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Mainstreaming the ecosystem services approach in strategic environmental assessment of spatial planning in Chile

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ABSTRACT

Spatial planning plays a key role in policy decision-making given its influence on the future changes over the land systems and subsequently on the quality, quantity and spatial distribution of the ecosystem services (ES) that they provide. A variety of strategies and instruments has been applied for integrating environmental objectives as well as concerns regarding the impacts generated by development planning policies. Thus, strategic environmental assessment (SEA) is considered today as a key instrument that helps to integrate environmental and sustainability issues in decision-making creating conditions for sustainable development along with a transparent and participatory process. Here, the ES approach gains relevance by offering a more holistic integration of the socio-ecological system and facilitating the communication and understanding of diverse stakeholders and decision makers during the planning process. However, despite the advantages offered by the ES approach, there is still a low level of explicit integration in both the spatial planning regulations and practical applications.

This research addresses the issue of integrating the ES approach in SEA at different scales in order to identify the possibilities and challenges for implementing this integrated framework in real-world spatial planning. This study was carried out in Chile where three main methodological steps were followed: 1) identification of the multiple actors related to the spatial planning and environmental assessment process as well as the networks among them based on the ES and SEA understanding, 2) exploration whether this integration is currently present at some point in the planning system and how ES have been considered so far in the development of spatial plans at different scales, and 3) participatory identification and prioritization of ecosystem services for scenario development in regional planning.

The main findings suggest that: 1) a common understanding related to SEA and especially to ES is still in an initial stage in Chile when the context of multiple actors is considered. Additionally, a lack of institutional guidelines and methodological support is considered the main challenge for integration, 2) ES were always present across each SEA stage and planning scale. Moreover, a relation is suggested between specific ES and the scope and focus of the different spatial planning instruments, and 3) the most important land-uses in terms of supplying a range of ES, benefits and beneficiaries were wetlands and native forest. In addition, provisioning ES was the most representative section after a prioritization process but closely followed by regulating ES.

It can be concluded that ES are clearly necessary for achieving a number of development objectives and dealing with a range of environmental problems. However, a critical aspect is the lack of an explicit consideration, which might decrease the potential advantages offered by the integrated framework ES-SEA. Furthermore, preconditions exist in Chile for integrating ES in SEA and the spatial planning practice, but they strongly depend on an appropriate governance scheme that encourages a close science-policy interaction as well as collaborative work and learning.

KURZFASSUNG

Die Raumplanung spielt eine wesentliche Rolle in politischen Entscheidungsprozessen, da sie einen Einfluss auf zukünftige Änderungen der Landsysteme hat und damit auch auf die Qualität, Quantität und räumliche Verteilung der Ökosystemleistungen (ES) beeinflusst, die von den Landsystemen bereitgestellt werden. Verschiedene Strategien und Instrumente wurden eingesetzt, um sowohl Umweltziele zu integrieren als auch Bedenken wegen der Auswirkungen durch die Raumplanungspolitik zu berücksichtigen. Daher wird die strategische Umweltverträglichkeitsprüfung (SEA) heutzutage als wichtiges Instrument gesehen, welches es ermöglicht, Umwelt- und Nachhaltigkeitsthemen in Entscheidungsprozesse einzubeziehen und somit die Voraussetzung für eine nachhaltige Entwicklung mit transparenten und partizipativen Prozessen schafft. In diesem Zusammenhang gewinnt der ES-Ansatz an Relevanz, da er stärker eine ganzheitliche Integration des sozio-ökologischen Systems ermöglicht und die Kommunikation und das Verständnis verschiedener Interessengruppen und Entscheidungsträger während des Planungsprozesses vereinfacht.

