices have raised concerns about over-tourism and cruise tourism and negative impacts on locals' lives, as described by a local activist:

(cruise ship tourism) is a mess in terms of moving around the city, also by car because there is a lot of traffic around Colón areas, especially at 6pm when buses have to come back to the ship. It also affects local shops; it reduces the diversity of commercial activities. In general, it contributes to all impacts of tourism impacts, but cruising tourism does it in a stronger way. Why? Because it is a very intensive tourism, more intensive than the rest. Personal interview 11/07/2018.

The rise of narratives questioning the tourism sector in the city and highlighting its negative impacts, **supported** the development a now touristic strategic plan, the Touristic Strategic *Plan 2020,* approved in 2017. The plan aimed to integrate the views and concerns of as many actors as possible, decongest certain areas, redistribute the benefits and impacts of tourism and ensure better tourist management in the city.

Another important issue of social values and ES coproduction is the fact that cruise ship passengers want to consume local cultural ES: local identities, symbolic representations and symbolic heritage. These ES have been adapted and adjusted to cruise ship passengers demands, through institutional agreements and infrastructure development. Thus, they have been transformed into touristic products; and adapted for tours of cruise passengers to visit and experience local spaces and identities.

Cruise travelling has become a mass product, characterised by cheap price tickets and all-inclusive packages. Even though, cruise ship are associated with luxury; products are cheap, but linked to luxury, hence cheap luxury. Along these lines, CLIA Spain has created a communication platform to improve cruise ship sector image in the city, named Escala BCN, which promotes values related to exclusiveness such as authenticity, good gastronomy, and uniqueness. These social representations also influence socio-natures **changes** and ES associated with food provision, for example Pullmantour Cruceros, one of the companies with cheapest tickets in the Mediterranean, created a new gastronomic initiative joining efforts with a 3 Michelin start chef. Furthermore, social values are also connected to food tastes and demands. Cruise ship passengers demand familiar tastes according to their country of origin (ex: American passengers require American products). Therefore, as ship agency officers and a food supplier officer assert, these products are shipped from United States to Europe, as a food supplier technical officer states:

If you have American passengers, then you must keep American products. A product like ketchup Heinz is produced in the United States and in Europe, but the ingredients of the United States and Europe are not the same. So, they send it from United Sates.

Figure 45 below presents a synthesis of the main relations among coproduction components, and bidirectional relations, based on the empirical data from the case study. The construction draws upon and extends the framework of (Norgaard 1994). Our findings support that conclusion that each component has the potential to transform and be transformed by other components. For example, existing socio-natures define and limit technology and infrastructure development and, at the same time technology and infrastructure developmental transform socio-nature and change ES capacities via technological substitution.

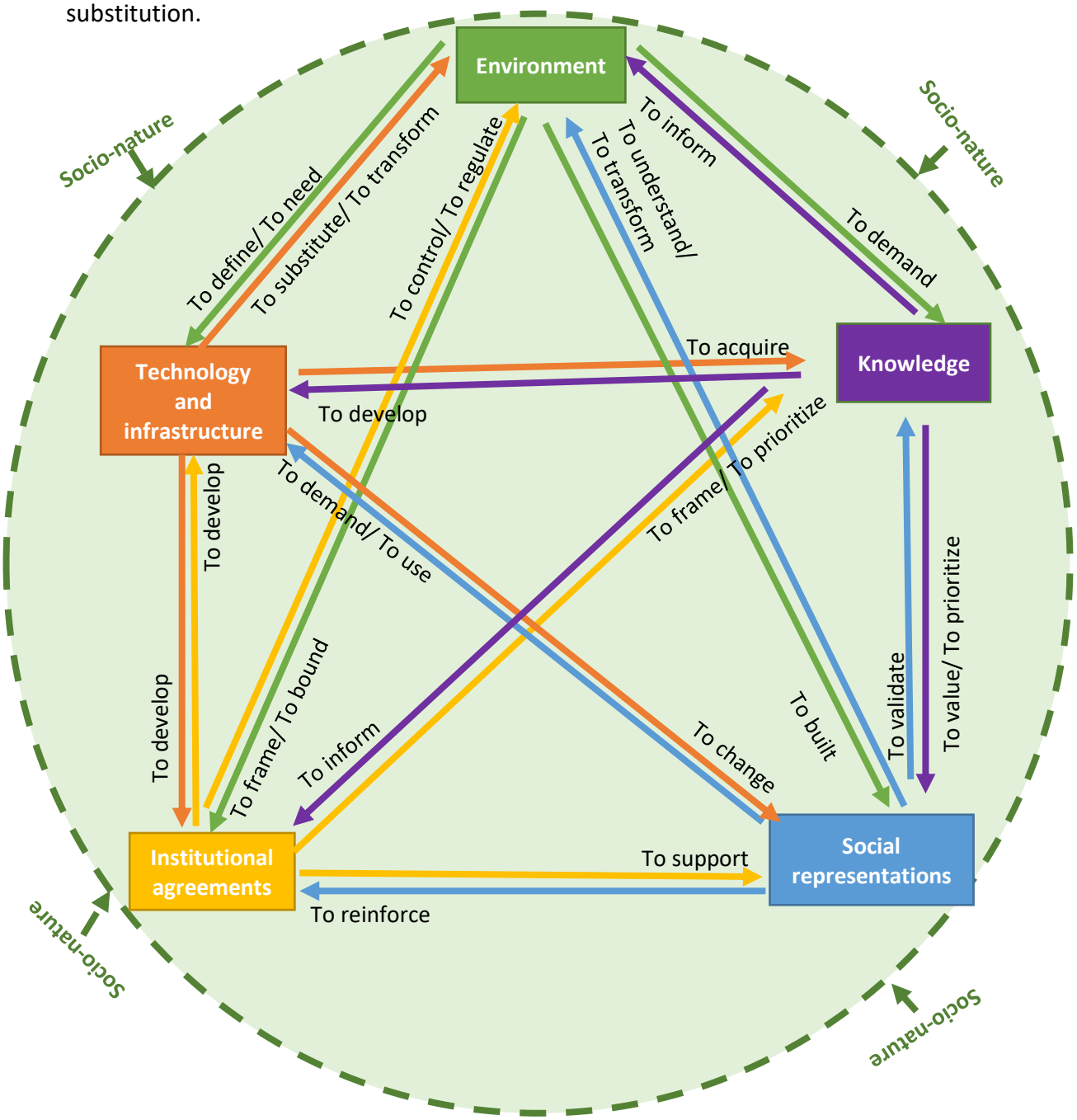


Figure 45. Coproduction components and their relations. Source: own elaboration based on Norgaard (1994)

4.3.5. The scalar relations of ES coproduction

ES flow coproduction process are characterised by scalar relations (Figure 46). To give an example, recreational and aesthetic services are produced and demanded locally, but coproduction processes are cross-scalar, with multiple relations at different scales; photos of visitors shared in social media, viewed worldwide, coproduce these services. The Barcelona-Catalunya film commission supports companies willing to record commercials or movies in the city, as local organization promotes international commercials to enhance Barcelona's touristic image.

Scalar relations also coproduce microclimate regulation. This is a very local service, located at specific spots with green urban areas. Microclimate regulation is supported by local urban green management. Nevertheless, scalar relations and process underly this service: 1) the Mediterranean has an important role in Barcelona's climate regulation, as the effect of the sea breeze; 2) Furthermore, urban green management integrates scientific knowledge and conceptualizations of 'nature' derived from regional and/or global sources. Local and global scales interact and result in coproduction and evolution of urban green management; and 3) In addition, cruise ship can have an impact over regional climate due to the emissions generate BC and ozone emissions, both ultra-fine particles belonging to 'short lived climate pollutants' (SLCP), which, in the atmosphere, absorb sunlight and lead to its warming.

Likewise, the air quality regulation service is coproduced by different scalar processes. It is regulated through local planning and urban green management. However, cruise ship tourism worsens air pollution in the city, especially due to the fact that in the berthing process, auxiliary engines keep working, burning fuel to provide the necessary energy to maintain hoteling services. During this time, cruise ship emits gases to the atmosphere. Consequently, gas emissions have a global impact, as increasing greenhouse emissions, but also contribute to regional and local air pollution. For instance, a cruise ship that in 2017 stopped in Barcelona six times on average it stayed in the city for 12.7 hours. During these hours these cruise ship demanded consumed 57.3 tons of fuel. As a result, it produced 164 tons of CO_2 that contributed to global warming, and 4.8 NO_X tons[21] that contributed to worsen regional and local air quality, acidification and creation of ozone.

Marine shipping operations use cheapest fuel, known as heavy fuel oil, characterised by large proportions of heavy molecules, such as long-chain hydrocarbons and aromatics. The Directive (EU) 2016/802, known as the 'Sulphur Directive', derived from International Marine Organization (IMO) regulation MARPOL Annex VI, states that once in the harbour ships have to switch low sulphur content fuel, maximum 0,1%. As a result Sulphur dioxide (SO_2) emissions in Barcelona have been reduced. There are still SO_2 emissions that derive a secondary pollutant, sulfuric acid, which is dissolved into water vapor in the air and carried by winds beyond Barcelona. Similarly, a secondary pollutant as ozone worsen regional air quality outside Barcelona's borders. Consequently, local cruise ship pollution transforms socio-natures inside and outside the city. In addition, in order to adjust to existing legislation, new technologies (scubbers) have been developed to absorb Sulphur oxide (SO_X)emissions. In Barcelona's harbour, cruise ships with scrubbers discharge polluted waste into the sea. Currently, there is no data available on the number of cruise ships using scrubbers in Barcelona, but worldwide statistics show that between 40-50% of cruise ships have scrubbers.

[21] Data provided by the Harbour Authority, Department of Environment.

Moreover, the use of a scrubbers raises energy consumption, up to 1-3% of fuel consumption(den Boer and ’t Hoen 2015).

Scalar relations are necessary in the case of provisioning services. For instance, food provision is produced locally, although depending to multiple regional and global phenomena, as soil formation, water, sun radiation. Furthermore, food provision ES is coproduced by technology and infrastructure managed by regional or international actors. Es food provision is distributed to cruise ship companies by international agreements. In addition, the impacts of food provision coproduction and distribution are multi-scalar, such as: local soil degradation, regional water pollution, air pollution, global greenhouse emissions and global loss of biodiversity. These negative impacts generate cross-scale interactions that result in more socio-environmental impacts. For example, the growth of global transport, increases local and regional air pollution, that outcomes in acidic rain, and hence soil degradation and water pollution.

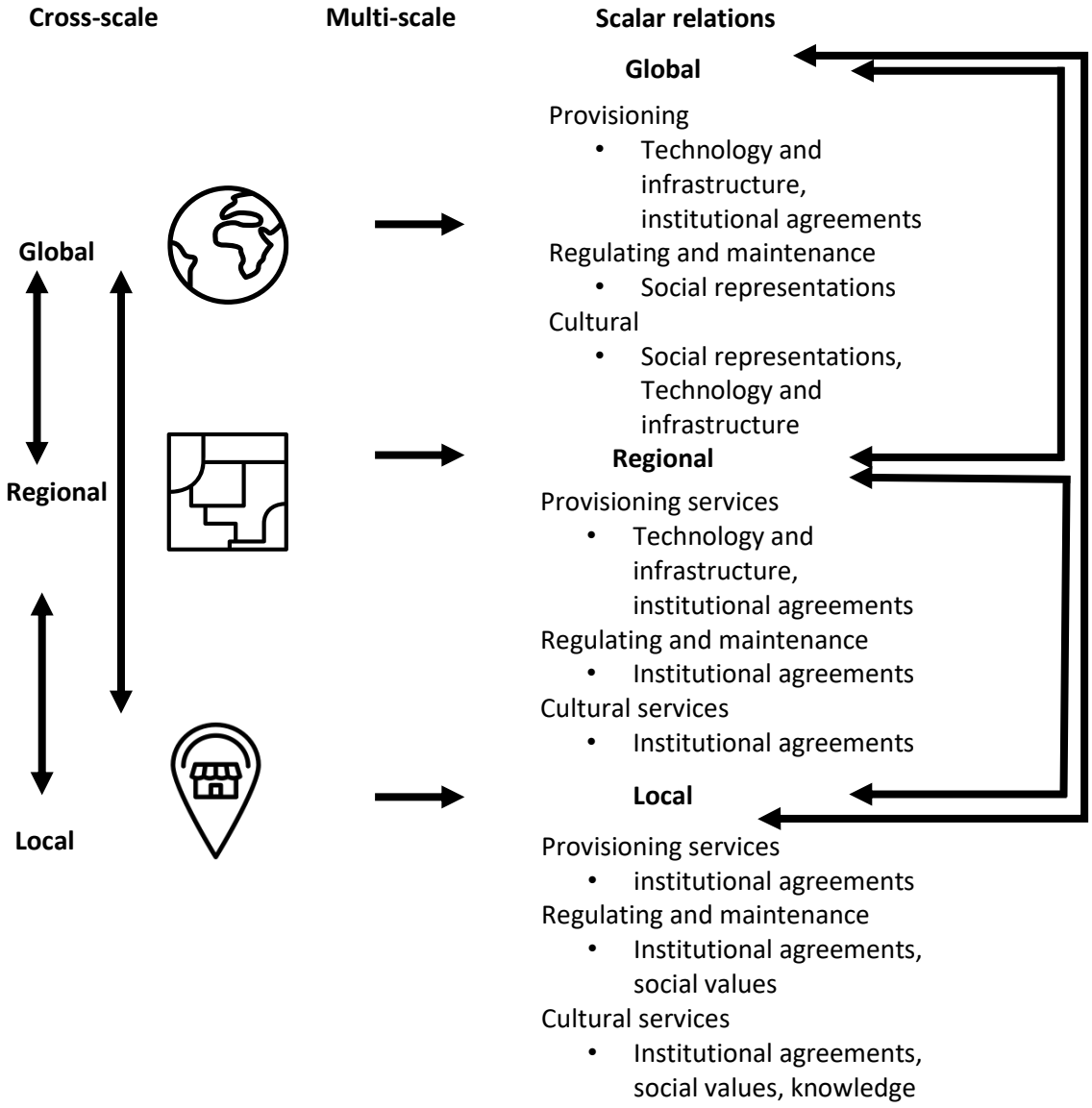


Figure 46. Scalar relations. ES consumed by cruise ships might be supplied and consumed at international, regional or local scale, as food services at global scale or microclimate at local scale. However, they are the result of cross-scalar interactions and feedbacks. Provisioning services as food

provision largely depend on international and regional institutional agreements and technology that condition ES local capacity. At the same time, provisioning services rely on international, regional and local interdepending socio-natural phenomena. Social representations concerning regulating services underpin regional and local regulations on these services, as local social representations condition regional and local institutional agreements. Likewise, social representations and technology incidence on cultural services regional and local institutional agreements, and local social values and knowledge condition regional and international social representations and institutional agreements. Source: own elaboration.

4.4. Discussion

The empirical results show that cruise ships ES flows circulate at global, regional and local scales, but also scalar relations. ES flows demanded in one specific location, Barcelona, generate multiple flows at different locations and scales, which involve different actors and coproduction processes. In Barcelona, cruise ships demands for ES flows trigger global flows, hence creating telecoupled systems, as with food or energy provision. Other ES flows are confined within regional or local borders, especially regulating/ maintenance and cultural ES. Nevertheless, these flows also involve multiple locations and actors, as intermediate actors. Similar to Drakou et al. (2018), our results show the relevance of ship companies as intermediaries, in our specific case marine chandlers. Intermediate actors are contributors to final ES benefits, but also create costs.

Our results highlight that institutional agreements and social representations are fundamental aspects that underpin other coproduction components and trigger socio-nature transformations and ES. Other studies (e.g., Spangenberg et al. 2014, Ernstson and Swyngedouw 2019) have also pointed out the relevance of use-value attributions and institutional agreements to ES coproduction; arguing that particular ES are prioritized by value-attribution and institutional agreements,. The outcomes of ES prioritization are different management decisions and associated socio-nature transformations. In our case, socio-natures are transformed as means to support ES cruise ship demand, prioritizing cruise ship demands over other demands, e.g., negative impacts over residents, such as exclusion of public space and social isolation.

ES prioritization and management decisions underpin political interests, hence socio-nature transformations and ES are political objects; i.e. any socio-nature transformation has political dimensions involving specific interest groups. Consequently, certain interests and actors have benefited, while others have suffered or been ignored. A political ecology approach aims to unravel how power relations underpin socio-nature transformations and derived conflicts and injustices; i.e. to expose winners and losers, occult costs, and the differential power relations that generate social and ecological outcomes (Robbins 2011).

In addition, the results of this paper also show how ES scalar dynamics change. In our increasingly global world, new global institutional agreements and global social representations have resulted in globalized local and regional ES flows. Cruise ship terminals were managed by local actors and the harbour authority, but now global private actors control them. Spangenberg et al. (2014) describe how traditional and local ES coproduction processes are transformed by global market forces. Thus, new institutional agreements and social representations take place, determined by global market dynamics. ES flows are then prioritized as market objects, they are commodified and transformed into tradeable global products.

Technology and infrastructure are also important components of coproduction. Technology has increased ES capacity, in some cases with associated trade-offs and costs in some others more sustainably (Palomo et al. 2016). Outeiro et al. (2017) and Palomo et al. (2016) reflect on level of human intervention via technology in ES coproduction and linked trade-offs; what is the limit of technological substitution of ES without risking destroying ecosystem capacity? Although their focus of attention is technology substitution, both recognize the importance of social representations and institutional agreements to ES coproduction. Thereby, a fundamental question is what institutional agreements and social representations guarantee ES ecological integrity, but also social sustainability and justice.

Environmental integrity and social justice related to ES not only rely on institutional agreements, but also coproduction factors such as identities and capabilities. Along this line, Fischer and Eastwood (2016) studied how identities and capabilities coproduce ES; identities and capabilities shape people interactions with the environment and ES consumption, at the same time the environment and ES are shaped by identities and capabilities. Identities can be defined as what is significant to a person and how people see themselves (Fischer and Eastwood 2016). Capabilities are linked to options about which people feel they have choice or agency (Fischer and Eastwood, 2016). Fischer and Eastwood (2016) argue that identities coproduce ES, as past experiences, social roles or preferences, shape people's interactions with the environment. At the same time, these interactions also shape people's identity. Cruise ship passengers' identities and capabilities determine who they are, their interests, their values, their demands and their behaviours; hence how they act as visitors and their behaviour in space, thus how they transform socio-natures and are transformed by them. For instance, technological and financial capabilities to access internet can determine how and what places cruise passengers visit, hence how and what ES are consumed. Therefore, people's capacity to coproduce ES and obtain benefits from ecosystems are subject to personal, social and environmental factors, as material capital, financial capital and knowledge to access internet. Future ES and cruise ship research should better integrate the analysis of these factors. That is to say, how social, environmental and personal factors condition people's capacities to coproduce and benefit from ES. As well as, analyse the distribution of such factors to rise environmental justice issues.

4.5. Conclusions

Through the analysis of cruise ship sector in Barcelona, this research provides an empirical understanding of spatial scalar relations of ES flows and coproduction processes. The research broadens current approaches in the field of ports and cruise shipping, revealing cruise ship interconnections, linked feedbacks and impacts beyond direct region of interest.