Diese Arbeit beschäftigt sich mit dem Thema der Integration des ES-Ansatzes in der SEA auf verschiedenen Ebenen, um Möglichkeiten und Herausforderung der Umsetzung dieses integrierten Rahmenwerks in der realen Raumplanung zu identifizieren. Diese Studie wurde in Chile mittels drei wesentlicher methodischer Schritte durchgeführt: 1) Identifizierung der verschiedenen Akteure, die an der Raumplanung und dem Umweltbewertungsprozess beteiligt sind sowie die Identifizierung der Netzwerke zwischen ihnen, welche auf dem Verständnis des ES-Ansatzes und der SEA beruhen, 2) Überprüfung, ob die Integration bereits teilweise im Planungssystem vorzufinden ist und wie die ES bisher in der Entwicklung von Raumplänen auf verschiedenen Ebenen berücksichtigt wurden, 3) partizipative Identifizierung und Priorisierung der ES für die Szenarienentwicklung in der Regionalplanung. Die Hauptergebnisse zeigen, 1) dass sich in Chile ein gemeinsames Verständnis der SEA und vor allem der ES noch in der Anfangsphase befindet, wenn man den Kontext verschiedener Akteure berücksichtigt. Außerdem kann ein Fehlen institutioneller Richtlinien und methodischer Unterstützung als wichtigste Herausforderung der Integration identifiziert werden, 2) dass die ES in den verschiedenen SEA-Phasen und Planungsebenen stets vorhanden waren. Außerdem kann ein Zusammenhang zwischen bestimmter ES und dem Umfang sowie der Ausrichtung verschiedener Raumplanungsinstrumente angenommen werden, und 3) dass die wichtigsten Landnutzungen, welche eine Reihe von ES zur Verfügung stellen, Feuchtgebiete und heimische Wälder sind. Zudem waren die bereitstellenden ES nach einem Priorisierungprozess am meisten vertreten, dicht gefolgt von den regulierenden ES.

Folglich ist die Integration des ES-Ansatzes eindeutig notwendig, um eine Anzahl von Entwicklungszielen zu erreichen und um eine Reihe von Umweltproblemen zu behandeln. Jedoch ist es als kritisch anzusehen, dass die ausdrückliche Berücksichtigung des ES-Ansatzes fehlt, sodass die möglichen Vorteile des integrierten Rahmenwerks ES-SEA verringert werden könnten. Zudem sind die Voraussetzungen für die Integration der ES in die SEA in der Raumplanungspraxis in Chile gegeben, jedoch sind sie stark von einem geeigneten Regelungssystem abhängig, welches eine enge Zusammenarbeit zwischen Wissenschaft und Politik sowie den Wissensaustausch fördert.

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LIST OF ACRONYMS AND ABBREVIATIONS

CICES	Common International Classification of Ecosystem Services
EIA	Environmental impact assessment
ES	Ecosystem services
ESP	Ecosystem Services Partnership
IMRP	Inter-Municipal and Metropolitan Regulating Plan
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
LWC	linear weighted combination
MA	Millennium Ecosystem Assessment
MRP	Municipal Regulating Plan
MSA	Maximum score approach
PPP	Policies, plans and programs
RLUP	Regional Land-Use Plan
RSD	Regional Strategy of Development
SEA	Strategic environmental assessment
SRA	Score range approach.
TEEB	The Economics of Ecosystems and Biodiversity

1 INTRODUCTION

1.1 Background and context

1.1.1 Spatial planning and sustainability

Including objectives and criteria for sustainability in the current formulation of policies, plans and programs (PPP) is recognized today as a central issue for achieving global development goals (UNDP 2010; UN 2014). From these goals, a considerable number is related to the land system, which is a fundamental but limited resource providing a range of goods and benefits for human well-being (Fürst et al. 2013b). Nevertheless, the high pressure and demand for natural resources such as cultivable lands, water and timber, along with accelerated changes in biogeophysical structures of the territory, are threating the future welfare and development of our societies (Mooney et al. 2009). In this context, land management and policy instruments for decision making play a key role in driving changes and impacts at multiple scales (Verburg et al. 2015).