Additionally we integrate temporal perspectives by the incorporation of coevolutionary dynamics between the coproduction components. For instance, Technology and infrastructure support the development of institutional agreements, and institutional agreements guide and support the development of new infrastructure and technology development.

The integration of scalar dimensions provides a fundamentally better understanding of the scalar complexities of ES flows and the social dimension of coproduction processes. This is especially relevant to better inform decision-making. ES decision-making needs to embrace scalar complexities to manage telecoupled phenomena and their associated impacts. Also, decision-making needs to comprehend the social dimensions of ES, as they are essential part

of ES flow and coproduction. Only then can ES decision-making and management can move beyond dominant technocratic approaches and address social and environmental justice issues

In a context of political declarations of climate and biodiversity emergencies, it is highly relevant to consider the complexity of socio-ecological settings, in order to explore the unknown and unexpected impacts (positive or negative) of decisions and actions and their feedback processes. Moreover, the dynamics of globalization add even more complexity to socio-ecological phenomena by increasing multi scale and cross scale process and unexpected impacts. The insights provided by this research on socio-ecological complexity support better understanding and management of these processes and impacts.

Last but not least, in the field of ports and cruise shipping this research broadened current approaches, by understanding cruise ship interconnections, linked feedbacks and impacts beyond direct region of interest. Hence, this investigation moves beyond dominant research on transport studies and current analysis of environmental impacts

Chapter V.
Access and power in ecosystem services

5. Access and power in ecosystem services

5.1. Introduction

The ecosystem service framework understands human and nature interactions from a utilitarian perspective, as it considers supplying ecosystem services to be a means to obtain benefits to improve human wellbeing. It has been largely described that the degradation of ecosystems and linked ES is threatening human wellbeing (Raudsepp-Hearne et al. 2010). However, the MEA (2005) shows that human wellbeing on the global scale has increased, while ecosystems and their services have been degraded (Raudsepp-Hearne et al. 2010, Berbés-Blázquez et al. 2017). Furthermore, the increase of ES supply might benefit some groups, while others might be excluded or suffer the costs, or the trade-offs (Berbés-Blázquez et al. 2017). These paradoxes show that the relation between human wellbeing and ecosystem services is much more complex than a direct cause-effect correlation. The relation between ES benefits and human wellbeing varies with space and time, as on different temporal and spatial scales actors might value ES benefits differently.

A fundamental question to consider on the relationship between ES benefit distribution and wellbeing is access; i.e. if there is no access to ecosystem service flow, individuals or social groups do not benefit from it (Daw et al. 2011). Adapting its definition from the work of Ribot and Peluso (2003), in ES research, access may be conceptualized as the ability of people or social groups to obtain benefits from ecosystems. Ribot and Peluso (2003) argue that by means of a web of mechanisms and processes, individuals or social groups can have access or control access of others. Control access refers to intermediate others' access to ES benefits.

In all the abovementioned cases, power is embodied in and exercised through access mechanisms (Table 7). Dovey (1999) differentiates between 'power to' and 'power over'. 'Power to' in essence entails empowerment, such as the capacity to influence things in one's interests. In contrast, 'power over' consists of the capacity of individuals or groups to influence others' social practices or ideas. Power is a set of forces and relations inherent in social relations that can rise or flow due to the predetermined or undetermined consequences of social relationships and practices (Ribot and Peluso 2003). Power relations may be expressed in coercion practices but may also be mediated by factors other than violence, as individuals or groups can influence and determine individual and collective actions without apparent intimidation (Foucault 1980, 1991). Hence, power is embedded in any social relation and practice (Van Assche et al. 2014), thereby underlying access mechanisms (Ribot and Peluso 2003).

Table 7. Access mechanisms based on Ribot and Peluso (2003)

Access mechanisms	**Description**
Formal or informal right-based agreements	Access mediated by rights ascribed by agreements, formal or informal, such as laws, plans, regulations, bilateral agreements, verbal agreements, customs or conventions.
Technology	Access mediated by technology, tools or infrastructure, such as physical barriers or water pipes. Furthermore, technology might also be used as a means to facilitate ES exploitation or to increase ES capacity.

(continuation Table 7)

Financial capital	Access mediated by different forms of finance that are used to produce, to distribute, to consume and to value ES.
Markets	Access mediated by the individual or collective possibility to participate into exchange relations.
Knowledge and discourses	Access mediated by control over information and knowledge. Furthermore, knowledge and information serve to shape discourses. Access is also mediated by discourses, beliefs and meanings.
Authority	Access mediated by authority situations. Individuals or groups in authority positions concentrate a bundle of access mechanisms that they can use.
Identity	Access mediated by membership in a social group or social identity.
Negotiation via social relations	Access mediated by multiple social relations, such as trust, obligation, friendship, dependence or obligation.

Access analysis involves studying the mechanisms by which individuals or groups have access to or control the access of others, and the power relations that mediate and underlie access mechanisms (Ribot and Peluso 2003). In the case of the integrated ES production-consumption process, conceptualized by Haines-Young and Potschin (2009) as a cascade-model, at each cascade step, access is achieved by different mechanisms (Berbés-Blázquez et al. 2017) mediated by different power relations. In other words, there are access barriers to and/or facilitators of ES (co-)production, flow distribution, benefit use/consumption and value prioritization (Figure 47) (Berbés-Blázquez et al. 2017). As mentioned in Section 2.1., coproduction refers to the process of human-nature interaction and transformation from biophysical processes and ecological functions into ES. These ES travel from providing to benefiting areas of ES, named ES flows. Once in benefiting areas ES are used or consumed to contribute to aspects of human wellbeing. People assign importance to wellbeing benefits, hence they assign value. Furthermore, access can have a double edge as the exclusion of some stakeholders is necessary for other stakeholders to access benefit (Corbera 2012a, Myers and Hansen 2019). For instance, in the case of beaches, touristic uses and users might exclude other users, such as traditional fishermen. Moreover, touristic users might exclude other tourists by means of privatization of beach areas. Therefore, exclusion is conceptualized as the opposite of access, a restriction in obtaining benefit from resources (Corbera 2012a), and hence in benefiting at each step of the ES cascade (Figure 47). Moreover, at each step, social and ecological components interact and transform the existing socio-ecological milieu. These socio-ecological transformations can interfere in the relation between ecosystems and wellbeing (Berbés-Blázquez et al. 2017), as one ecosystem service or social group gain can cause losses for others (Daw et al. 2015), thereby creating trade-offs at each particular cascade step.

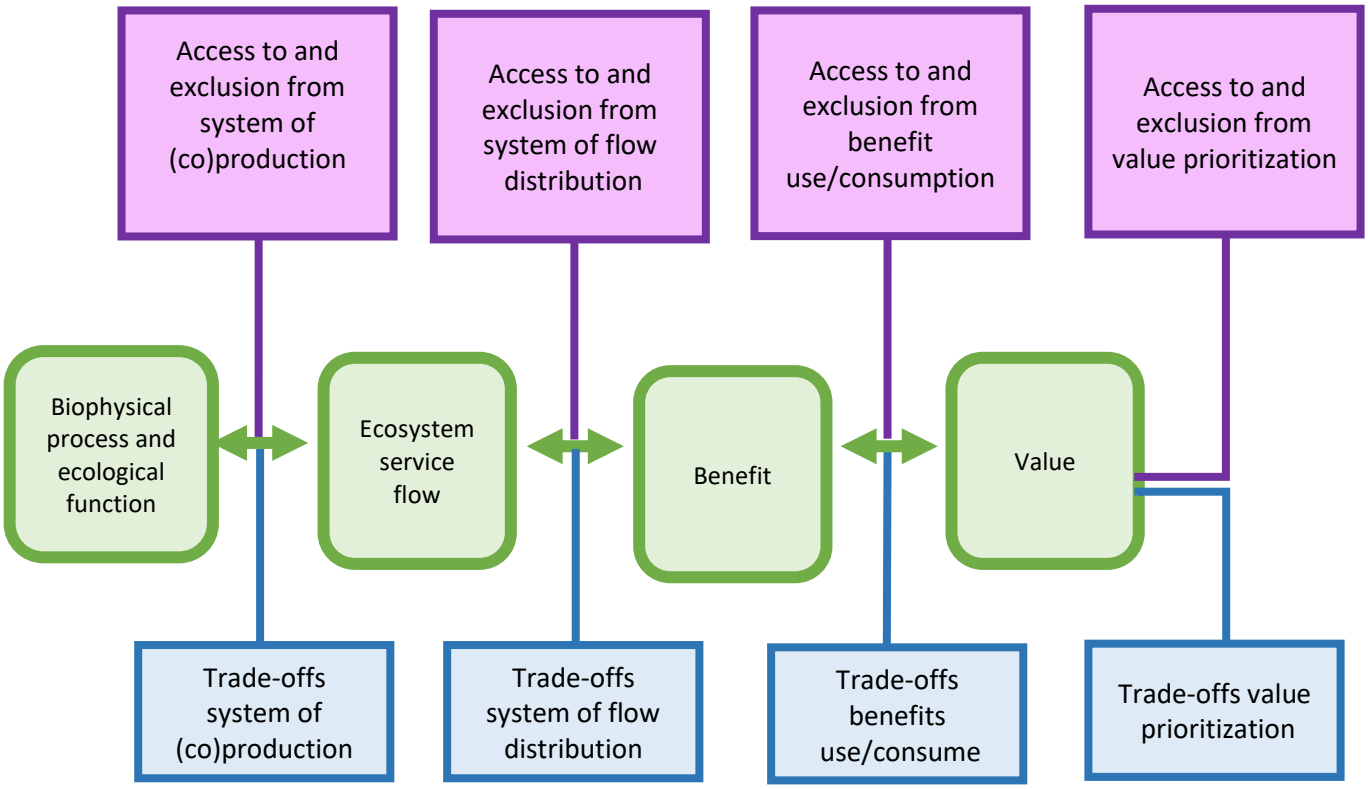


Figure 47. ES access conceptual framework. Through certain mechanisms, groups or individuals have access to or control who has access to ES production, distribution of ES flow, benefit use or consumption and value prioritization. At the same time, other groups or individuals do not have access, being excluded. In addition, at each step trade-offs among social groups and individuals take place. Source: own elaboration based on Berbés-Blázquez et al. (2017).

ES benefit distribution and access literature has been focused on the benefit and value steps of the cascade-model (Berbés-Blázquez et al. 2017). Authors such as Daw et al. (2011), Hicks et al. (2009), Dawson and Martin (2015), Horcea-Milcu et al. (2016), Chaudhary et al. (2018) and Villamagna et al. (2017), and initiatives such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and Ecosystem Services for Poverty Alleviation (ESPA), have provided great empirical work on disaggregated analysis of beneficiaries and how different social groups access and experience ecosystem service benefits to wellbeing. They have assessed social and personal circumstances that facilitate or limit benefit access. This research field is connected to Sen's capability approach (Sen 1999). Sen believes that human wellbeing relies on people's capabilities to achieve what they value being and doing, which is connected to freedom of choices (Deneulin and McGregor 2010, Polishchuk and Rauschmayer 2012). Therefore, better human wellbeing will be obtained with the maximum number of choices and freedom to achieve what humans value doing and being. To this end, humans need to remove obstacles and barriers that limit their choices and freedom, and hence, to remove access barriers that limit their choices and freedom to benefit from ES. Here, Hicks and Cinner (2014) aim to combine access to ES benefits and Sen's approach by analysing the relation between people's rights and resources and the benefits they are able to use. Furthermore, the very last step of the cascade-model has been addressed by authors such as Iniesta-Arandia et al. (2014), c et al. (2014) and Jacobs et al. (2018) as well as IPBES, who have made great efforts to assess value pluralism and how

different social groups value ES benefits. However, these studies lack understanding of the access processes and mechanisms behind value preference.

To the best knowledge of the author and as Berbés-Blázquez et al. (2017) argue, there is a gap in empirical studies and methodological tools applicable to analysing access in the initial and intermediary steps of the cascade-model. In other words, access to ES coproduction and flow has not been studied much as an integral access approach to all cascade components. Exceptionally, Berbés-Blázquez et al. (2017) studied the access mechanisms in the first step of the cascade-model: the mechanisms of access to ES production of the Bribri indigenous community in Costa Rica.

This research aims to complement existing efforts and gaps in studying access by assessing access mechanisms and underlying power relations through all the steps of the cascade-model. The research provides an integral analysis of access, which widens existing analysis as it allows us to understand how different social groups have access or are excluded at each step of the cascade-model. The analysis can show whether winners at one step might be losers at others, or if certain social groups have access to all cascade-model steps and vice versa.

The analysis of access and control of access uses Ribot and Peluso's theory of access and access mechanism typologies (Ribot and Peluso 2003) (see Table 7). The analysis aims to integrate the characterization of access, who has access and who is excluded from it – in terms of ES production, flow, benefit and value – so as to understand the power dynamics behind it. In this research, we apply access mechanism categories to study access to ES demanded by cruise ships and their passengers in the port of Barcelona. Moreover, access analysis is further complemented by a trade-off assessment between social groups, such as cruise passengers and residents, in the last steps of the cascade. Hence the objective is to understand how each socio-ecological transformation taking place at each cascade step interferes in the relation between ecosystems and wellbeing.

Power and access are not a common field of study in cruise ships, although there are some exceptions that research power relations between global actors, such as cruise lines, and local actors at destination ports. Van Bets et al. (2017) study the power relations between local destinations and global cruise lines in Bonaire. Further, London and Lohmann (2014) assess power relations between destinations and cruise lines by different port typologies. Also, Font et al. (2016), Klein (2003, 2005, 2011) and Clancy (2008) study conflicts between local stakeholders and cruise industry practices. Lopes and Dredge (2018) analyse how cruise tourism shore excursions in the case of Copenhagen create value and the control and distribution of this value. Also, Gui and Russo (2011) analyse the role of global cruise lines' value chain and local actors and services. Furthermore, Brida and Lanzilotta (2017), Brida and Zapata (2010, 2008) and Klein (2010) assess the difference between economic and socio-cultural impacts on cruise destinations. These manuscripts study power inequalities and benefit distribution at destination harbours. Their results show the power imbalance between cruise lines as global actors and local and regional destination managers. However, the aforementioned papers do not approach the whole cruise ship chain, hence the chain and associated power relations along the ES cascade.

With this approach we want to contribute to the field by analysing holistically access and power dynamics of the cruise ship industry, thereby providing a better understanding of cruise ship industry dynamics. Understanding how access and power relations are negotiated

along the chain can be fundamental to local and regional managers, as it provides core knowledge about access strategies and benefit distribution, hence understanding what the access strategies and mechanisms are, and who the winners and losers are of the ES production-consumption process. Thus, local and regional managers can have the necessary information to improve their negotiation positions in the face of global cruise line dynamics (Klein 2011, Lopes and Dredge 2018).

5.2. Methods

In Section 3.5, a detailed explanation of the research design and methods can be found. This research follows a mixed-method approach combining semi-structured interviews, and documentary analysis of official documents and reports and surveys of cruise ship passengers. The semi-structured interviews were structured in five main blocks, with the last three blocks corresponding to data collected for this chapter, i.e. actors and relations involved in identified ES, access mechanisms to ES and exclusion from ES and trade-offs. Likewise, the survey of cruise ship passengers conducted asked about ES demanded by cruise ship passengers, what they would visit and how they would move around. During the interviews, if respondents commented on existing official documents and/or reports, these official documents and reports were reviewed and analysed.

All of the 42 interviews were transcribed and later codified following Charmaz (2006), i.e. first initial coding, second focused coding and third final theoretical coding. The outcome of the focused coding was the codebook to operationalize the codes (Table 8).

Table 8. Codebook research objective 3

Nodes	Definition	Nodes inside
Access	The ability to benefit from things (e.g., material objects, persons, institutions and symbols)	A-objects, A-ES, A-symbols
Access control	The ability to mediate others' access	AC-ES, AC-products, AC-institutions
Access maintenance	The keepability to benefit from something open. To maintain access, subordinate actors often transfer some benefits to those who control it	AM-products, AM-ES
Gaining access	More general process by which access is established	AG-institutions, AG-ES, AG-actors
Formal or informal right-based agreements	Formal, when benefits are obtained from rights attributed by law, custom or convention. Informal, when benefits are obtained through less formal mechanisms or illegal mechanisms	A-RB-Concessions, A-RB-property, A-RB-word agreement
Technology	Access to technology mediates ability to benefit from ES	A-T-internet, A-T-cruise infrastructure
Financial capital	Access to monetary capital, finances or equipment	A-F-stock markets, A-F-investment

(continuation Table 8)

Markets	Ability to access specific exchange relations	A-M-global food market, A-F-regional market
Discourses and knowledge	Access to knowledge and information as means to control others' ability to have access. Also influences discourses, beliefs, meanings	A-DK-city image, A-DK-pollution data
Access to authority	Access to authority positions where it is possible to influence others	A-A-institution position, A-A-official role
Access to identities	Access through social identity, being part of a community	A-I-resident, A-I-tourist
Access to social relations	Access via the negotiation of other social relations	A-SR-trust, A-SR-dependence
Impacts on air quality	Air pollution from cruise ships	I-AQ-sulphur, I-AQ-distribution
Impacts on water quality	Water pollution from cruise ships	I-WQ-Scrubber, I-WQ-distribution
Waste management	Waste from cruise ships	WM-landfill, WM-recycle
Impacts on mobility	Effects on urban mobility in Barcelona due to cruise ships' activities	I-M-saturation, I-M-traffic
Impacts on space	Effects on use of space in Barcelona due to cruise ships' activities	I-S-saturation, I-S-change
Social relations	Effects on social relations in Barcelona due to cruise ships' activities	I-SR-isolation, I-SR-commercial
Impacts on climate	Effects on global and local climate due to cruise ships' activities in Barcelona	I-H-reflection
Impacts on health	Effects on human mental and physical health due to cruise ships' activities in Barcelona	I-H-respiratory, I-H-stress

The next step was to find the relations between codes and build models to explain access and exclusion mechanisms and power relations. The results are presented in the following sections by showing exemplar quotations. Behind the exemplar quotations presented in this text lie many repeated examples of the same kind englobed under the same code. In other words, to show the results one exemplar quotation is used, but this quotation does not represent a single experience or process, but rather is an example of the same experience or process found across different respondents and contexts.

5.2.1. Case study: Barcelona's cruise ship harbour

As previously mentioned in Section 3.4.3. the Olympic Games and the renewal of Barcelona's waterfront were key factors in the cruise ship development in the city. In fact, the waterfront renewal process meant a great influx of capital, similar to the cases of Boston and Baltimore (Desfor and Jørgensen 2004, Desfor and Laidley 2011). These waterfront transformations were characterized by the control of neo-liberal market dynamics in the production of waterfront spaces, which consolidated waterfront uses for recreation, commercial and touristic uses (Desfor and Laidley 2011). Thus, new uses excluded industrial or residential old uses. Nevertheless, these transformations are not free of conflict. Indeed, waterfronts are spaces of conflict (Desfor and Laidley 2011).

In the case of Barcelona, the transformation of the Old Port is a clear example of waterfront transformation under neo-liberal dynamics and a space of exclusion and struggle, as analysed by Tatjer (2013), Sutton (2015) and Trias Gibert (2016). The development of cruise tourism in the city is inherently linked to waterfront and port renewal processes. Therefore, cruise sector development and associated physical spaces are also dominated by market dynamics and processes of exclusion and social struggle.

5.3. Results

Access to each ES cascade-model steps depends on a bundle of interacting access mechanisms. Most significant mechanisms of access to ES coproduction are right-based agreements and negotiation via social relations, however technology is also a relevant mechanism in the case of provisioning ES. Access to ES flow is mostly defined by right-based agreements and negotiation via social relations. Furthermore, mechanisms such as financial capital and market access are also important to ES flow access for provisioning and cultural ES. Access to ES consumption/use is linked to mechanisms of financial capital and knowledge. Finally, value prioritization access relies on the access mechanism of knowledge and discourses.

5.3.1. Access and power in ecosystem services (co)production

The production of provisioning ES is conditioned by having access to physical resources, such as fresh water or fuel. A fundamental mechanism of access to physical resources is right-based agreements, such as concessions and property rights. For example, through formal institutional agreements, such as concessions, the Catalan regional government outsourced the access and exploitation of freshwater resources to a public-private consortium, named Aigües de Barcelona. This public-private consortium, through financial capital transfer to the regional government, obtains the concession of access and exploitation of freshwater resources. Consequently, the public-private consortium controls the access to ES water provision production.

The access to production through concessions not only relies on the payment of financial capital but also the fulfilment of certain criteria (years of concession, conditions of exploitation, among others) set by local or regional public institutions. Particular stakeholders can condition the definition of these criteria by means of social relations, such as lobbies and negotiation. Influential groups can shape concession criteria in accordance with their interests and exclude those that cannot fulfil the requirements. For instance, in Barcelona's harbour, cruise lines, like hotels, have access to water at lower than standard prices, as they

are classified as industrial activity (in comparison with domestic use). The classification of the cruise sector as industrial activity is a privilege for cruise companies.

Access to technology is also fundamental to provision ES. For instance, in the case of food provision production, access to technology is a central aspect to food producers. Access to technology such as agrochemicals, transgenic seeds, agricultural machinery and modern irrigation infrastructure is controlled by big corporations and food producers can gain access via financial capital. In fact, six multinationals control at the same time: 75% of the private investigation into crops; 60% of the commercialized grain market; and 76% of the global sales of agrochemicals (ETC Group 2013, Vargas and Chantry 2014).

According to the study of Berbés-Blázquez et al. (2017), access to other elements of food production, such as land, water or labour, are mediated by financial capital and formal and informal right-based agreements, such as land property or labour conditions. Also, in this case, certain social groups or actors that have access to negotiation via social relations shape institutional agreements to follow their interests, while neglecting others. Since the economic crisis of 2007–2008, more than 40 million hectares have changed hands, and different actors, such as private investment funds, who have great economic and social power are seizing huge land surfaces (Vargas and Chantry 2014). As a whole, the agro-industrial model contributes to worsening rural communities' conditions and access to production means, and hence to the exclusion and marginalization of rural populations (Montagut and Dogliotti 2006, Vargas and Chantry 2014).

The production of cultural ES services for cruise ships in the city of Barcelona has been controlled by a public-private partnership in charge of tourist promotion called 'Barcelona's Tourism Consortium'. The consortium is composed of the municipality of Barcelona, the Chamber of Commerce of Barcelona and the Foundation Barcelona Promotion, an organization promoted by the Chamber of Commerce to support the internationalization of local business and international investments, so as to promote the image of the city as an attractive location for business and investments. The municipality representation in the consortium is 45%, while together the Chamber of Commerce and Foundation Barcelona Promotion's representation is 55%. This public-private institution has been characterized by the dominance of private interests of the touristic sector, such as cruise sector interests, while the decision-making role of the municipality has been despised. At the same time, the economic contribution of the public sector is higher than private contributions: in 2019, the municipality transferred 5.949.901 euros to the consortium, while the Chamber of Commerce transferred 15.000. Nevertheless, most of the consortium's budget comes from its own commercial activity, such as sales of touristic products and services.[22]

The access to the production of regulating/maintenance and cultural ES, such as climate regulation and air quality regulation, aesthetic experience, leisure, recreation and tourism, depends on right-based agreements such as urban plans. For instance, Barcelona's urban plans define where green spaces are located and who will have access to them. Different groups and institutions aim to intervene in spatial planning through negotiation via social relations.

[22]Barcelona Turisme (2018).

In the case of waterfront spaces, such as spaces for cultural services, within-harbour borders are regulated by a far more flexible and permissive regulation framework than those of urban and coastal areas. Private actors, like building companies or investment funds, are extremely interested in harbour land because of their high plus-value rates and the more flexible urban regulation in the form of strategic plans. Interviewed urban and tourism academic experts assert that through special plans and the creation of public-private consortiums, new urban waterfront plans are developed. Hence, private actors take control over waterfront spaces. An academic expert on urban planning describes it as follows:

They (private investors) are the same companies investing in different ports, for them it is a Disney World because there is less regulation and public subsidies, and hence high profit (…)is a strategy of transforming waterfronts, and giving value to waterfront land, and to control the consumption in these areas, they generate all the means of consumption needed in the area, they control it. Personal interview 09/07/2018

Similarly, private actors, such as cruise lines, port operators and investment funds, are taking control over the construction and operation of cruise ship terminals. As explained by several interviewees, cruise lines are investing in cruise terminal development; they invest in building terminals, docking and commercial facilities. The harbour authority owns the harbour land, but cruise lines, through long-term concessions or authorization agreements given by the harbour authority, exploit new cruise infrastructure.

The control of terminal operations allows cruise companies to control access to the terminals. Multiple respondents claim that in this way they guarantee priority berthing of their ships and obtain economic profit when other ship companies berth in their terminals through the retention of a proportion of port taxes paid by passengers, as a cruise ship academic expert explains:

The companies pay for building the terminal, but then they get paid for the use of the terminal. The port collects taxes for the use of the terminal, some of them the passenger pay as a tax, and then gives it back to the companies. Having a terminal is quite profitable. Personal interview 31/07/2018

Barcelona's terminal concessions are not exclusively owned by cruise companies, but rather by groups of private investors. Barcelona Port Investments SL, formed by Royal Caribbean Ltd (38%) and Global Ports Holding Plc (62%), own terminals A–C's concession. Global Ports Holding Plc is an international cruise ship operator present in several ports around the world. This group is partially owned by a global port operator, Global Ports Holding B.V., which is a subsidiary company of Global Investments Holding (GIH), a private company that invests in port infrastructure, real estate and energy production, among others. Furthermore, Global Ports Holding Plc is also owned by Centricus Partners LP, an investment fund, and free float on the London Exchange Stock. Terminals D and E are owned 100% by Iberocruceros SL, which is part of Costa Cruises, one of the cruise ship brands owned by the Carnival Corporation, the biggest cruise ship company worldwide. Moreover, cruise ship companies are also partially owned by investment funds, also called 'institutional investors' (entities that buy and sell securities and other investment assets on behalf of their members). Therefore, cruise terminals and cruise line companies are part of international companies: for example, Carnival Corporation owns ten cruise line brands, such as AIDA Cruises, Costa Cruises and P&O Cruises (Figure 12). Cruise corporations are encompassed in global stock market dynamics

and forces; i.e. companies' equities are largely owned by global and powerful investment funds, such as Vanguard or BlackRock.

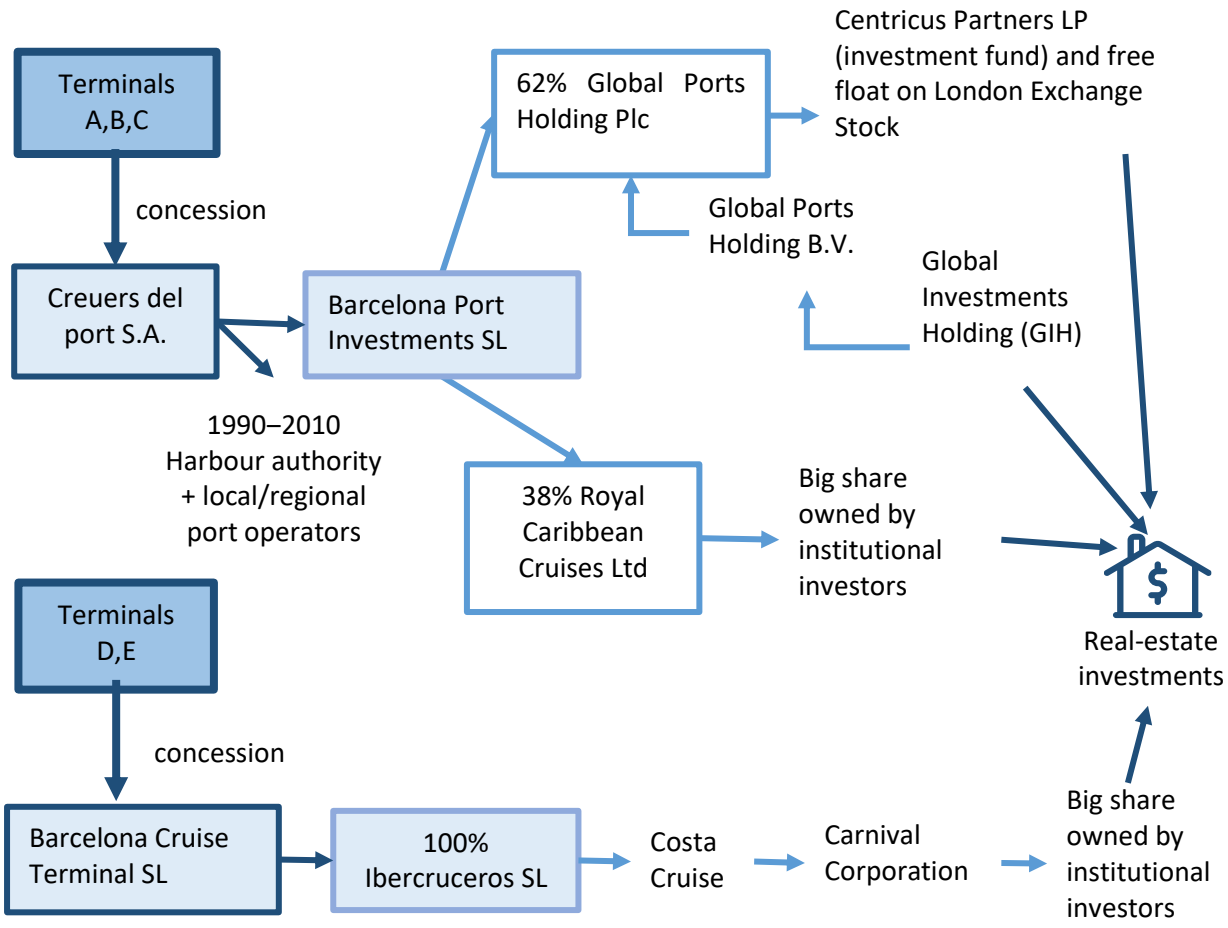


Figure 48. Terminal ownership process and relations. During the 1990s and the first decade of 2000, cruise ship terminal ownership concessions were controlled by a local or regional port operator together with the harbour authority. Nowadays, cruise ship terminal concessions are owned by cruise companies and global port operators. Both at the same time are partially owned by global investment funds, who also own real-estate companies. Global actors, cruise companies and real-estate businesses are using Barcelona's brandmark as a means to align their interests. Source: own elaboration.

Remarkably, the aforementioned global investment entities also invest in real estate (Figure 48). There are synergies between cruise ship companies and the real-estate sector, as both aim to transform harbour and coastal land into highly profitable investment using Barcelona's international brand, as an academic expert on urban planning explains:

Both are related, perhaps not directly but related through a territory where they are speculating and through a brand (Barcelona brand). We could say that real estate takes advantage of the investments made by the others (cruise companies) and the others (cruise companies) may take advantage of real-estate investments to dispute attractive routes that generate high profitability. Personal interview 16/06/2018

5.3.2. Access and power in ecosystem services flow

Thanks to long-term concessions and ownership of terminals, cruise companies have time to develop and implement their own strategies for passenger and port services, such as terminal management, onshore handling services (hotel accommodation, transfers, medical assistance, local tours and other ground operations, such as supply operations) and commercial areas for passengers. By means of mergers, acquisitions and agreements with global providers, cruise companies vertically integrate services previously offered by the harbour authority or local and regional incoming agencies or ship agencies. Therefore, long-term concessions open the door for vertical integration and greater control of service and products supplied to cruise ships. Provision ES are generally supplied to cruise lines by global marine chandlers, who act as intermediaries. Cruise lines and intermediaries' relations are formalized through bidding agreements. These agreements are global; hence cruise lines wish to supply to any port worldwide. The number of marine chandlers capable of handling large quantities under required cruise line specifications is limited. As several respondents agree, only very large companies can comply with cruise lines' demands, hence access to markets is limited to large companies. Consequently, nowadays four marine chandlers have the control of European market, as an academic expert on tourism argues. A marine chandler technical officer explains:

They are global companies, so they plan a worldwide supply strategy (…) If you (a supply company) do not have the infrastructure to supply worldwide, you are out. Personal interview 15/11/2017

Suppliers unable to reach cruise companies' demands, such as global supply, have been excluded from ES flow distribution, such as local and regional food suppliers or cruise line ship agents, as a marine chandler technical officer explains:

There are non-local suppliers, they have disappeared. Some years ago, 10 or 15 years ago, there were some, an average of seven or eight. And 30 years ago, there were around 20 local suppliers in Barcelona's harbour. Slowly they have disappeared, and other companies have grown. 'If there is an empty spot, I go' (other companies have covered the market share left) (...) Local suppliers, the small ones, have been bought by larger companies, which they can provide on a global scale. Personal interview 15/11/2017

At the same time, cruise companies have also developed horizontal integration through acquisitions and mergers of cruise lines, the cruise sector controlled by four companies: Carnival Corporation, Royal Caribbean, Norwegian Cruise Line and MSC Cruises. Therefore, cruise companies manage and control passengers' movements in different harbours in several countries worldwide and at the same time control several value chain sectors. Hence, cruise companies have a greater capacity to exercise their power over intermediaries and impose their own requirements for onshore services, including prices. A cruise ship academic expert and ship agency officers agree that cruise companies also have a greater capacity to exercise their power over harbour investment and management of cruise terminals' operation and port services, as an academic expert on the cruise ship sector asserts:

They are big companies with an increasing power, and they almost own the terminals as they have very long concessions, therefore they have become powerful actors in the harbour. Personal interview 27/06/2018

Several academic experts argue that these companies have acquired high-powered negotiation positions in front of the harbour authority. They have become powerful actors within the harbour, gaining the capacity to shape institutional agreements via negotiation via social relations, while the harbour authority has lost control, thereby losing the capacity to shape institutional agreements through mechanisms of authority and negotiation via social relations.

In this context, Barcelona's harbour authority role has become that of interlocutor and facilitator for cruise company strategies. Barcelona's harbour authority is an autonomous institution in terms of budget and management. Spanish harbour authorities can plan and manage its assets and activities autonomously. Under the umbrella of being 'business-friendly', Barcelona's harbour authority has promoted private management of cruise terminals and long-term terminal concessions. This strategy has been supported by the National Ports (*Puertos del Estado*), the administration in charge of the management of Spanish ports, which approved in 2016 a programme to attract and consolidate the cruise sector in Spanish harbours, with strategies such as tax reduction and long-term terminal concessions for cruise ship companies, a programme called 'Blue Carpet'. Furthermore, public funds have been used to build the necessary infrastructure to support terminal construction and operation (as explained in Section 4.3.4.).

The administration board of Barcelona's harbour authority is composed of national and regional government representatives. The president of the board is nominated by the regional Catalan government and four representatives, while the Spanish government has three representatives. Local administrations are represented by two seats on the board, one for Barcelona's municipality and one for El Prat de Llobregat, as the harbour is located within both municipalities' borders. On the board there are also four members of the Chambers of Commerce, business organizations and relevant sectors in the port area, such as labour unions. Commonly during the interviews is highlighted the fact that within Barcelona's harbour authority council, the municipality government has little to say. Hence, the municipality access to authority is very limited, as a port operator technical officer illustrates:

The municipality doesn't count: it has only two votes, out of 15 or 20, on the administration committee. They (the municipality) can say whatever they want, they can vote whatever they want, it doesn't count for much. Personal interview 20/10/2017

The lack of Barcelona's municipality power decision control has been especially relevant to new terminal construction. The municipality aimed to limit the number of terminals while the harbour authority wanted to build new ones, particularly to comply with the interests of MSC, a global marine shipping company with a subsidiary cruise ship company. Numerous interviewees indicate that, in spite of the resistance of the municipality, by means of negotiation via social relations, lobbying and pressing the harbour authority council, MSC obtained the permit for another new terminal construction. An international academic expert on cruise ship argues:

Pressure and blackmail a bit. That's how they all work. They all do the same to get their benefits. Personal interview 31/07/2018

Notwithstanding, the number of terminals dedicated to cruise ships has been defined by an agreement between the municipality and the harbour authority signed in January 2018. The harbour authority made some concessions to the municipality's demands, such as stopping

the activity of cruise terminals closer to the city at the end of the concession period (Figure 22, in Section 3.4.3). The relocation of three cruise terminals has been demanded by local social movements as a necessary measure to reduce air pollution coming from the cruise ships. However, the aforementioned terminals are old and obsolete, and new and big cruise ships cannot berth there. Furthermore, counterpart new terminals will be built in the cruise ship dock. As commonly retold by some interviewees, the corresponding negotiation process between the municipality and the harbour authority is characterized by the municipality's lack of authority, and the role of the harbour authority as a business facilitator for companies in the harbour, such as cruise companies.

As with other strategic plans, the 2018 agreement has been developed outside formal urban planning mechanisms, specifically as a bilateral agreement between the harbour authority and the municipality. As a result, urban planning participation mechanisms and democratic processes are not followed. Consequently, these agreements are characterized by a lack of public information, an open participation period and technical evaluation studies. Therefore, other actors and interests are excluded as they do not have access to negotiation mechanisms, such as public participation procedures.

In Barcelona, the access to ES flow and distribution of cultural ES is basically controlled by incoming agencies. Incoming agencies provide destination-based tourism services, such as airport transfers, hotel accommodation, medical assistance, boarding services, ground handling services and local tours. Incoming agencies in Barcelona are generally subsidiary companies of ship agency companies. Hence, port agency services and land tourism are integrated in the same companies. These are global companies that provide services worldwide. Furthermore, global tourist operators have also entered the incoming agency services market for cruise ships. Global tourist operators also offer cruise lines a worldwide contract: one single contract for all or many cruise line destinations for tourism services.