A number of instruments exist which influence the land system (e.g. sectoral instruments such as forest regulations, water regulations, economic promotion, etc.), including stakeholders as well as land-use change processes. One of the most relevant instruments and nowadays legally based in most of the countries worldwide is spatial planning. The aim of this instrument is to provide the basis for a more equilibrated allocation of the different land uses present in a territory, thus pursuing long-term sustainability for economic and social development as well as for environmental issues (UN 2008; Fürst et al. 2013b). Spatial planning also plays a central role in coordinating different sectorial policies in a framework that considers three main elements: 1) a sectoral perspective that aims at a cross-sectoral and inter-agency collaboration including public, private and voluntary activities within the territory, 2) a territorial focus that facilitates both a vertical integration of different scales of planning and also a horizontal integration of multiple activities within a particular scale of planning, and 3) an organizational view that promotes cooperation and networks of actors aimed at integrating strategies, programs and plans taking into account relevant agencies

present in the territory along with a range of stakeholders (Kidd 2007; Scott et al. 2013).

An important aspect is that the spatial planning process is carried out under a wide set of values and rationalities, which are completely context dependent especially in terms of a particular type of society, a specific time window and under a specific set of rules and institutions (Daily et al. 2009; Goncalves and Ferreira 2015).

It is certainly possible to find some common entry points between different planning systems, however this work focuses on the particular case of Chile. The reasons for selecting this country are because it meets three fundamental criteria. First, the administrative system considers a tiered arrangement that includes national, regional, provincial and municipal levels (OECD 2013). Then, it allows exploring ES integration at multiple scales of planning. Second, environmental assessment is mandatory in Chile for all scales of spatial planning, and this must be carried out using a strategic environmental assessment (SEA). This is an official regulation and has been compulsory since 2010, hence, today there is an adequate number of SEA reports available for analysis. Third, the concept of ES has been gradually included in the political discussion and recently it was even considered in a national guideline for sustainable spatial planning (MMA 2015). Therefore, given the potential provided by the combination of these factors and the window of opportunity for policy development and implementation, we considered Chile as a suitable case study.

1.1.2 Environmental assessment in spatial planning

To date, a variety of approaches, strategies and instruments have been applied for integrating environmental objectives as well as concerns regarding the impacts generated by development planning policies (Runhaar 2016). Some examples are provided by Perminova et al. (2016) for assessing land-use impacts such as life cycle assessment, material flow analysis, ecological footprint, SEA, among others. In the particular case of spatial planning, there is no general agreement regarding any particular approach, although nowadays in most of the countries worldwide, the use of

environmental impact assessment (EIA) and SEA is strongly encouraged, even as a legal requirement (Loiseau et al. 2012; Kumar et al. 2013; Runhaar 2016).

EIA and SEA provide a number of common entry points, which can be easily coupled for enhancing the effectivity of the planning process by implementing the ES approach (Helming et al. 2013). However, there are essential differences between these two instruments in terms of focus and procedural thinking. EIA is mainly focused on impacts at project level, and it has been the most commonly used approach during the last decades. In contrast, SEA, initially considered closely related to EIA, is recognized today as a different instrument but fundamental for strategically addressing sustainable development at level of policies, plans and programs (PPP) (Honrado et al. 2013). SEA is defined as a strategic instrument which helps to integrate environment and sustainability issues in decision-making creating conditions for sustainable development along with a multi-stakeholder involvement in a transparent and participatory process (OECD 2006; Partidario 2012). Table 1.1 shows general aspects of the EIA and SEA process along with their principal differences.

Table 1.1 Principal differences between EIA and SEA

Aspect/Instrument	**EIA**	**SEA**
Process	Linear	Iterative
Screening	Projects requiring EA are often listed	Mostly decided case by case
Scoping	Combination of local issues and technical checklists	Combination of political agenda, stakeholder discussion and expert judgement
Public participation	Often include general public	Focus on representative bodies
Assessment	More quantitative	More qualitative (expert judgement)
Quality review	Focus on quality of information	Both quality of information and stakeholder process
Decision making	Comparison against norms and standards	Comparison of alternatives against policy objectives
Monitoring	Focus on measuring actual impacts	Focus on plan implementation

Source: NCEA 2016

Thus, SEA is seen as a more suitable instrument for integrating the ES approach into the decisional framework giving its strategic role in the development of PPP (Geneletti 2011; Partidario and Gomes 2013).