Repeatedly tourism academic experts and ship agency officers state that the globalization and standardization of touristic services allow tour operators and incoming agencies to reduce costs and increase their margin of profit. Consequently, cruise lines also increase their margin of benefits when they sell their excursions to cruise ship passengers, as a ship agency officer describes:

A very important share of the economic profit is excursions. That is where they (cruise companies) make their money. Personal interview 4/07/2018

The cost reduction affects different actors of the supply chain, such as local guides and bus drivers. Since local guide salaries are well regulated, bus drivers are more affected, as argued by tourist guides and a bus company spokesman:

Cruise companies make lots of money with us; we do not make money, they do. Passengers do not pay much for the ticket, they pay for the excursions. They (cruise companies) sell the excursion for 40 euros or more per person, and to us they pay less than 200 euros for four hours. Personal interview 18/12/2017

The distribution of provision and cultural ES answers to a segmented model, where onshore provision and tourist services are provided by global companies, marine chandlers and integrated tourist operators, while cruise lines control ship operations and terminal management.

5.3.3. Access and power in ecosystem services consumption/use

The access to ES consumption in the case of provision services inside a cruise ship is controlled by cruise ship companies by mechanisms of financial capital through which passengers obtain cruise tickets and food products. Cruise lines partially control the access to cultural ES consumption, as cruise lines offer different tours to their passengers. Passengers gain access to these tours through financial capital. Nevertheless, only 8%[23] of passengers visit the city via prearranged tours, while 79%[24] visit the city outside organized touristic tours. Passengers use knowledge and existing information online to decide what to visit, hence they gain access through knowledge and technology. Online information contained in media, blogs or social networks can be produced and controlled by public institutions and tourist sector stakeholders, such as Barcelona's Touristic Consortium. Tourist sector stakeholders push to control this information, as it defines how cultural ES are consumed by cruise passengers. Traditionally, this control was carried out by attending fairs and congresses to promote a specific image of the city and certain touristic spots, as well as by using commercials, movies and media. Nowadays, Barcelona's Touristic Consortium also controls the city's touristic image by using influencers and bloggers, as explained repetitively by some interviewees and as a Barcelona's Touristic Consortium officer explains:

Nowadays it (the promotion) is increasingly online; we (Barcelona's Touristic Consortium) have social networks and especially Facebook and Instagram. We (Barcelona's Touristic Consortium) are investing in these channels. And now more and more, we not only invite journalists but also influencers, youtubers, bloggers and instagramers. Personal interview 12/06/2018

Those spaces and symbols promoted as touristic attractions, by new or traditional means, become saturated spaces. For instance, the concentration of tourists in certain areas of the city, particularly Ciutat Vella, is significative for cruise ship tourism. Respondents commonly highlight the fact that cruise ship tourists visit the city for a very short time, and hence they concentrate their visit in the Ciutat Vella district (Figure 42), as described by a municipality technical officer:

Here, many cruisers go without an organized tour, they take the shuttle bus to Las Ramblas, go up as far as the Plaça Catalunya and down though the Gòtic; 90% of them do it. In the case of cruises, it is very directional; all the impact of people is accumulated in terms of intensity and occupation of space in Las Ramblas. It is basically an impact on Las Ramblas and the Gótic. The route was: Ramblas, Plaça Catalunya, Portal of the Angel, Gòtic, Cathedral, then it was a bit spread out until they got back to the shuttle bus. Personal interview 26/06/2018

As pointed out by quite a few respondents, the problematic aspect is that cruise ship passengers visit already saturated areas of the city, as described by a municipality technical officer:

These are highly saturated spaces of the city, such as the Ramblas, Gòtic… and cruise ships aggravate the problem. Personal interview 26/06/2018

[23] Data extracted from the survey I carried out in January 2018 and June 2018, with a sample of 756 cruise passengers in Barcelona.

[24] Data extracted from the survey; see previous footnote.

The excessive pressure of tourism in certain city areas has effects on residents' mobility. In the case of cruise ships, this is especially relevant as cruise ships' organized tours are generally composed of big groups, 25 to 50 passengers, walking around very narrow streets, as explained by tourism experts, and as an academic expert on tourism argues[25]:

Small or individual groups do not especially create an impediment to the urban practices of the residents, but a large group, cruise passengers in most cases, create an impact. Personal interview 11/06/2018

Likewise, Brandajs and Russo (2019) show how certain city spaces, such as the Royal Square, have become spaces dominated by cruise ship tourists, and how they have modified residents' and non-cruise ship tourists' mobility. Moreover, cruise ship passengers also have important impacts on the mobility of residents and other tourists around the harbour area.[26]

Through the analysis of the interviews it has been identified that saturation of touristic areas can result in municipal regulations aimed at controlling and reducing the impacts. For instance, as explained by several interviewees, the municipality has limited the access to tourists and Barcelona residents to overmassified touristic spots, such as Park Güell and Ramón Berenguer Square. In both cases, residents are excluded from these spaces due to tourist massification, as illustrated by a municipality technical officer:

There was a place (Ramón Berenguer Square) where buses stopped, including touristic buses. There was a place where kids were playing. School buses were also stopping there, schools from the area or from other areas. But what happened? Lots of touristic buses started to stop there, so there was a problem. In order to solve it, buses were banned from stopping there and there was an urban renovation of the area. This renovation meant that the safe spaces where kids played disappeared. So the space that was for locals, tourist massification made it impossible. Personal interview 26/06/2018

This exclusionary phenomenon cannot be attributed only to cruise ship tourism, but to the whole tourism flow in the city. In fact, Barcelona received about 8 million tourists in 2018, and of these 3 million were cruise ship visitors.[27] Some interviewees point out that the growth of both cruise ship tourism and non-cruise ship tourism has caused the privatization of public spaces for touristic uses (bar and restaurant terraces) and, among others, the disappearance of traditional local commerce in touristic areas. Interviewees also argue that as a result, urban landscapes and social relations have changed. These transformations have significant effects on residents, especially on elderly residents. Long-standing social relations and networks disappear, together with referent spaces of neighbourhood life. Therefore, the residents feel excluded and displaced from their own living space and neighbourhood community. Consequently, as local activist respondents frequently comment, the feelings of loneliness and social isolation increase, especially among elderly residents:

You (the resident) are an extra actress inside a theme park, where your culture is valued, but without you.[28]

In addition, local activists and some tourist experts also state that the conversion of traditional shops into touristic stores creates serious problems for residents' access to basic

[25] See Brandajs and Russo (2019).
[26] See Ros Chaos et al. (2018).
[27] See Ajuntament de Barcelona (2017d).
[28] Quote extracted from Agència de Salut Pública de Barcelona (2016).

products. Residents need to walk longer distances to buy daily products and these are more expensive, as described by a local activist:

(tourism) has a lot to do with the issue of traditional and local shops, the diversity of shops, especially in Ciutat Vella, and of course what and where the neighbours can buy. In this district (Ciutat Vella) everything is more expensive, the shops we know are closing...
Personal interview 11/07/2018

The streets and spaces that traditionally residents used are now occupied by tourists. This creates discomfort and mobility problems for residents, especially elderly residents who are the ones with reduced mobility. Residents experience stress, as a local activist and resident describes:

You constantly walk around stressed, you have to walk and push aside people; it is what I call the touristic bad mood. This happens every day, every day… this has to affect our health.
Personal interview 10/07/2018

Another important factor that disturbs residents' mental and physical health is noise, and cruise ship tourism in particular contributes to increased noise during the day, due to organized tours composed of big groups and tourist guides using speakers. In response to this, in 2017 the municipality approved a good practice codebook for tourist guides, aimed at limiting the size of the tourist groups, using radio guides or planning itineraries that minimize discomfort in the daily life of the city.[29]

As a response to tourism massification and its consequences, neighbours have organized themselves. The involvement in local activism has served as empowerment in the struggle against social isolation, as commonly noted by local activists, and as a local activist explains:

It is the only thing left, and it makes you feel supported, it makes you feel better. Personal interview 10/10/2017

A core factor in empowerment is access to knowledge. Knowledge access and control defines the capacity to influence decision-making. In this case, data on cruise ship contamination can be used to support arguments against or in favour of cruise ship activities, and hence influence decision-making. Knowledge related to cruise ship emissions is produced by the Environmental Department of the Harbour Authority, which monitors air quality inside the port and publishes reports monthly and annually. However, the monitoring stations are not standardized to EU regulations for air quality monitoring, hence the data collected are not official, but rather indicative. External actors (universities, research centres) also provide knowledge regarding harbour and cruise ship emissions and air quality impacts, but financed by the harbour authority. Consequently, these reports are owned by the harbour authority, and accessible by a formal information petition. Environmental NGOs argue that the harbour authority lacks transparency, as exemplified by a local environmental activist:

We (the environmental NGO in the context of the agreement signed between the harbour authority and the municipality in 2008) asked for information on what mechanisms of control are implemented to guarantee that ships are following current ship emissions legislation from 2010. However, the harbour in this agreement says that they will do a report on how to control ship emissions. But we ask for something very specific, which is this system

[29] Declaration of good practices in the guide for groups in the public space of Barcelona (Ajuntament de Barcelona 2017b).

of fuel monitoring (...) What we will do (the environmental NGO) is a formal request for information. However, we know that the answer can be ambiguous. Personal interview 19/12/2017

Likewise, cruise lines are accused of a lack of transparency. Cruise companies share data via the Cruise Line International Association (CLIA), hence they aggregate the data of the whole cruise sector, as an international environmentalist activist points out:

The tricky point is always the official data, or the lack of it. The way they aggregate so you cannot track a single ship, or to differentiate ship type or size. Personal interview 04/06/2017

Furthermore, cruise companies are able to produce their own knowledge and data, which serve their own interests, as an international academic expert on the cruise ship sector argues:

There is a lack of transparency, but then you have, on the other hand, this pretending to give information, a kind of look here but don't look there. Personal interview 31/07/2018

The lack of official data is especially significant in regard to air pollution impacts. Detractors and defenders of the cruise ship sector reject each other's knowledge as biased and unreliable. In spite of these cross accusations, the impact of cruise pollution has been widely studied and proved by authors such as Carić (2016), Carić and Mackelworth (2014), González et al. (2011), Howitt et al. (2010), Maragkogianni and Papaefthimiou (2015), Tichavska and Tovar (2015) and Viana et al. (2014).

Most recently, Faig Abbasov et al. (2019) published a study, based on 203 cruise ships and their AIS data, that classifies Barcelona as the most cruise-polluted city in Europe (Faig Abbasov et al. 2019). Air pollution experts repeatedly say that areas closer to the harbour are more affected by primary pollutants, namely soot and black carbon particles. Ciutat Vella and Sants are the areas with the highest percentage of NO_2 emissions from cruise ships at 18% and 16%, respectively (Port de Barcelona 2016). Further away from the source, in Barcelona's harbour, the soot is diluted, as explained by an academic expert on air pollution:

Space distribution is according to size. The coarse particle matter (PM10) falls first, and therefore closer to the harbour. Nearby neighbourhoods are more affected by coarse particles and primary pollutants as they have not yet been mixed with other pollutants. Hence, if you check the sulphur dioxide in Barceloneta it is still sulphur dioxide, but further away it is mixed with other pollutants and can become sulphuric acid. As with soot, in the first blocks the concentration is very high, but further away it is diluted. Personal interview 08/11/2017

Furthermore, air pollution experts also stated that cruise ship emissions[30] and derived air quality impacts exacerbate an already long-existing problem in Barcelona. Barcelona surpasses air pollution limits fixed by the World Health Organization and the European Union, especially NO_2. That is why the European Commission has repeatedly warned the Spanish institutions about their failure to reduce air pollution. In July 2019, the European Commission referred Spain to court. NO_2 pollution is a very serious problem that causes 5,900 premature deaths in Spain (EEA 2015).

[30] Appendix E for more information.

Another fundamental impact derived from cruise ship ES consumption is waste. Waste produced inside cruise ships is discharged in Barcelona. The International Convention for the Prevention of Pollution from Ships (MARPOL) regulates six waste typologies. In Barcelona, most of the waste collected from cruise ships is solid waste, classified as Annex V, and sludge, bilge water or residues from ships' engine rooms, classified as Annex I (Figure 49).

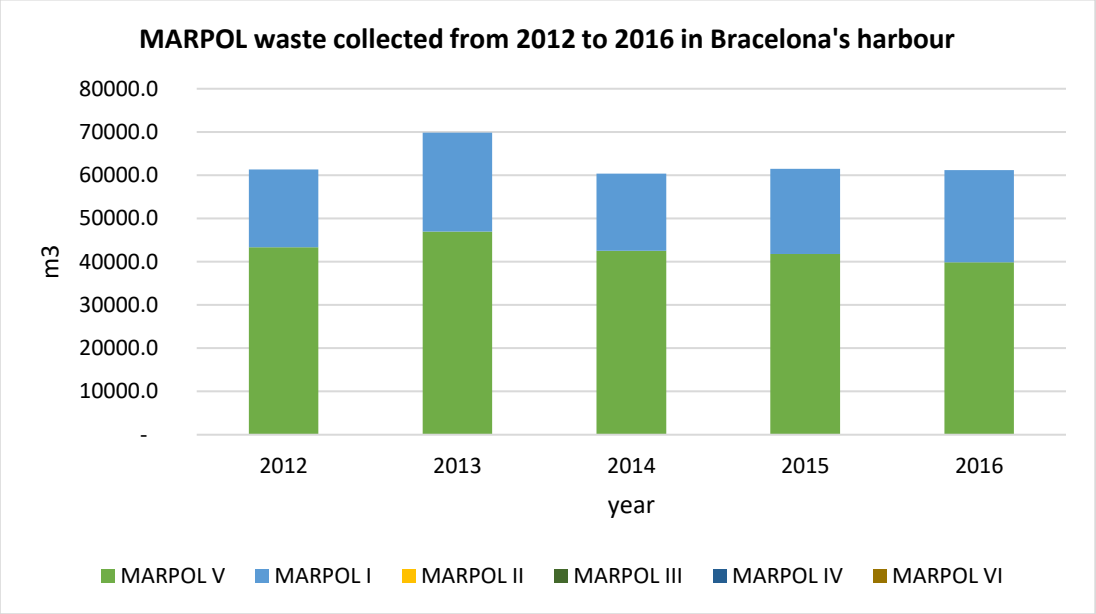


Figure 49. MARPOL waste collected between 2012 and 2016 in Barcelona's harbour. Source: own elaboration based on data provided by the Barcelona harbour authority

The waste collected and classified as Annex I has to undergo separate processes. First, fuel contained within Annex I waste can be recovered and resold to ships. The non-recoverable part of Annex I waste is composed of wastewater and polluted sludge. Wastewater is cleaned in wastewater treatment plants before being discharged into the sea, and polluted sludge is deposited in surrounding landfills. Part of the solid waste is also recovered, and non-recoverable waste is disposed in surrounding landfills, eco-parks or incinerators. Waste has important regional and local environmental costs in Barcelona, as part of the cruise ship waste stays in landfills located in the Barcelona region. Therefore, the negative effects of landfilling are suffered on a regional scale, such as the pollution of surface water, groundwater, soil and air. On the local scale, touristic activities carried out by cruise ship passengers and non-cruise ship tourists increase the production of municipal waste and the administration efforts related to waste management. In addition, as repeated by municipality technical officers, cruise ship tourists are concentrated in certain areas (such as Ciutat Vella), which implies a concentration of waste management efforts. A municipality officer illustrates the diverse distribution of efforts:

The cleaning services of the city water the whole Ciutat Vella district every day, but some areas have to be watered three or five times a day. These areas are the most crowded ones in the district. This fact is related to tourists in the sense of accumulation, accumulation of people in certain spaces. Personal interview 24/10/2017

5.3.4. Access and power in ecosystem services value

Access to and control of discourses are central in the struggle to define preference value. For example, several interviewees assert that cruise ship companies aim to control discourses related to their image, such as discourses conceptualizing cruise tourism as luxury and elitist tourism, instead of mass tourism. In the same vein, several interviewees point out that cruise ship companies also aim to control media as a means to build greenwashing strategies, as an international academic expert on cruise ships explains:

They will be everywhere, in any public representative in Spain, in the city council, meeting with the editorial team of newspapers in Barcelona regularly. Every other week just stopping to say hi, or meeting with the TV... and consider how much they are spending on advertisements in these same media. It is complex. Personal interview 31/07/2018

In the case of Barcelona, the CLIA in Spain uses local media to spread its messages and has created a communication platform, named 'Escala BCN', as one CLIA officer describes:

For some time, we have identified half-truths. Certain people with a very negative view on the cruise ship sector and making it look like something from outside that was not positively contributing to the city and taking advantage of it were in control of the discourse, especially on social networks. We (CLIA Spain) decided that we wanted to create a platform carried out by local people from Barcelona, who like cruises and live off them, people that consider them (cruises) a good thing. So this platform promotes the good things that cruises bring to Barcelona. Personal interview 19/09/2018

In contrast, environmental and tourism degrowth social movements do not have the same capacity, as they lack the financial capital and infrastructure to produce and spread discourses. However, since 2015 the municipality has changed its approach to tourism policy. The current local government has been working to control and regulate tourism impacts, especially in highly pressured areas. In this regard, the municipality has made efforts to enhance participation and communication among different stakeholders related to the tourism sector, such as the participation process during the development of the Strategic Tourism Plan 2020 or cruise ship workgroups, where different actors share information and knowledge on cruise ships in order to manage cruise ship passenger flows.

The access and control of discourses is highly relevant to cultural ES value. Public and private institutions aim to set value preference for certain spaces or symbols. For instance, the Barcelona Tourism Consortium promotes specific touristic attractions in the city, as explained above, through traditional methods (fairs, congresses and media) or new methods (Internet and social networks). However, municipal officers argue that over the last four years the municipality has also been working to have more control over the consortium and the production of touristic ES, and hence to strength their authority role within the consortium.

Every time we (the municipality) have to be more relevant for the governance of the consortium. In the consortium there is the Chamber of Commerce and the municipality. Due to the agreements that we made in 1993, the executive committee is managed by the Chamber of Commerce, but this does not mean that the municipality has nothing to say. Slowly the city council agreed with the Chamber of Commerce to define the rules that the consortium has to deploy. Personal interview 18/07/2018

Thus, through strategic agreements, such as a mobility strategy, and touristic plans, the municipality aims to intervene in which spaces should be promoted and which ones not, as a municipal technical officer explains:

We (the municipality) have approved a mobility strategy, district by district, to see what has the potential to become a touristic attraction, and what should remain unknown. With this strategy, for example, what has been agreed is that the Sant Antoni Market should not be mentioned in tourist promotion. Personal interview 06/09/2018

5.4. Discussion

By combining the theory of access (Ribot and Peluso 2003), the cascade-model (Haines-Young and Potschin 2009) and the access framework developed by Berbés-Blázquez et al. (2017), this research contributes to ES access and power relations literature and extends the analysis of Berbés-Blázquez et al. (2017). Therefore, this dissertation provides an empirical analysis of access, exclusion and power, and points out trade-offs through the cascade-model steps. Thus, this research moves beyond the benefit and access nexus, as it provides a holistic view of access while unpacking access in each of the cascade-model steps. This analytical approach can be used to inform political decisions and management that aim to include power inequality issues in integral ES policies.

The empirical results of this research show that right-based agreements, negotiation via social relations, knowledge and financial capital are extremely important access mechanisms throughout the cascade-model steps. Right-based agreements and negotiation via social relations are core access mechanisms in the first steps of the cascade, coproduction and flow, whilst knowledge and financial capital are fundamental mechanisms of access to benefit consumption/use and value. These results reinforce previous ES access research, such as the work of Hicks and Cinner (2014), who argue that mechanisms related to right-based agreements, negotiation via social relations and knowledge are connected to a larger number of, and diverse access to, ES benefits. Moreover, in the case of ES production right-based agreements, negotiation via social relations and technology and tools for food production, among other access mechanisms, are also important to ES access, as also suggested by Berbés-Blázquez et al. (2017).

Different ES might have different bundles of access mechanisms, such as power relations behind these mechanisms. In the case of regulating and maintaining services, access and access control mechanisms are more difficult to control because they are more fluid and not excludable (their use does not exclude others). Furthermore, as highlighted by Fisher et al. (2014), they are composed of larger cross-scale interactions and multiple feedback and processes. Provision and cultural services can be more easily controlled by access mechanisms (Fisher et al. 2014). In the case of provision services, they are physical commodified objects that have been co-produced and distributed by well-structured supply chains. By means of the supply chain, several actors and processes control access to these services. Cultural services are generally less susceptible to access control; nevertheless, as Fisher et al. (2014) argue, access to cultural ES can be well controlled when cultural ES are linked to specific places, or when property rights can be applied and/or an access fee is applied, as in the case study of this research.

Scale is fundamentally linked to ES, not only because ES can be co-produced, distributed, used and valued, all on different spatial and temporal scales (Scholes et al. 2013), but also because

ES are the result of complex socio-ecological processes that operate on many scales, including multi-scalar, interlinked and cross-scalar. The results of this research prove the relevance of multi-scale and cross-scale feedback for accessing ES. Provision and cultural ES are controlled by global actors but accessed by local actors on a local scale; global companies, such as cruise ships, marine chandlers and incoming agencies, control access to provision and cultural ES, which are consumed and valued in the city of Barcelona. Therefore, scale and social groups interact through cross-scale processes, and social groups control others' access to ES on different scales.

Moreover, the integrated analysis of access through the different cascade-model steps offers a holistic and scalar understanding of access and its associated power relations; consequently it also provides an understanding of the scalar processes linked to exclusion and trade-offs. Thus, access and scale interactions show the control of ES by global actors and processes, such as the power relations behind the process of access and access control. In the case of the cruise ship sector, the process of globalization and its consequences for port authorities have been studied by Gui and Russo (2011) and London and Lohmann (2014), and for marine traffic by Heaver et al. (2000), Notteboom and Winkelmans (2001) and Slack (2001). The harbour authority aims to attract and secure cruise business through large-scale public investment and minimizing its power capacity, while assuming that benefits will spread throughout the destination (Lopes and Dredge 2018). As a matter of fact, cruise tourism is controlled by global actors, but supported by public national investments. Trade-offs and exclusion are also embedded in scalar interactions, and as a result of the global dominance of the cruise ship sector, local and regional stakeholders, such as companies and public institutions, are excluded from decision-making, whilst they are affected by trade-offs. Hence, while the harbour authority answers to private and national interests, regional and local actors' voices are neglected, but receive part of the environmental and social trade-offs, especially city residents.

This investigation allows reflection on wellbeing distribution and trade-offs. In this regard, Berbés-Blázquez et al. (2017) point out that the analysis of access can show trade-offs between social groups and wellbeing conceptualizations. Different actors, such as residents and tourists, hold different wellbeing conceptualizations and priorities. However, current discourses support wellbeing linked to economic gain and tourist recreation, while other conceptualizations are undermined. Moreover, this research shows the importance of other wellbeing conceptualizations, such as wellbeing needs related to identity and participation in a community. More research is needed to understand the multiple conceptions of wellbeing and the trade-offs. In this regard, a future line of investigation could be the integration of Max-Neef et al.'s (1998) approach and their needs matrix.

The analysis of access also contributes to understanding the significance of the relation between financial capital and ES. The results show the importance of financial capital as an access mechanism; i.e. financial capital works as an operative part of bundles of access mechanisms. For example, financial capital is fundamental to harbour space control; i.e. global companies and global investment funds through financial mechanisms access and control harbour space. New cruise ship spaces, such as terminals, follow global neo-liberal dynamics of space appropriation and commodification (Weaver and Lawton 2017). A parallelism can be seen with investment in the tourism sector and real estate. Authors such as Saskia Sassen (2018) and Neil Smith (2012) argue that city land ownership is changing, and more and more global financial corporations own and control urban space. As a result, the

control capacity of local and regional actors is weakened. Private capital takes different forms to take control of space, i.e. different financial instruments, such as Mortgage-backed Securities (MBS)[31]. Sealey et al., (2018) studied the relations between financial credit mechanisms, such as MBS, and land-use change in the USA. Socio-ecological research, such as ES research, needs to understand how modern financial processes and mechanisms intervene in each cascade-model step.

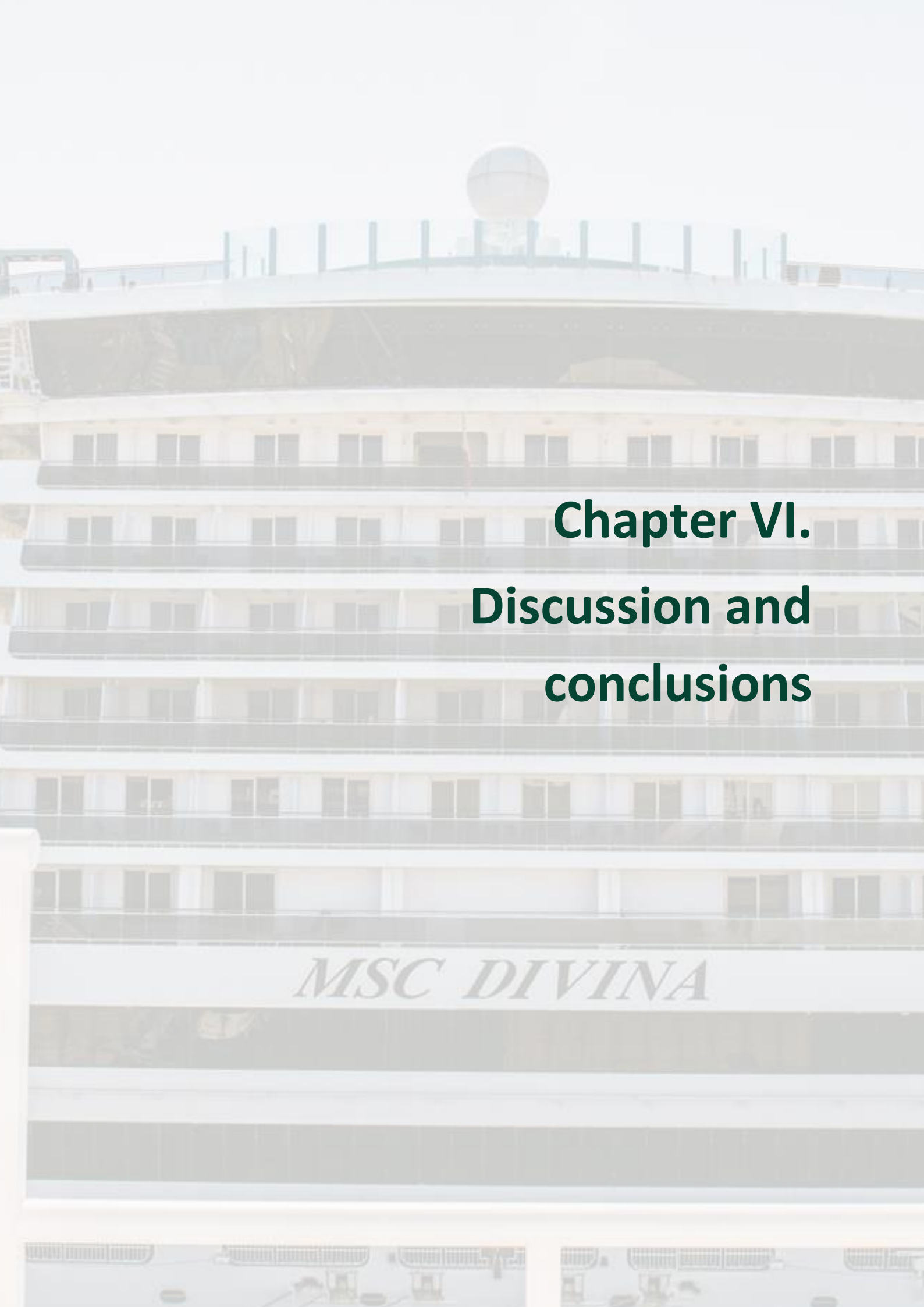
5.5. Conclusions

The analysis of access shows the complexity of the relationship between ES and human wellbeing. Different webs of mechanisms mediate the access in ES different cascade steps. However, some mechanisms are more important than others, as in ES production technology and right-based agreements are core access mechanisms. ES flow core access mechanisms are right-based agreements supported by financial capital and social relations. The most relevant access mechanism for ES consumption/use is the interaction between technology, knowledge and financial capital. Fundamental access mechanisms for value are knowledge and discourses.

The analysis has also revealed that access mechanisms are mediated by power structured through scalar interrelations, i.e. multi-scale and cross-scale. Thus, global actors intercede in regional and local actors' power relations and access, and vice versa.

Finally, access analysis exposes who is excluded from ES, and how, as well as who receives associated trade-offs, and how. The integral analysis developed in this research allows the disclosure of exclusion and trade-offs in each ES cascade step.

[31] MBS are investment instruments consisting of a bundle of home loans owned and issued by banks.



Chapter VI. Discussion and conclusions

6. Discussion and conclusions

This section summarises, and reflects on the results of, this research. The discussion is divided into eight subsections. The first is a discussion of the results on socio-ecological interrelations in the ES framework, and the contributions to, and limitations of, this research in relation to this topic. The second reflects upon scalar relations of the ES, whilst the third assesses how this study contributes to the integration of socio-ecological systems and political ecology through socio-ecological complexity. The fourth subsection examines the possible contributions of the results of this research to coastal management. The fifth describes methodological contributions from this study, while the sixth suggests several policy recommendations. The seventh subsection identifies future research ideas, and the last presents the main conclusions and some final reflections.

6.3. A holistic understanding of socio-ecological systems

The first part of the research aimed to identify socio-ecological complexity gaps in coastal ES literature. Our results show a clear misrepresentation of the social dimension. This fact is also true for ES general literature. In section 2.5. the reasons of the lack of integration are explained. Nevertheless, as also explained in section 2.5. in recent years there have been great efforts to better integrate social aspects, as to integrate value pluralism and disaggregate analysis among social groups. In the case of coastal ES, the misrepresentation of social aspects in ES assessments is more aggravated because ES research on marine and costal research systems has remained behind (Barbier 2012, Liquete et al. 2013, Portman 2013) in concordance with a knowledge gap on marine ecosystems (see, Norse and Crowder 2005).

The ES framework is an abstraction of reality that aims to represent a specific understanding of the nature-society relationship (Norgaard 2010). As with any other abstraction, ES looks at certain aspects of the nature-society relationship while obviating others (Thorén and Stålhammar 2018). Certain social aspects have been especially overlooked, such as the human contribution to ES coproduction, the role of power relations, or the pluralism of values and wellbeing dimensions. However, more recently, there has been a raised awareness of, and interest in, integrating social science and the humanities (Thorén and Stålhammar 2018, Vadrot et al. 2018), as well as interdisciplinary approaches having been undertaken, such as IPBES (Thorén and Stålhammar 2018). Therefore, there is an intention to expand the abstraction, in order to address the human-nature relationship from an interdisciplinary and integrated approach, thus further developing the socio-ecological approach within the ES framework.

With the objective of further developing a holistic socio-ecological approach, I developed a framework that integrates the socio-ecological complexity gaps identified during the literature review. To this end, the framework integrates ES flows, coproduction, access, power relations, temporal and spatial scales, value pluralism and uncertainty. Through the analysis of ES flows, from production areas to areas of benefit, it is possible to identify and understand the where, when and whom of the supply and demand for ES. This is a necessary step in order to understand how ES is coproduced; that is, to understand the interactions between biophysical entities and their processes and socio-cultural systems. In like manner, the analysis of coproduction aims to jointly understand how flows of energy and metabolism operate (as fuel or food supplies to cruise ships), whilst understanding how these interact with money, power, values and meaning-making operations. For example, how values

attributed to food interact with food production and supply processes. Thus, the study of the coproduction of ES demanded by cruise ships and passengers in Barcelona integrates an understanding of the interactions between material – energy and metabolism – and non-material – money, power values and meaning-making – socio-ecological components.

Taking into account Allen et al. (2017), who describe complexity as being a combination of materiality and abstraction, coproduction in fact permits an investigation of the interrelations between materiality and abstraction. The observer sets the limits on what coproduction is and how to view it, that is the abstraction. By means of a settled abstraction, the observer can study how different social constructions and material situations relate and transform each other.

6.4. The socio-ecological complexity of scalar relations

The conceptual framework proposed in chapter 2, aimed to overpass the dominant linear-cyclical approach in ES research, by conceptualizing the complex and non-linear relations and feedback processes of coastal ES. To that end, the framework embraces the analysis of flows as coproduction, scalar relations and access of ES. The application of the framework in the case of cruise ships show that cruise ships ES flows take place at international, regional and local scales, but these flows are also interconnected among scales. That is to say, the **ES demanded by cruise ships in Barcelona, are composed by multiple flows at different scales, interrelated among them and which comprise multiple actors and coproduction processes.**

The study of spatial scalar relations (e.g., multi-scale and cross-scale) has shown how **socio-ecological components are organised in complex and changing nested hierarchies** with emerging properties. For instance, local and regional ES flows are now subjugated to global ES flows, and local and regional ES coproduction processes are now articulated by global dynamic structures. As such, institutional agreements and social representations are structured by the properties of global market dynamics. Moreover, since flows and coproduction processes are organised into hierarchical systems, the analysis has revealed socio-ecological components as parts and wholes at different scales. Thus, the analysis of the cruise ship sector, viewed through the lenses of socio-ecological complexity and hierarchy theory, has provided an understanding of how parts and wholes (i.e. holons) behave at different scales. For example, local institutional agreements, as wholes, articulate cruise ship within the harbour, and at the same time, such agreements are a part of global institutional structures.

The results of this study also indicate the **significance of scalar relations in accessing ES**. For instance, global actors control access to the local cultural ES, with global incoming agencies controlling what and how cruise ship passengers consume local cultural ES through organised excursions. Exclusions and trade-offs are also embedded into scalar relations. For example, trade-offs derived from ES food production involve multiple scales and social groups, such as local food producers who cannot compete with cheaper prices at the global level, or regional food suppliers who are unable to meet cruise companies' demands. In addition, as a result of the **global dominance of cruise ship sector local and regional stakeholders, such as local residents or local public institutions, they are excluded from any decision-making** because they are excluded or misrepresented in the decision- making processes.

Moreover, the conceptual framework suggested and applied in this study uses the cascade-model, which represents the processes of ES, from the biophysics to the value attribution.

The analysis carried out, in terms of studying ES flow, coproduction and access, was intended to cover all cascade-model components. In this manner, it was possible to understand the multi-scale and cross-scale processes that covered all of the cascade-model components, and how these processes shape ES flows, coproduction processes and access.

This study also integrates the perspective of the coevolutionary dynamics between the coproduction components. The integration of coevolution dynamics for analysing the transformation process in complex socio-ecological systems and ES has rarely been addressed, with (to the knowledge of the author) the only example being the work carried out by Depietri et al. (2016), who study the constant transformations of urban and peri-urban landscapes through coevolutionary lenses. Complex systems are in constant transformation as a result of interrelations between their parts and the context of the system (Prigoginec 1986). Norgaard (1994) argues that socio-ecological systems, such as complex systems, are in constant transformation because of the evolution happening between humans and their environment. The coevolution framework developed by Norgaard (1994) pointed out that changes in socio-ecological systems are bidirectional. For example, the waterfront transformations derived from institutional agreements frame and shape future waterfront institutional agreements. However, this is not only a bidirectional process; it is a multi-causal process, as multiple relations interact at different temporal and spatial scales. That is to say, institutional agreements that lead to waterfront changes are the result of multiple socio-ecological interactions at different scales, such as local and global social narratives, or global and local harbour technology and infrastructure development. Coevolution also integrates the impacts and trade-offs that these transformations generate because impacts related to the environment are integrated as transformations derived from coevolution dynamics. Thus, **integrating coevolution and coproduction provides a better understanding of the constant multi-causality transformation of the system and its parts.**

Coevolution provides a frame for better integrating the social and ecological components of socio-ecological systems. Through the coevolution approach, separation between the environmental and human components is diminished, as socio-ecological systems are the result of constant transformations that derive from social and ecological interactions. Thereby, the coevolution approach applied in the case of the Barcelona cruise ship sector has allowed a better integration of the social and ecological components, and has challenged the nature-society dualism. In order to reinforce socio-ecological integration and a holistic worldview, Section 4.3.4 showed how coproduction processes, as understood through coevolution, are encapsulated in socio-nature realities. In this way, there is no distinction between nature and no-nature, as everything is the result of human-nature interaction. Thus, nature as pristine and something external to humans does not exist, all is the result of coevolution and coproduction processes.

However, in this study, the distinction between nature and society has not been truly overcome, especially in relation to the ES derived from urban areas. Following the urban ES literature, specific urban socio-ecological spaces have been identified as ES producers, such as urban green spaces, waterfronts, parks and beaches. These spaces are assumed to be natural or semi-natural and, as such, produce ES. In contrast, other urban spaces are not natural or semi-natural, and do not provide ES. In this way, only specific urban spaces and their associated components can be integrated into an ES analysis. Consequently, other spaces and components have been neglected, as well as trying to obtain an understanding of complexity in cities. The city should be considered as a whole socio-ecological system,

composed of holons, that provides ES. At the same time, the city itself should also be conceptualised as a holon, relating to broader socio-ecological systems.

6.5. The cruise ship sector as a means of accumulation by dispossession

The framework built throughout the literature review (see section 2.6.) includes access and power relations to account for when, where, by whom and how (e.g., through which mechanism) stakeholders have access to ES. With such knowledge is possible to identify excluded stakeholders and exclusionary processes, e.g., those actors that do not have access to ES and derived benefits. Adding to that, the framework also permits to identify trade-offs between social groups along ES cascade-model steps. Thus, to identify winners and losers at each cascade step.

The results of the research show that different **ES have different bundles of access mechanism, and different power relations behind these mechanisms**, **being right-based agreements, negotiation via social relations, knowledge and financial capital the most important ones** through all the cascade-model steps. Some actors do not have access to these mechanisms, thence they are excluded from ES access. At the same time, these neglected actors are affected by trade-offs, as they receive part of the environmental and social trade-offs. For example, in certain areas of the city cruise ship passengers occupy public spaces, which results in the exclusion of residents uses.