Among the advantages provided by SEA for enhancing the spatial planning process, the following fundamental principles can be identified: decision oriented, early intervention, integrated, strategic, proactive, focused, flexible, and participative. These principles must be integrated in the design of a spatial plan from the beginning in order to ensure an efficient and transparent process. In the Chilean context, these principles are proposed in national guidelines for implementing SEA in different spatial planning instruments (MMA 2012; Rozas-Vásquez et al. 2014), however, a practical implementation following all these principles is still being developed.

1.1.3 Ecosystem services and integrated spatial planning

The management of ecosystems and during the last decades of their services has been the subject of an extensive and dynamic multidisciplinary debate. Initially it mainly involved the interest of academia and research institutions, but today it is also of growing interest to practitioners and decision makers in a range of fields. Thus, a number of environmental policies, regulations, institutions and even specific programs oriented to ecosystem services are available today in many countries (Greiber and Schiele 2011).

In its broadest form, the concept of ES is defined as the benefits people obtain from ecosystems. This definition arose from one of the most relevant and key scientific initiatives worldwide, the Millennium Ecosystem Assessment (MA). This initiative included the collaboration of hundreds of experts from different fields to raise awareness about the global status of ecosystems, their services and the future consequences on human well-being (MA 2005). Certainly, such a definition has been reviewed and others have been proposed with slightly different philosophies, however, a fully accepted definition is still a pending task. The most commonly cited definitions in the literature along with a complete analysis of their implications can be reviewed in Nahlik et al. (2012).

A similar situation can be described in the case of the classification system, where several efforts have been made in order to capture in a more accurate way the essential aspects of the ES dynamics (Costanza et al. 1997; MA 2005; Wallace 2007). In all the cases, for framing any ES intervention in decision-making an adequate classification system is needed that allows assessing impacts and trade-offs, which are among others, decisive components for development and sustainability. Today, a consistent classification scheme is the Common International Classification of Ecosystem Services (CICES), which is compatible with the experimental ecosystem accounts proposed by UNEP and also offers the possibility for mapping (http://cices.eu/), particularly relevant for spatial planning. CICES classifies ES in three sections, mostly in concordance with the previously defined by MA in 2005: 1) provisioning, 2) regulation & maintenance, and 3) cultural (supporting ES were excluded in CICES). Additionally, each section presents hierarchical levels (division, group, class, class type) where is possible to increase the detail of the ES classification in relation to the different spatial and thematic scales under analysis (Haines-Young and Potschin 2013).

Some examples of the use of the ES concept in decision-making across the world are provided by Raymond et al. (2008), Goldstein et al. (2012), Balvanera et al. (2012) and Fürst, et al. (2013), where most of the applications are concentrated in spatial planning and environmental management. In this sense, spatial planning and its focus on territorial development is increasingly giving room to the use of ES in the decisional space. One important reason is that a number of development goals are related with fundamental issues such as food production, water provision, cultural aspects and health, which are strongly related to ES. In addition, spatial planning is a key policy instrument for decision-making, which drives future land-use changes for achieving these demands for development and, therefore, it might impact on the quality, quantity and spatial distribution of ES (Geneletti 2011; Mascarenhas et al. 2015; Rozas-Vásquez et al. 2017).

The integration of ES in spatial planning is considered as an appropriate approach for information and communication, as well as for facilitating consensus

building among different actors because it provides a basis for multi-sectoral and interdisciplinary collaboration (Albert et al. 2014; Galler et al. 2016). Thus, as pointed out by Geneletti (2011) and Mascarenhas et al. (2014), including ES in policy decision-making and particularly in spatial planning should take advantage of existing instruments such as SEA.

Opportunities for improving environmental assessment and supporting development objectives of spatial plans by considering the ES approach are present at many stages of SEA (Kumar et al. 2013). Additionally, SEA and ES have a number of common entry points which can be easily coupled for enhancing the effectivity of the spatial planning process (Geneletti 2011). Figure 1.1 shows a simplified scheme of this integrated framework, where the ES concept provides information to the spatial planning process, and at the same time facilitates communication with a range of actors who influence the decisions on the territorial system. Here, the role of SEA is offering a legal and institutional frame for a more participative, transparent and flexible process for promoting sustainability at different scales of spatial planning.