The analysis of access and power relations is a starting point from which to understand the relation between financial capital and ES. Financial capital is an important access mechanism. For instance, the results show how financial capital serves to control space in a harbour. Through financial capital, global cruise ship companies and global investment funds control access to cruise ship terminals, and thus to harbour space. The relation between financial capital and harbours has also been studied by Desfor and Vesalon (2008) and Desfor et al. (2011), who examine the relations between the circulation of capital and harbour areas, through Harvey's concept of capital accumulation and the spatial and temporal fix concept. Harvey (1982), Desfor and Vesalon (2008), Desfor and Laidley (2011) and Desfor et al (2011) argue that post-industrial harbour and waterfront transformations are spatial fixes resulting from strategies of capital accumulation. Spatial fix is a concept coined by Harvey (1982) to explain how capital systems deal with overaccumulation crises. Spatial fix has two meanings: 1) a literal fix, meaning 'the durable fixation of capital in place in physical form' (Jessop 2006, p. 4); that is, capital is a spatial entity that, through investment, becomes fixed and material; and 2) more metaphorically, fix as a solution to capitalism's tendency towards crisis by means of space restructuring and/or spatial strategies. In order to challenge the tendency of capitalism towards crisis, especially due to overaccumulation, spatial fixes transform capitalism in two different ways. First, spatial fixes transform internally-given spaces or economic areas via long-term investment in fixed spaces, with fixed capital enabling the flow of other capital (Jessop 2006). Second, spatial fixes externally transform by exporting surplus capital or labour outside the limits of the space or region in which it was produced (Jessop 2006). Thus, the way capitalism solves overaccumulation strategies is through space, by restructuring it or expanding its borders.

Consecutive loops of spatial fix are enabled by the modernisation of physical and social infrastructure (Jessop 2006). In this way, capital creates new spaces for accumulation by destroying or restructuring existing spaces, as in the case of post-industrial harbour transformation. In such regard, **the construction of new cruise terminals and cruise ships is**

also a strategy of capital accumulation. This are, in fact, spatial fixes continually open to new accumulation due to constant technological innovation. Furthermore, in accordance with existing cruise ship research (e.g., Gui and Russo 2011, Rodrigue and Notteboom 2012, Weaver and Lawton 2017), our results indicate that a future trend of cruise companies will be to expand towards port services and terminal operations (i.e. vertical integration), including touristic amenities close to cruise ship harbours. These future expansions can also be considered to be a form of capital accumulation that aims to overpass capital surplus by expanding to new markets and creating new investment opportunities. Cruise companies will aim to control these new spaces and services in order to have greater control over the ES consumed by cruise passengers; for example, to have greater control over the cultural ES consumed by passengers onshore and the associated expenditures.

Capital accumulation is a constant and never-ending process, as new opportunities for capital accumulation are continually being created. Capital accumulation mechanisms, such as ES control or space acquisition, are linked to the dispossession of others from their means of subsistence, known as accumulation by dispossession (Kallis et al. 2013). Harvey (1982, 2005) points out that, after the 1970s, the capitalist system was moved up from the national to the global economy. This scaling up served to find new spaces for capital accumulation. Consequently, accumulation by dispossession was also scaled up and new spaces of accumulation by dispossession were found.

In the case of the cruise ship sector, cruise companies, food and energy suppliers, and incoming agencies have scaled up and become global companies. These **global companies participate in the process of accumulation by dispossession**, such as making large investments in cruise ship harbour infrastructure, with these spaces being dispossessed from other actors, such as fishermen or residents. Moreover, ES commodification has also presented a new opportunity for capital accumulation by dispossession (Farrell 2014, Heynen and Robbins 2005, Kallis et al. 2013, McAfee 2012). In the case of cruise ships, the **cultural ES of the destinations are commodified as touristic products and are dispossessed from the locals**. In the same way, cruise companies generate capital accumulation by environmental dispossession; that is, by transferring environmental burdens or exposure to contaminants (Latorre et al. 2015). For example, cruise companies accumulate capital by using cheap, pollution-heavy fuel and transfer the derived environmental burdens to the cruise destinations or the open ocean, hence exposing the residents of cruise destinations and open-ocean habitats to pollutants.

To summarise, analysis of the access mechanisms allows an explanation, at each cascade-model step, of who has access and who does not, as well as the scalar interrelations and power relations that underpin access and exclusion. In addition, the analysis of access has allowed the introduction of critical perspectives concerning the relation between ES, space and capital. In this regard, **this study integrated socio-ecological complexity into coastal ES assessment as a means of introducing political ecological interests within an ES framework**; for example, to reveal socio-environmental disparities (winners and losers) and understand power relation inequalities behind social and environmental realities.

6.6. Contributions to coastal management

In Section 1.9.1, it was highlighted that, although coastal management and research has worked towards integrating social and ecological systems (see Bremer 2011, Ariza et al. 2016, Stojanovic et al. 2016), there is still a knowledge gap regarding coastal socio-ecological

complexity (Sardá et al. 2015). The gap refers to aspects such as the integration of social and ecological components, the scalar interactions of social and ecological components, the relations between ecosystem services, governance systems and values, and the impacts of coastal ecosystem services on human wellbeing.

This study has contributed to filling the existing gaps in five different ways: 1) through an analysis of coproduction, it **integrates coastal social and ecological components**; 2) the study of coproduction processes served to obtain an **understanding of the scalar interrelations** of social and ecological components through the cascade-model steps; 3) the analysis of ES flows was also used to help **determine the scalar process of ES production, supply and demand**; 4) the study of coproduction and access provided a deep **understanding of the relations between governance, values and ecosystem services**, and showed how institutional agreements and value interact with ecosystems to coproduce ES. The study on access revealed how formal and informal institutional agreements, social relations, discourses and identity are interrelated with ES; and 5) the identification and examination of trade-offs and externalities derived from the use/consumption of ES was also useful in **understanding the benefits, or lack thereof, to wellbeing.**

As explained in Section 2.5, although coastal systems are the result of the interface between land and sea, in ES research, very often coastal areas are not considered as a single unit for analysis (Portman 2013). Publication of the MEA (2005) aggravated this condition, as it included marine ES as a separate unit of analysis, uncoupled from terrestrial ES research. Consequently, ES marine research has been examined, but through a different body of literature to that of terrestrial ES (Portman 2013). This separation can also be seen between the urban and harbour literature. Even though ports and cities are connected through material, energy and knowledge flows, port and urban studies have generally ignored each other's findings (Ducruet and Lee 2006). In the urban literature, ports are set aside from the urban milieu, with the exception of waterfront redevelopment studies (Ducruet and Lee 2006). Port specialists acknowledge that port activities occur within an urban context, but they rarely analyse this context (Goss 1990). Hence, urban and port studies have been disconnected, neglecting the existing complex relations between port and city.

In the case of the Barcelona's cruise ship sector, the harbour and city regions are connected by different ES flows. For instance, water flows from regional sources provided to cruise ships, or waste flows from cruise ships discharged into the harbour and treated in Barcelona's region. Or people, as cruise passengers, flowing to specific (touristic) parts of the city, while other areas are excluded. At the same time, the city contributes to supplying passengers to cruise ships; for instance, via the airport. However, the relations between cities and harbours are being modified, as ports have progressively been disconnected from surrounding urban development. Ports' current configurations and processes respond more to macroeconomic dynamics and sectorial competition (Ducruet et al. 2016). As a result, ports have transformed into complex entities with multiple functions and flows that surpass the jurisdiction of port authorities (Ducruet and Lee 2006). This disconnection is partially observed in the case of the cruise ship sector. The cruise ship sector is also driven by global macroeconomic dynamics and harbour competition, being delinked from the local and regional economic development of their host cities. As such, most cruise ship supply flows are global flows, rather than local and regional flows. Nevertheless, cruises ships are still connected to their host cities, as they are a fundamental part of the cruise product.

This study examined the complex relationships between port and city at different scales and between different actors. However, as mentioned, the city was not considered as a whole system, but rather as a sum of its parts. Further research should better integrate port and city subsystems to be studied as a joint, complex system. The study of the port-city as a system could serve to integrate land-sea analyses, which could help in the conceptualisation of the coast as a single unit for analysis.

6.7. Conceptual and methodological contributions

The bundle of conceptual methodologies and methods used in this study allowed the socio-ecological complexity to be addressed. As such, **the cascade-model, the coevolution model, the scalar relations analysis, the access theory and the political ecology approach were used to build a conceptual apparatus that allowed a conceptual examination of the socio-ecological complexity**. This conceptual apparatus made it possible to obtain a profound understanding of the complex relations between the social and ecological components because it integrated the symbolic and material elements of ES coproduction and complex cycle access.

This conceptual strategy was also complemented by a methodological strategy; that is, the combination of a case study and GT. Following the coding steps, it was possible to establish relations between the codes; in this case, between the cruise ships' social and ecological components. Hence, it was possible to better understand how social aspects, such as value prioritisation, transformed ecological processes in the case study. Moreover, the GT and case study combination served to address the plurality of the perspectives that are at stake in the cruise ship sector in Barcelona. At the same time, this combination avoided reducing the plurality to one unique truth, but rather allowed a representation of different worldviews and voices at multiple scales. In this manner, it was feasible to identify and understand multiple perspectives of the cruise ship phenomenon, and thus better understand its complexity.

To summarise, the combination of conceptual and methodological strategies made it possible to gain a profound understanding of the socio-ecological complexity because it provided a holistic conceptualisation of the complex relations between the social and ecological components (production processes and feedbacks, scalar relations and links to access and wellbeing). Remarkably, this combination helped in better understanding the constant transformation processes of socio-ecological systems because it integrated the relation and feedbacks between the socially-constructed and material components. In addition, the understanding of these relations and feedbacks were not reduced to one reality, but represent the plurality of views at stake. Thus, this conceptual and methodological apparatus contributes to the environmental system and ES perspectives, as it reinforces the social dimension, as well as the plurality, in a systemic worldview.

6.8. Policy recommendations

Our results show how the ES demanded by the cruise ship sector are more and more controlled by global companies, whilst the capacity for decision-making, and ES control by local and regional actors, is partially neglected. Due to their powerful position, global companies are able to amass economic benefits for themselves, and hence reduce the economic profits of host harbours. In order to recover part of the control and decision-making capacity, harbour authorities must regain control of the cruise terminals by reducing the duration of cruise ship terminal concessions, or by controlling, partially or totally, the

operation of existing and future terminals. In this way, the harbour authority will have more control over the decision-making in relation to cruise ship terminal operation. Moreover, when cruise companies use cruise ship terminals, they pay taxes to the terminal operators for the use of these. If the harbour authority could own and operate the cruise terminals, it could collect the totality of the taxes paid by the cruise ship companies for use on/in those terminals.

This study showed that, due to the fact that cruise ships are supplied by global providers, local and regional companies do not get much economic benefits, as is the case for the local and regional onshore service providers, such as incoming agencies, food suppliers and tour operators. Furthermore, sectors such as onshore excursions, where local and regional companies still provide services to the cruise companies, are subjected to strict cruise ship company demands and low profit margins. In this way, global suppliers and cruise companies obtain the greater share of the profit, while local and regional suppliers only obtain a smaller share.

Future policy actions should aim to rebalance this existing situation. Policy measures should be aimed at **redirecting the supply of onboard and onshore services to local and regional supplier**s. One possible way to achieve this would be to establish a mandatory ratio of local and regional supply to cruise ships. In addition, this local and regional supply should not be focused only on cruise ship company demands, but also on the profits of local and regional suppliers. In this way, local and regional profit would be prioritised, as well as cruise company sector profit.

Future actions and debates regarding the cruise ship sector should also address environmental regulations and their control. As the results showed, local environmental organisations have asked for more control over shifting the fuel used inside harbours, from a high to low sulphur content. According to an agreement signed in 2018 by the municipality and the harbour authority in Barcelona, the harbour authority has to commission a study on how to control the fuel shift inside the harbour (Ajuntament de Barcelona 2018c). Moreover, local environmental organisations have also asked for the implementation of an **Emission Control Area (ECA) in the Mediterranean**. ECAs are marine areas that are subject to stricter regulations in air emissions from ships. In 2015, the North and Baltic Seas were declared Sulphur ECAs (SECAs), in which the content of sulphur in marine fuels is limited to 0.1%.

In the case of the Mediterranean, an ECA has still not been implemented. In March 2017, the alliance Clean Cruise Ship Network, formed from different environmental organisations, mostly from the Mediterranean region[32], signed a declaration: 'Declaration to designate the Mediterranean Sea an Emission Control Area to limit air pollution from ships'(Clean Cruise Ship Network 2017), which states that the signatories to the declaration 'urge policy makers to take action on shipping related air pollution and work in particular towards the establishment of a Mediterranean Emissions Control Area.'

[32] Environmental organisations of the Mediterranean region part of the Clean Cruise Ship Network are (in Spain) Ecologistas en Acción (www.ecologistasenaccion.org) and (in France) France Nature Environnement. (www.fne.asso.fr), in Italy Cittadini per l'aria (www.cittadiniperlaria.org), in Greece (Hellas Ornithological Society (www.ornithologiki.gr), in Malta Birdlife Malta (birdlifemalta.org). Also other European organizations as NABU and Transport and Environment are part of the Clean Cruise Ship Network.

In 2018, thanks to the insistence of local environmental organisations, the municipality of Barcelona and the Catalan government gave public support to a future ECA in Barcelona (Sostenible 2018, Ajuntament de Barcelona 2018b). Neither the Catalan government nor the municipality are able to implement the ECA, as it concerns Spanish government responsibilities. Nevertheless, both institutions can demand, and apply pressure for, the rapid implementation of an ECA and for more technological and financial means to further control emissions in the harbour. However, the harbour authority is an autonomous entity, subject to Spanish government rule, although it is not subject to regional and local rules. This is why local organisations have been demanding a change regarding harbour government towards more local and democratic harbour governance (Plataforma per la Qualitat de l'Aire 2017). In this way, since the harbour is a part of the city of Barcelona and el Prat de Llobregat, decision-making in/about the harbour should be based on the same democratic principles and processes that apply in both cities. **Harbour decisions** should not be subject to a bilateral agreement between the municipality and the harbour authority, as happened in the agreement signed in 2018 between the harbour authority and the municipality, but rather **should be open to the influence of Barcelona's residents**.

As post-normal science argues, decision-making concerning complex socio-ecological issues is characterised by uncertainty, values in conflict and pressing decisions require knowledge and information, coproduced by different scientific communities and all the stakeholders with a stake in the given issue (Benessia et al. 2016). In the case of cruise ships, existing data have generated distrust among the parties. Given this situation, local organisations have demanded greater transparency regarding the studies financed by the harbour authority, wanting more control over what needs to be studied, what indicators should be used, how the studied should be undertaken and by whom. Such investigations are financed by the harbour authority and carried out by research institutions or consulting companies. The **studies could be coproduced by all stakeholders** (the cruise companies, the harbour authority, public administrations, local organisations), **and evaluated by an expert and ethical committee that is independent of the cruise ship sector**. The data and interpretations could easily be accessed by the general public, which would build new relations of trust and collaboration among the stakeholders.

In a similar vein, local activism organisations are working on research and actions for tourism degrowth (Assamblea de Barris per un Tuirsme Sostenible 2018). Tourism degrowth advocates for redefining the tourism sector by prioritising the rights and wellbeing of local communities, rather than tourists (Higgins-Desbiolles et al. 2019). In addition, they aim to enhance the interest of local communities in hosting tourists, instead of the profit accumulation going to the tourism industry (Higgins-Desbiolles et al. 2019). **Barcelona, as an international touristic city, could lead the shift towards tourism degrowth.** Transforming the tourism sector from a profit accumulation business towards to an activity based on socio-environmental justice and the priority of interests and local communities. With that aim, knowledge and information are fundamental, as it is necessary to have an understanding of tourism flows and externalities, as well as the underpinning of unequal relations in the city and beyond. Cruise ship industry externalities reach beyond the city of Barcelona, and all externalities should be addressed.

Tourism degrowth also advocates for limits on the number of regular tourists and cruise ship tourists. **A reduction in the number of cruise ships arriving in Barcelona's harbour would mitigate some of the impacts generated by the cruise ship sector**; for instance, the

saturation of the city centre, and the impacts of this saturation on the daily mobility of the residents. A limitation on cruise ships per day is a debate that has been presented in other European cruise destinations, such as Venice, Palma and Dubrovnik (Brady 2019). This debate should be opened to all the residents of these cities, who could collectively decide whether cruise ships should be limited or not. Therefore, the number of cruise ship terminals in Barcelona should not be a decision made by the harbour authority, but should result from an open decision-making process in which Barcelona's residents could have a say.

6.9. Future research

The framework created and used in this study was intended to contribute to coastal ES research by integrating political ecology approaches into socio-ecological complexity. Hence, the framework serves to analyse how complex socio-ecological processes define ES access, and how power relations mediate in ES access. In such a manner, this framework is not an apolitical framework, but rather a normative tool aimed at providing a starting point from which to politically address future coastal ES research. However, future research should aim to better understand the reasons behind the access and power relation processes, to link these processes in a broader context and dynamic.

Future ES research should also be aware of the limitations of the ES framework when addressing the social aspects of socio-ecological complexity. Stojanovic et al. (2016) argue that the social sciences are reluctant to address certain aspects of society by system conceptualisation, as this simplifies and undertheorizes social objects and processes. To overcome this important shortcoming, we propose that system and complexity theories be complemented by non-system-thinking approaches. In this regard, the political ecology discipline greatly expands the ES academic arena. The critical approach of political ecology provides the necessary tools for counteracting the dominant ecologically- and economist-oriented approaches in ES. Socio-ecological complexity offers an alternative normative perspective, aimed at understanding the complexity of socio-ecological systems, whilst identifying the winners and losers in these systems. Thus, socio-ecological complexity analyses, at the same time, socio-nature transformations, the power relations that underpin these transformations, and the social and environmental injustices associated with these transformations.

Political ecology also enriches the analysis of ES flows. Through the ES framework, it is possible to identify telecoupled flows of ES around the globe, whilst political ecology analyses the social and environmental injustices outcomes of these flows; that is, the winners and losers of these flows. This study identified the telecoupled flows of ES demanded by the cruise ships and the associated socio-environmental impacts and trade-offs at each cascade step (e.g., impacts and trade-offs at ES (co)production, flow, benefit use and value). As Yu et al. (2013) point out, throughout telecoupled flows, unequal relations between rich and poor countries emerge, as rich countries' patterns of consumption change and displace the traditional, local land use of poorer countries. Future research should further analyse these unequal relations among telecoupled systems.

Trade-offs do not only occur between distant systems (as telecoupled systems), but also between social groups within systems (Daw et al. 2011), such as the trade-offs between residents and tourists. Different social groups hold different conceptualisations and values of wellbeing (Daw et al. 2011). The prioritisation of one group's wellbeing neglects that of the other. This study did not aim to understand, in any depth, the conceptualisations of wellbeing

of the different social groups related to cruise ship tourism in Barcelona, such as the residents and tourists. Future research should investigate wellbeing conceptualisations through the Max-Neef (1998) approach and its needs matrix. In this regard, during the fieldwork involved in this study, one question emerged concerning an unexplored, but rather fundamental, aspect – the mental and physical health of residents in high touristic areas. Simply put, how are situations of stress and isolation deriving from tourism disturbing the health of the resident? A future integral analysis of wellbeing and trade-offs should consider multiple human wellbeing dimensions at multiple scales at each cascade step. This analysis would enrich the assessment of tourism, as it would provide a broader representation of the externalities and inequalities of tourism. In this way, Bramwell and Lane (2008) and Higgins-Desbiolles et al. (2019) advocate for research beyond the analysis of the negative impacts of tourism, suggesting the inclusion of the borderline aspects of equity, fairness and socio-environmental justice.

Tourism is a phenomenon constituted by multiple and complex social and environmental relations – an expression of human and natural relations (Pueyo-Ros 2018). However, few studies address tourism from a socio-ecological system perspective (Herrero-Jáuregui et al. 2018). In this regard, there are important gaps in tourism research that could be addressed by a socio-ecological approach and an ES framework, such as the lack of environmental and social justice studies, to add to the case-study-based literature (Higgins-Desbiolles et al. 2019). The analysis presented here contributes to the tourism – particularly the urban tourism – environmental and social justice debate, through the introduction of socio-ecological complexity (e.g., through the understanding of coproduction, the study of access mechanisms and the identification of winners and losers). Thus, the introduction of socio-ecological complexity can contribute to expanding urban tourism research, moving the field beyond case-study-based studies.

Moreover, as first mentioned in Section 3.3., most cruise ship literature studies focus on the phenomenon in the Caribbean, while very few consider the Mediterranean, the second largest cruise ship market after the Caribbean. This is why more research related to the cruise ship phenomenon should be carried out in the Mediterranean, as well as the growing markets in Asia, South America, Australia, and the North Sea and Arctic Sea regions. In addition, a comparative analysis of different cruise ship regions could provide significant insights.

6.10. Conclusions and final reflections

This study addressed three research objectives. The first was to understand how the coastal ES literature integrates socio-ecological complexity. Complexity theory was used to set the basis for addressing socio-ecological complexity in this dissertation throughout five essential socio-ecological complexity properties – ecological and social interrelations, multi-scale analysis, coevolution, plurality and uncertainty. This has been complemented with concepts from political ecology that allowed to assess environmental justice issues. For this study, a systematic review of coastal ES literature was carried out, in order to understand how these properties have been approached. The literature review identified important gaps in coastal ES research, in terms of: 1) a lack of integration between the ecological and social components; 2) only a partial understanding of ES coproduction processes, such as the core aspects of coproduction, which does not include institutions and governance systems, knowledge, socio-historical legacies, social representations, technology or infrastructure; 3) the absence of an understanding of how power relations mediate trade-offs and access, and

the distribution of ecosystem service benefits; 4) a gap concerning scalar interrelations, such as studies that integrate multi-scale and cross-scale analyses; 5) no coverage of the multiple dimensions of HWB, especially the intrinsic and relational dimensions, as well as a lack of understanding about how HWB is distributed among the different social groups; and 6) whilst the coastal ES literature partially assesses uncertainty, it is only superficially analysed.

The second objective of this study referred to the characterisation (ES flows, coproduction and multi- and cross-scale interactions) of ES used by cruise ships. Taking into consideration the gaps identified by the literature review, an integral framework was built. This framework addressed the analysis of the ES flows, coproduction and scalar relations. The application of the framework in the case of cruise ships proved that cruise ship ES flows take place at different scales and across scales. The results also showed that the ESs demanded by cruise ships comprise multiple actors, multiple scales and several coproduction processes.

The third objective was to understand how power relations condition access to ES, and the distribution of externalities derived from the use of ES. The suggested framework was complemented by an analytical framework that allowed access to be examined holistically, through all the cascade-model steps. This was achieved by using the access theory of Ribot and Peluso (2003), the cascade-model of Haines-Young and Potschin (2009) and the access framework developed by Berbés-Blázquez et al. (2017). In this way, an empirical analysis of access, exclusion and power relations was carried out, as well as the trade-offs through all the cascade-model steps. The results demonstrated that ES access is mediated by different webs of mechanisms. Some mechanisms are more relevant than others, depending on the ES demanded. The results also showed that these mechanisms are structured by power relations composed of scalar relations. Finally, the results revealed the winners and losers associated with the cruise ship sector.

A core issue of this study was the holistic framework used to analyse ES. The framework was able to address social and ecological integration, ES flows, coproduction, power relations, temporal and spatial scales, value pluralism and uncertainty. In order to understand the complex and non-linear interactions and feedback processes of coastal ES production, supply, demand and use, the framework articulated the relationship between coproduction and access and power relations; that is, the study of coproduction and power served to sort out the socio-ecological relations and feedback loops enabling ES processes.

This framework was used to study the cruise ship sector in Barcelona. This study was performed by identifying the ES demanded by the cruise ships and their passengers, and analysing the coproduction processes, access and power relations. As a result, this study contributes to an empirical understanding of the scalar interrelations of ES flows and coproduction processes. Moreover, the empirical results also allow an understanding of the coevolutionary loops involved in ES coproduction. In this way, is was possible to gain an understanding of the human contribution to ES, and thus to truly understand the socio-ecological interrelations and feedback processes pertaining to ES analysis. Furthermore, this study also contributes to an understanding of the scalar interrelations of ES flows. Scalar interrelations are fundamental aspects, such as scalar complexities revealing telecoupled phenomena and their derived impacts. In this way, research and management can further the region of interest, and integrate the impacts and benefits beyond a narrow region of attention. Furthermore, the comprehension of trade-offs and benefits in and beyond the region of interest enables the integration of social conflicts and environmental justice issues.

The analysis of access shows the complexity of the relationship between ES and human wellbeing, and how different webs of mechanisms mediate the access to ES at different cascade-model steps (Berbés-Blázquez et al. 2017). The assessment of access carried out here revealed that access mechanisms are mediated by power relations that are structured by scalar interrelations. Adding to that, access analysis also shows who has access to ES and how, and who are excluded from ES, and how, at each cascade step, as well as who receives the associated trade-offs at each cascade step, and how. This holistic analysis led to the disclosure of access, exclusion and trade-offs at each ES cascade step. Thus, it enabled the assertion of ES distribution conflicts; that is to say, social and environmental-justice conflicts.

The framework used approached ES from a socio-ecological complexity perspective, and consequently it intended to identify and understand the multi-causality of the socio-ecological relations and feedback loops. The framework does not focus on specific causal relations, but rather in providing a holistic comprehension of the multi-causality. Consequently, the causal relations between the two specific socio-ecological processes were not studied in detail. The aim was a holistic overview from studying the human and non-human relations, which is, in fact, the major potential of geography. Geography is mainly a non-reductionist and holistic scientific discipline (Pitman 2005). In the last two centuries, most scientific disciplines have tended towards reductionism, but since the second half of the 20th century, some disciplines, such as environmental science, have advocated for system analysis (Pitman 2005). As a holistic discipline, geography can majorly contribute to socio-ecological complexity.

No framework can be indefinitely expanded to integrate each aspect of complex reality, but an abstraction of reality is possible. ES framework expansion is limited, as not all aspects of the human-nature relation can be integrated. Moreover, James (2015) pointed out that the expansion of an ES framework can only take place within the limits of the service-provision metaphor. Adding to that, the ES framework was based on the stock-flow conceptualisation of nature-human relations. This conceptualisation excludes other perspectives that are not conceptualised as stock-flow. Moreover, the stock-flow conceptualisation departs from nature – an entity separated from humans. In this regard, Loreau (2010, p.29) considered that 'the separation between humankind and nature is one of the most powerful founding myths of modern Western civilisation'. Authors such as Loreau (2014) and Morton (2016) have argued that it is necessary to acknowledge humans as being part of nature, and that both share fundamental needs and values. In this regard, but still within a system approach, Díaz et al. (2018) suggested a new concept as part of the IPBES conceptual framework –Nature's Contributions to People (NCP). This concept acknowledges the fundamental role of culture in determining the relations between people and nature (Díaz et al. 2018). The notion of NCP is to escape from ES, as it has failed to engage social scientists, and has even aroused active rejection due to the hazards of nature commodification and the associated social environmental inequality and injustice (Lele et al. 2013, Pascual et al. 2014, Díaz et al. 2018).

Last, but not least, no conceptual framework is politically neutral. Thus, the conceptualisation of ES is not neutral, but is rather political, as it reflects specific ideas, values and power structures (Kull et al. 2015). These will lead to specific debates and environmental interventions. That is why academic researchers need to reflect under what terms and reasons should the contribution of social science and humanities take place, and especially what are the constrains of their involvement. That is why the framework proposed in this study goes beyond the analysis and proposes a normative tool – a critical view of ES that can

shape future coastal management debates towards the integration of deliberations concerning environmental and social justice, access, power relations and trade-offs. The framework is a starting point from which to more deeply understand some of these aspects. It is a useful tool for raising awareness about the aspects of ES and coastal management that have so far been overlooked.

Chapter VII.
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7. References

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Chapter VIII.
Appendices

8. Appendices

8.3. Appendix A. Supplementary information for Chapter II

Table 9. Complete summary of the results of the literature review. The majority of the reviewed manuscripts contain significant gaps regarding socio-ecological components. They fail to integrate some of the cascade components, especially flow. The papers do not completely embrace coproduction and power relations, and neither do they assess uncertainty, value pluralism and spatial and temporal scales interactions. † T= Technical; M=Methodological; E=Epistemological; O=Ontological ‡ MT= Medium-term; ST= Short-term; MS=Multi-scale; CS=Cross-scale § L=Local; R=Regional; LT= Long-term. |Mon.= Monetary; Env.= Environmental; SC.= Sociocultural.

CES	CES catego	Socio-ecological integration	Coproduction	Power relations	Institutions and govern	Uncertainty	Temporal	Spatial scale §	Value Plurali
Provisioning	Food provision	Focus on benefit and capacity of fisheries and increasingly also aquaculture. Some papers also study flow through fishing catches and landings	Emphasis on: link between ecological conditions and productivity of fisheries; anthropogenic drivers and impacts on fisheries. Few papers describe institutions and regulations	Not common. Some papers identify trade-offs (provisioning vs. regulating) and conflicts (traditional fishing vs. aquaculture). Very few study link between power relations and control of ES.	Not common. Few papers identify actors and conflicts. Some papers describe policy and policy bodies. Policy recommendations.	T. Few M and E	MT	L, R. Few MS, No CS	Mon. and Env. Very few SC
	Water storage provision	Focus on capacity and benefit of coastal and marine water for consumption and irrigation	Not considered	Not considered	Not considered	T	MT	L, R. No MS, No CS	Mon. and Env.
	Biotic materials and biofuels	Focus on benefits of mangroves for wood production	Emphasis on link between land use change and capacity (mangroves)	Not common. Few papers identify conflicts (aquaculture vs. traditional uses mangroves) and trade-offs (biotic materials vs. coastal protection).	Not considered.	T	MT	L,R. very few N and SR. No MS, No CS	Mon. and Env. Very few SC

(continuation Table 9)

Regulation and maintenance	Air quality regulation	Focus on capacity and benefit of sea water and coastal vegetation (mangroves) for air regulation	Emphasis on link between land use change and capacity (mangroves)	Not considered	Not considered	T and M		L and R, Very few SR. No MS, No CS	Mon. and Env.
	Water purification	Focus on capacity of concentration of nutrients or pollutants in wetlands, salt marshes, benthic invertebrate species and mangroves. Some papers study flow through retention of excessive nutrients and pollutants. Few papers assess benefits of water purification (e.g., treatment costs)	Emphasis on: link between ecological conditions (eutrophication) and capacity. Link between land use change (agriculture and urban) and capacity (wetlands and salt marshes)	Not common. Few papers identify trade-offs (water purification vs. Food provision and vs. coastal recreation).	Not common. Few papers identify actors and conflicts. Some papers describe policy and policy bodies. Policy recommendations.	T	MT. Few LT, ST and MS	L and R. Few N and SR. No MS, No CS	Mon. and Env.
	Microclimate	Focus on capacity of coastal vegetation for local weather regulation	Not considered	Not considered	Not considered	No data	No data	L. No MS, No CS	No data
	Ocean nourish	Focus on capacity of nutrient cycle (soil formation and nutrients)	Not considered	Not considered	Not considered	T, M and E	No data	L and R. No MS, No CS	Env.
	Coastal protection	Focus on benefit and capacity of biotic structures such as mangroves, wetlands, coral reefs. Few papers also asses flow through coastal exposure (e.g., wave attenuation)	Emphasis on: link between ecological conditions of biotic structures (wetlands, mangroves, coral reef) and capacity; link land use change (agriculture and urban) and capacity (mangroves)	Not common. Few papers identify trade-offs (coastal protection vs. food provision, vs. biotic materials and vs. recreation)	Not common. Few papers identify actors and conflicts.	T and M	MT	L and R. Very few MS, No CS	Mon. and Env. Very few SC.

(continuation Table 9)

	Climate regulation	Focus on capacity and benefit of mangroves for CO_2 sequestration and concentration. No other climate active gases are assessed.	Emphasis on link between land use change and capacity (mangroves)	Not common. Few identify conflicts and power relations in PES markets	Few papers identify institutional arrangements, policies, actor and conflicts Policy recommendations.	T, E	MT. Few LT and MS	L and R. Very few, N and G. Very few MS, No CS	Env. and Mon.
	Lifecycle maintenance	Focus on capacity and benefit of nursery habitat on mangroves, seagrass and Few papers assess flow through fish production and biodiversity in nursery habitat	Emphasis on link between ecological conditions of habitats and capacity. Few papers describe institutions and regulations	Not common. Few identify trade-offs/conflicts (lifecycle maintenance vs. aquaculture, vs. fisheries and vs. tourism)	Not common.	T, E	MT. Few ST	L and R. Very few, N and G. No MS, No CS	Env. and Mon.
	Biological regulation	Focus on flow of invasive species and pathogens	Not considered	Not considered	Not considered	T	No data	L and R. very few G. No MS, No CS	Env.
Cultural	Symbolic and aesthetic values	Focus on benefit of aesthetic values such as sea views, coastal landscape and heritage	Emphasis on link between human pressures and impacts on aesthetic values (degradation of landscape wildness)	Not considered	Not considered	M, E and O	MT	L and R. very few SR, N and G. No MS, No CS	Mon. and SC

(continuation Table 9)

	Recreation and tourism	Focus on benefits of tourism and tourist value preferences. Some papers assess flow of natural resources (mangroves, biodiversity) for tourism and recreational activities. Few papers assess capacity of ecosystem for bathing, biodiversity and naturalness	Emphasis on: socio-economic context; link between human pressures and impacts on ecological conditions or wildness	Not common. Few papers study value diversity conflicts among actors (e.g., tourist vs. residents)	Not common. Few papers identify actors and conflicts.	T and M	MT	L and R. No MS, No CS	Mon. and SC
	Cognitive effects	Focus on benefit of research and education (institutions and public policy)	Not considered	Not considered	Not considered	M and E	MT	L and R. No MS, No CS	Mon. and SC

8.4. Appendix B. Supplementary information for Chapter II

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8.5. Appendix C. Survey questioner

SGR INTERFASE UAB

PASSANGER SURVEY OF CRUISE SHIP IN BARCELONA

We thank you in advance for your participation. We are requesting some of your time to answer this survey, which is part of a PhD research project focused on the analysis cruise ship tourism in Barcelona. The goal is to know the social, economic and environmental impacts (positive and/or negative) of cruise ship tourism in Barcelona. It can be completed in less than 10 minutes, approximately.

Survey results will be used only for scientific purposes and they will be completely anonymous and confidential. However, if you wish to receive more information (or the survey results), please, enter your e-mail here:

……

1. In which cruise ship are you traveling (name of the cruise ship)?

   ……..

2. Are you in Barcelona for….?

   ☐ Embarking
   ☐ Landing
   ☐ Visiting

3. How many hours are you staying in Barcelona?

   ……..hour/s

In case you've visited the city answer questions from 4 to 15

4. How did you visit the city? Tick the ones that apply

   ☐ Organized tour bought on the cruise
   ☐ Organized tour bought by yourself
   ☐ Freely without any pre-arranged tour
   ☐ Others: ……..

5. How did you move around the city? Tick the ones that apply

   ☐ By taxi
   ☐ Public transport (metro and bus)
   ☐ By touristic bus
   ☐ By private bus
   ☐ By bike
   ☐ Others: ……

6. Did you visit Sagrada Familia?

   Yes No I don't know

   If yes, what were the reasons? Tick the ones that apply

Enjoying the beauty of the building	
Learning about Gaudi's architecture	
Taking photos	
For religious or symbolic reasons	
Others: ……	

7. Did you visit Las Ramblas?

   Yes No I don't know

   If yes, what were the reasons? Tick the ones that apply

Walking/cycling around the area	
Visiting Boqueria Market	
Food (sea food, paella, fish, tapas or others)	
Taking photos	
Enjoying the cultural heritage of the area	
Visiting monuments in the area (Opera, buildings or others)	
Others: ……	

8. Did you visit Camp Nou?

   Yes No I don't know

   If yes, what were the reasons? Tick the ones that apply

Seeing the stadium	
Watching a football match	
Learning about Barcelona's history	
Taking photos	
Others: ……	

9. Did you visit Park Güell? Tick the ones that apply

   Yes No I don't know

   If yes, what were the reasons? Tick the ones that apply

Need of clean air (non-polluted)	
Need of fresh weather	
Observing animals and plants	
Walking/cycling or other outdoor sports	
Visiting the Gaudi's architecture	
Learning about art and architecture	
Taking photos	

Enjoying the landscape views of the city ☐
Others: …… ☐

10. Did you visit Barceloneta neighbourhood?

Yes No I don't know

If yes, what were the reasons? Tick the ones that apply

Walking/cycling around the area ☐
Food (sea food, paella, fish, tapas or others) ☐
Taking photos ☐
Enjoying the cultural heritage of the area ☐
Others: …… ☐

11. Did you visit Barcelona's waterfront?

Yes No I don't know

If yes, what were the reasons? Tick the ones that apply

Need of clean air (non-polluted) ☐
Need of fresh weather ☐
Learning about nature ☐
Observing animals and plants ☐
Walking/cycling or other outdoor sports ☐
Food (sea food, paella, fish, tapas or others) ☐
Partying ☐
Enjoying the seaside views ☐
Taking photos ☐
Others: …… ☐

12. Did you visit the beach?

Yes No I don't know

If yes, what were the reasons? Tick the ones that apply

Need of refreshing ☐
Swimming ☐
Snorkelling ☐
Sunbathe ☐
Relaxing ☐
Practicing beach sports (surf, windsurf or others) ☐
Enjoying the seaside views ☐
Taking photos ☐
Food (sea food, paella, fish, tapas or others) ☐
Others: …… ☐

13. Did you visit Tibidabo Mountain?

Yes No I don't know

If yes, what were the reasons? Tick the ones that apply

Need of clean air (non-polluted)	
Need of fresh weather	
Learning about nature	
Observing animals and plants	
Walking/trekking/ cycling or other outdoor sports	
Visiting the theme park	
Enjoying the landscape views of the city	
Visiting Tibidabos's church	
Taking photos	
Others: ……	

14. Did you visit Montjuïc?

Yes No I don't know

If yes, what were the reasons? Tick the ones that apply

Need of clean air (non-polluted)	
Need of fresh weather	
Observing animals and plants	
Walking/cycling or other outdoor sports	
Enjoying the landscape views of the city	
Taking photos	
Visiting museums (National Catalan Museum, Pueblo Español, others)	
Visiting Montjuïc Castel	
Visiting Olympic area	
Others: ……	

15. Did you visit any other place in Barcelona or Catalunya?

Yes No I don't know

If yes, which one/s (say maximum 4 places)?