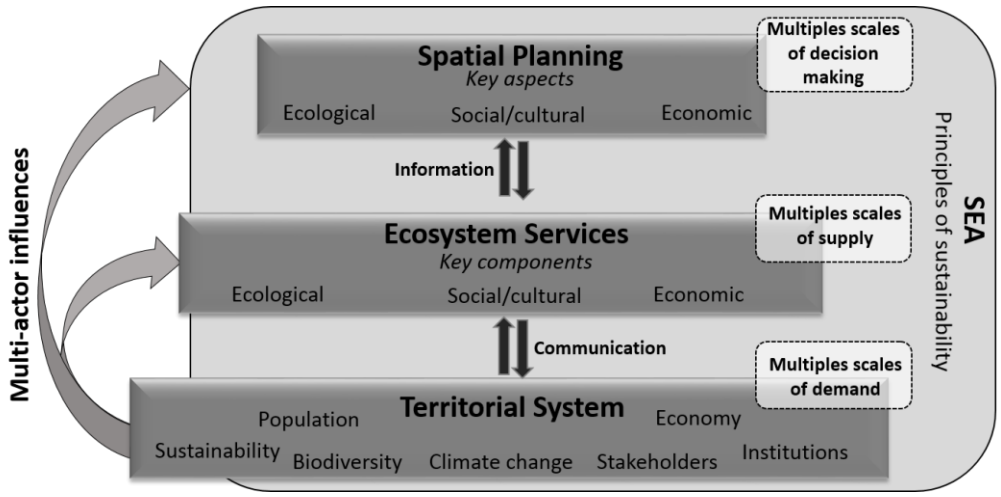

Figure 1.1 Simplified framework for integrating ES in spatial planning through SEA. Modified from Rozas-Vásquez et al. (2017)

The significant advantages of coupling ES in SEA have considerably increased the research on this field, including analysis of legislation and practices (Geneletti

2015), but also the development of guidelines elaborated by international organizations such as OECD (2010), UNEP (2014) and the World Resource Institute (Landsberg et al. 2011), among others.

A fundamental task now is to evaluate the applicability of this integrated framework in real-world planning processes and environmental policy decision-making (Ruckelshaus et al. 2015). Currently, significant international initiatives such as The Economics of Ecosystems and Biodiversity (TEEB) and the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) recently established in 2012, provide an interface for communication and action between scientists and policy makers (Albert et al. 2014; Ruckelshaus et al. 2015). However, despite this growing interest, the use of ES in supporting decisions is still limited, and only few examples of its application exist particularly in the case of SEA and spatial planning (Slootweg 2015; Mascarenhas et al. 2015).

The objectives of this research address the issue of integrating the ES approach in SEA at different scales in order to identify the possibilities and challenges for implementing this integrated framework in real-world spatial planning. These objectives are defined according to a three-step approach (section 1.3, Figure 1.2), which involves the multiple actors related to the spatial planning and environmental assessment process, the analysis of current practices exploring whether the ES concept has been included so far, and a practical application through a case study.

1.2 Objectives and research questions

In this study three objectives are addressed which include a set of research questions as indicated below:

Objective 1

To analyze the current understanding and network relations in a multi-actor arrangement as a first step towards a successful integration of ES in SEA and spatial planning.

Related research questions

- Who are the key actors to be included to enable the implementation of ES in spatial planning through the SEA process, and which are the current network relations based on their associated conceptual understanding?
- How is the integration of ES in SEA and spatial planning perceived by the different actors, and which challenges are recognized?
- Which methodological approaches are identified for SEA, and which are considered as shared between SEA and ES?
- Which are the critical connections and gaps in the relation science-policy, and which channels of communication/information are used by the actors for their knowledge and understanding of ES and SEA?

Objective 2

To explore how ES have been considered in the development of spatial plans at different scales by considering the framework offered by the strategic environmental assessment.

Related research questions

- How has the ES concept been addressed throughout the SEA process?
- Does the spatial planning scale affect the consideration of specific (groups of) ES?
- Is there a planning scale that appears more suitable for the integration of ES?

Objective 3

To identify and prioritize ecosystem services for supporting development objectives and scenario analysis in regional planning through a case study in La Araucanía region, Chile.