Place 1: ……

Place 2 ……

Place 3: ……

Place 4: ……

If yes, what were the reasons? Tick the ones that apply

	Place 1	Place 2	Place 3	Place 4
Need of fresh weather				
Need of clean air (non-polluted)				
Learning about nature				
Observing animals and plants				
Walking/cycling or other outdoor sports				
Learning about architecture, arts or other cultural heritage				
Partying				
Taking photos				
Food and drink				
Enjoying the landscape views				
Others: ……				

16. If you were to send a postcard from Barcelona, which one would you send? Tick the ones that apply

☐ 

☐ 

☐ 

☐ 

☐ 

☐ 

☐ 

☐ Another one (please, explained or draw it)

17. Regarding the previous question, why did you choose this/these image/s?

……

……

……

18. How do you value the following issues in the city? Rate out of 5 (1=Very poor, 2= Poor, 3= Fair, 4= Good, 5=Very good)

	1	2	3	4	5
Clean air (non-polluted)	○	○	○	○	○
Sea water quality (non-polluted)	○	○	○	○	○
Too warm weather	○	○	○	○	○
Quality of the food	○	○	○	○	○
Feeling safe against natural disas (flooding, tsunami, strong waves, sea storm, others)	○	○	○	○	○

19. How did you arrive in Barcelona? Tick the ones that apply

☐ 

☐ 

☐ 

☐ 

☐ 

☐

Others: ……

20. Where did you travel from?

Country ☐

21. Where do you live?

Country ☐

22. How old are you?

☐ 16-25
☐ 26-35
☐ 36-45
☐ 46-55
☐ 56-65
☐ 66-75
☐ 76-80
☐ More than 80

23. Gender

☐ Male ☐ Female ☐ Other ☐ Prefer not to say

24. How many people are you travelling with?

……

25. What relationship do you have with the people you are travelling with?

☐ Family
☐ Friendship
☐ Co-workers
☐ Other:……

Finally, if you wish, add any other relevant comment

……
……
……

THANK YOU SO MUCH FOR YOUR COOPERATION! 

8.6. Appendix D. Interview protocol

Objectives of the interviews

- Identify ES demanded by cruise ships and passengers
- Understand flows and coproduction process of these ES
- Identify actors and power relations involved ES
- Identify and assess access mechanisms to ES and
- Identify and assess exclusion to ES and trade-offs

Interview guides

- The researcher will the interviewees to set a place, time and date of the interviews.
- The researcher will start with a brief introduction to explain the participants the objectives of the research and specify that the data are being gathered only for scientific purposes.
- The researcher will ask the permission of the informants to record the interviews and take notes. If yes, the researcher will use an audio-recorder and take written notes during the interview.
- At the end of every interview, the researcher will recapitulate the topics conversed and enquire the interviewees to comment on what they have explain, if that is possible.
- After each interview, but the same day of the interview, the researcher will summarise and write impressions on the topics discussed and the behaviour of the interviewees.

Questions

- The researcher will adjust the questions to each participant, always considering the objectives of the research. Questions will be structured in five main blocs;
    - ES identification
        - When ships are at the harbour what supplies they need?
        - How are these supplies obtained?
        - When passengers visit the city, what do they visit? For what reasons?
    - ES flows and coproduction
        - From where are these supplies coming?
        - By which processes serves the supplies to cruise ships?
        - By which processes produce the ES to serve cruise ships?
        - From where are ES demanded by passengers come from?
        - By which processes facilitate ES demanded by passengers?
        - By which processes produce ES demanded by passengers?
    - Stakeholders and relations

        - Who serves the supplies to cruise ships?
        - Who regulates the mechanisms to supply to cruise ships?
        - Who is involve in the production of ES for cruise ships?
        - Who facilitate ES demanded by passengers?
        - Who regulates the mechanisms to supply ES to passengers?
    - Access
        - Who has access to ES production?
        - By which mechanisms have access to ES production?
        - What power relations are behind these mechanisms?
        - Who has access to ES from production to consumption?
        - By which mechanisms have access to from production to consumption?
        - What power relations are behind these mechanisms?
        - Who has access to ES use?
        - By which mechanisms have access to ES use?
        - What power relations are behind these mechanisms?
        - Who decides ES values?
        - By which mechanisms have access value?
        - What power relations are behind these mechanisms?
    - Exclusion and trade-offs
        - Who is excluded to ES access at different steps, coproduction, flow, use, and value?
        - What are the externalities/trade-offs at different steps: coproduction, flow, use, and value?

8.7. Appendix E. Emission data Barcelona's harbour[33]

Table 10. Summary of cruise ship emissions 2017 in Barcelona's harbour. Data provided by Barcelona's Harbour Authority.

Nº of stops	*Average length of stay (h)*	*Total Hours of stay*	*Total scale energy (kWh)*	*Auxiliary Energy Stay (kWh)*	*Total fuel per stay (tons)*	*Emissions CO_2 per stay (tons)*	*Total sum of emissions NO_X (tons)*	*Emissions NO_X of auxiliary per stay (tons)*
775	15,8	10310,47	43690143	30094810	8738,029	24990,76	524,2095	360,2031

Table 11. Detailed data of cruise ship emissions 2017 in Barcelona's harbour. Data provided by Barcelona's Harbour Authority.

Nº of stops	Average length of stay (h)	Hours of stay	Emission factor	Total scale energy (kWh)	Auxiliary Energy Stay (kWh)	Total fuel per stay (tons)	Emissions CO_2 per stay (tons)	Total sum of emissions NOx (tons)	Emissions NOx of auxiliary per stay (tons)
30	10,4	310,6	10	1.717.518,89	1.121.821,97	343,5	982,4	17,2	11,2
30	12,8	383,8	12	2.748.110,83	1.895.340,86	549,6	1571,9	33,0	22,7
26	11,9	309,4	12	2.120.980,58	1.437.226,18	424,2	1213,2	25,5	17,2
3	10,2	30,7	12	218.873,50	142.452,93	43,8	125,2	2,6	1,7
1	10,2	10,2	2	76.877,67	49.959,00	15,4	44,0	0,2	0,1
2	13,1	26,2	12	123.015,83	85.304,83	24,6	70,4	1,5	1,0
5	9,7	48,3	12	289.014,67	185.066,15	57,8	165,3	3,5	2,2
8	16,2	129,8	10	685.072,93	497.449,13	137,0	391,9	6,9	5,0
2	23,7	47,4	12	280.234,22	216.961,90	56,0	160,3	3,4	2,6
5	8,7	43,4	12	307.016,07	190.341,33	61,4	175,6	3,7	2,3
17	9,3	157,4	12	927.634,44	586.582,43	185,5	530,6	11,1	7,0
9	9,5	85,3	12	499.264,49	317.926,31	99,9	285,6	6,0	3,8
52	10,8	562,4	10	3.895.575,92	2.575.022,82	779,1	2228,3	39,0	25,8
31	14,6	452,2	10	1.688.988,37	1.199.895,61	337,8	966,1	16,9	12,0
10	29,1	291,5	10	1.193.559,41	949.647,45	238,7	682,7	11,9	9,5
3	11,3	34,0	12	178.380,86	119.409,22	35,7	102,0	2,1	1,4
4	9,2	36,7	12	204.294,62	128.877,91	40,9	116,9	2,5	1,5
3	7,4	22,3	12	156.530,56	92.255,44	31,3	89,5	1,9	1,1
22	10,0	220,4	12	1.581.255,18	1.023.245,91	316,3	904,5	19,0	12,3
3	10,5	31,5	12	198.127,00	129.856,69	39,6	113,3	2,4	1,6
34	7,1	241,4	12	1.934.674,16	1.121.062,23	386,9	1106,6	23,2	13,5
20	7,8	155,3	12	1.205.978,01	720.881,87	241,2	689,8	14,5	8,7
2	8,2	16,4	12	104.774,50	63.762,10	21,0	59,9	1,3	0,8
2	18,7	37,3	10	155.064,00	115.577,28	31,0	88,7	1,6	1,2
6	12,8	77,1	10	286.650,25	197.878,21	57,3	164,0	2,9	2,0
3	11,9	35,7	10	124.418,82	84.328,83	24,9	71,2	1,2	0,8
13	23,5	306,0	10	933.572,11	722.104,91	186,7	534,0	9,3	7,2
14	7,1	99,0	12	518.095,82	299.746,53	103,6	296,4	6,2	3,6

[33] Data provided by Barcelona's Harbour Authority.

(continuation Table 11)

1	9,3	9,3	12	49.197,55	31.187,52	9,8	28,1	0,6	0,4
1	6,7	6,7	12	35.599,59	20.137,88	7,1	20,4	0,4	0,2
32	9,3	296,5	12	1.419.529,14	897.927,34	283,9	812,0	17,0	10,8
1	12,3	12,3	12	65.092,16	44.485,21	13,0	37,2	0,8	0,5
6	13,7	82,1	12	680.706,62	552.390,88	136,1	389,4	8,2	6,6
2	9,7	19,3	12	100.858,51	64.602,72	20,2	57,7	1,2	0,8
4	21,1	84,5	12	432.338,65	328.994,27	86,5	247,3	5,2	3,9
18	11,5	206,8	12	1.428.922,92	1.123.880,62	285,8	817,3	17,1	13,5
7	13,9	97,6	12	651.707,87	530.605,69	130,3	372,8	7,8	6,4
24	6,9	165,2	12	1.104.835,04	633.085,52	221,0	632,0	13,3	7,6
1	31,9	31,9	12	154.206,28	123.956,63	30,8	88,2	1,9	1,5
8	12,9	103,0	16	533.605,36	368.594,28	106,7	305,2	8,5	5,9
3	33,2	99,7	9	876.501,21	707.824,44	175,3	501,4	7,9	6,4
2	11,5	23,0	16	106.052,04	71.255,46	21,2	60,7	1,7	1,1
1	10,5	10,5	16	49.402,90	32.351,32	9,9	28,3	0,8	0,5
2	12,0	23,9	16	99.726,68	67.648,09	19,9	57,0	1,6	1,1
1	10,9	10,9	16	47.260,73	31.343,33	9,5	27,0	0,8	0,5
9	15,7	141,5	16	583.773,49	421.259,74	116,8	333,9	9,3	6,7
1	21,9	21,9	16	85.138,46	65.141,21	17,0	48,7	1,4	1,0
19	14,1	267,7	16	1.371.282,00	966.876,18	274,3	784,4	21,9	15,5
34	9,1	309,2	16	951.185,11	598.264,18	190,2	544,1	15,2	9,6
12	16,0	191,5	10	497.324,59	359.944,36	99,5	284,5	5,0	3,6
1	10,8	10,8	12	36.102,89	23.845,19	7,2	20,7	0,4	0,3
3	10,7	32,0	16	182.532,00	120.204,00	36,5	104,4	2,9	1,9
10	10,3	103,0	16	557.830,91	363.848,43	111,6	319,1	8,9	5,8
10	10,0	100,0	16	546.244,03	353.370,35	109,2	312,5	8,7	5,7
1	18,7	18,7	16	88.584,36	66.047,23	17,7	50,7	1,4	1,1
3	14,4	43,3	12	137.871,62	97.700,27	27,6	78,9	1,7	1,2
11	15,2	167,3	10	602.206,61	431.608,91	120,4	344,5	6,0	4,3
5	11,8	59,1	12	225.339,89	152.426,14	45,1	128,9	2,7	1,8
2	6,7	13,4	12	45.967,52	26.075,65	9,2	26,3	0,6	0,3
1	34,5	34,5	16	144.136,74	116.842,09	28,8	82,4	2,3	1,9
1	9,5	9,5	16	52.900,49	33.729,18	10,6	30,3	0,8	0,5
1	32,4	32,4	16	83.870,38	67.549,26	16,8	48,0	1,3	1,1
8	11,8	94,3	10	209.674,41	141.722,22	41,9	119,9	2,1	1,4
1	10,1	10,1	16	35.951,89	22.749,57	7,2	20,6	0,6	0,4
1	33,8	33,8	10	147.882,07	119.646,07	29,6	84,6	1,5	1,2
1	11,2	11,2	16	37.462,04	24.993,59	7,5	21,4	0,6	0,4
5	35,6	178,2	10	268.994,42	218.810,67	53,8	153,9	2,7	2,2
5	30,2	151,1	10	232.261,69	185.593,03	46,5	132,9	2,3	1,9
2	28,0	55,9	10	86.744,08	68.666,15	17,3	49,6	0,9	0,7
1	46,9	46,9	3	69.026,10	57.532,20	13,8	39,5	0,2	0,2
1	9,5	9,5	16	41.079,15	26.178,39	8,2	23,5	0,7	0,4
1	24,2	24,2	10	41.910,66	32.555,74	8,4	24,0	0,4	0,3
7	13,4	93,7	12	196.222,07	136.775,54	39,2	112,2	2,4	1,6
14	28,1	393,2	12	840.039,33	665.339,73	168,0	480,5	10,1	8,0
7	11,1	77,8	10	146.372,06	97.447,08	29,3	83,7	1,5	1,0
10	10,6	105,7	16	321.034,39	210.906,91	64,2	183,6	5,1	3,4
5	21,1	105,4	10	188.889,91	143.691,67	37,8	108,0	1,9	1,4
2	19,4	38,8	16	103.094,64	77.338,80	20,6	59,0	1,6	1,2
1	10,3	10,3	16	32.510,40	20.669,65	6,5	18,6	0,5	0,3

(continuation Table 11)

6	31,9	191,3	12	381.578,05	306.770,88	76,3	218,3	4,6	3,7
1	13,1	13,1	16	35.733,87	24.221,73	7,1	20,4	0,6	0,4
4	9,5	38,1	16	125.092,35	77.735,70	25,0	71,6	2,0	1,2
5	11,2	55,9	12	105.039,75	70.046,61	21,0	60,1	1,3	0,8
1	10,4	10,4	10	9.986,66	6.536,85	2,0	5,7	0,1	0,1
6	25,1	150,9	16	220.761,28	172.346,88	44,2	126,3	3,5	2,8
4	10,7	42,6	16	105.132,47	69.218,87	21,0	60,1	1,7	1,1
4	12,2	48,6	14	81.522,76	55.532,84	16,3	46,6	1,1	0,8
2	12,6	25,3	16	59.658,04	41.022,60	11,9	34,1	1,0	0,7
1	34,7	34,7	12	48.901,19	39.674,47	9,8	28,0	0,6	0,5
2	12,3	24,6	14	41.171,90	28.137,65	8,2	23,6	0,6	0,4
1	10,3	10,3	14	18.084,62	11.805,88	3,6	10,3	0,3	0,2
3	12,6	37,8	16	80.828,24	55.532,86	16,2	46,2	1,3	0,9
1	11,3	11,3	16	24.862,78	16.639,06	5,0	14,2	0,4	0,3
1	9,1	9,1	16	15.616,04	9.824,07	3,1	8,9	0,2	0,2
1	9,4	9,4	16	19.503,05	12.370,05	3,9	11,2	0,3	0,2
2	18,7	37,4	16	82.420,61	61.442,01	16,5	47,1	1,3	1,0
1	10,4	10,4	16	21.050,41	13.754,29	4,2	12,0	0,3	0,2
1	9,9	9,9	16	16.643,61	10.734,50	3,3	9,5	0,3	0,2
1	29,3	29,3	16	42.782,74	34.054,02	8,6	24,5	0,7	0,5
2	12,2	24,4	16	32.779,79	22.338,84	6,6	18,8	0,5	0,4
3	28,4	85,3	16	118.852,89	94.275,09	23,8	68,0	1,9	1,5
1	10,5	10,5	16	17.664,27	11.572,47	3,5	10,1	0,3	0,2
1	9,6	9,6	16	28.206,12	18.048,60	5,6	16,1	0,5	0,3
1	16,4	16,4	16	13.423,06	9.761,78	2,7	7,7	0,2	0,2
4	10,8	43,2	16	39.013,12	25.772,70	7,8	22,3	0,6	0,4
2	11,4	22,7	16	33.014,27	22.106,97	6,6	18,9	0,5	0,4
1	11,9	11,9	7,7	6.889,24	4.665,02	1,4	3,9	0,1	0,0
2	11,2	22,4	14	38.115,40	25.439,40	7,6	21,8	0,5	0,4
6	10,7	64,5	14	67.201,86	44.339,02	13,4	38,4	0,9	0,6
4	11,3	45,0	14	46.348,12	30.958,20	9,3	26,5	0,6	0,4
3	10,0	30,0	14	31.908,24	20.638,80	6,4	18,3	0,4	0,3
5	17,0	84,8	16	77.272,29	56.598,25	15,5	44,2	1,2	0,9
2	10,7	21,5	14	6.293,04	4.150,33	1,3	3,6	0,1	0,1
1	10,8	10,8	14	5.780,85	3.824,46	1,2	3,3	0,1	0,1
3	10,2	30,5	14	15.700,79	10.203,17	3,1	9,0	0,2	0,1
2	11,9	23,8	14	11.749,61	7.961,81	2,3	6,7	0,2	0,1
2	13,3	26,6	16	12.863,85	8.954,38	2,6	7,4	0,2	0,1
1	11,2	11,2	16	5.565,74	3.708,94	1,1	3,2	0,1	0,1
2	59,0	118,0	14	66.323,97	56.186,67	13,3	37,9	0,9	0,8
2	36,7	73,3	14	21.233,98	17.321,06	4,2	12,1	0,3	0,2
3	56,2	168,6	14	56.039,27	47.324,80	11,2	32,1	0,8	0,7
1	34,9	34,9	16	10.477,59	8.363,16	2,1	6,0	0,2	0,1
1	12,6	12,6	14	2.547,07	1.750,33	0,5	1,5	0,0	0,0
1	12,0	12,0	12	4.609,20	3.129,84	0,9	2,6	0,1	0,0
1	15,2	15,2	14	3.361,54	2.407,86	0,7	1,9	0,0	0,0
775	15,8	10310	1649,7	43690142,9	30094810,3	8738	24990,8	524,2	360,2

8.8. Appendix F. Acceptance of co-author

I, Eduard Ariza Solé

I STATE THAT

As a **DOCTOR COAUTHOR**, I am informed that Mr/Mrs Liliana Solé Figueras uses as part of her doctoral thesis co-published works.

And, for this reason

I STATE

That accept the use of the following work:

- Solé, L., & Ariza, E. (2019). A wider view of assessments of ecosystem services in coastal areas: the perspective of social-ecological complexity. *Ecology and Society*, *24*(2), art24. https://doi.org/10.5751/ES-10883-240224

Signed

Eduard Ariza i Solé

Bellaterra (Cerdanyola del Vallès), 16 of September of 2019