Related research questions

- How are the strategic objectives of the spatial plan related or dependent on any ES?
- Which is the territorial context that allows identifying and prioritizing the most relevant ES for regional development?
- How should priority ES for mapping and scenario assessment be defined?

1.3 Structure of the research

This research is structured based on an adapted version of the framework of integrated assessment proposed by van der Sluijs (2002) and the advocacy coalition approach developed by Sabatier (1988). The first is focused on an interdisciplinary process where the scientific knowledge and policy are combined in order to provide useful information to decision makers. This framework involves practitioners and stakeholders as well as the utilization of analytical and participatory methods, scenario analysis, and policy exercises, among others. The second approach tries to explain policy changes in an environment with multiple public and private actors with a set of perceptions and beliefs (similar and/or opposite). It also considers the influence of external drivers and the effects of "relatively" stable factors within the political system such as basic social values and constitutional rules. Following these ideas, a three-steps approach is proposed for analyzing the current state of integration of the ES in policy decision-making in Chile and for exploring the challenges and opportunities for practical implementation (Figure 1.2).

The first step addresses the multiple actors related to the spatial planning and environmental assessment process as well as the networks among them and the understanding on integrating ES in planning in the Chilean context. The second step examines whether this integration is currently present at some point in the planning system and how ES have been considered so far in the development of spatial plans at different scales. The final step is related to the adoption and practical implementation where the ES context is established in a particular case study, and subsequently priority ES are identified by different actors in a participatory process for supporting regional development objectives. This final step contributes a real process of spatial

planning at the regional level, where results will be considered in the updating process of the current plan.

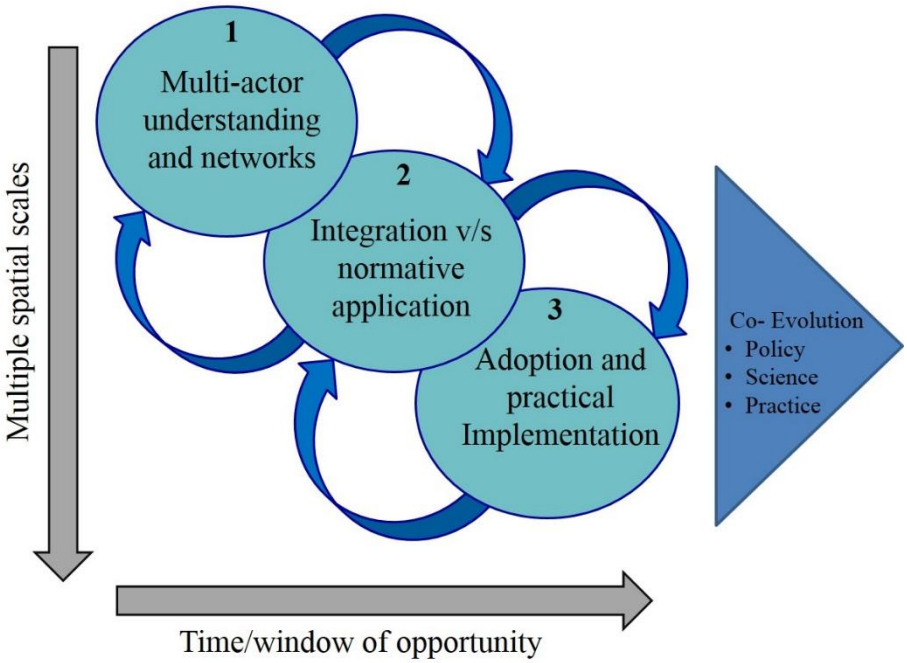

Figure 1.2 Research structure

This approach also suggests a gradual sequence for adoption and implementation of the ES concept in policy and decision-making, which includes feedback processes under an interface policy-science-practice as suggested by Österblom et al. (2010).

In order to provide practical applications for illustrating each step, a series of scientific papers as listed below was prepared.

1.- **Rozas-Vásquez D**, Fürst C, Geneletti D, Muñoz F. (2017). Multi-actor involvement for integrating ecosystem services in strategic environmental assessment of spatial plans. *Environmental Impact Assessment Review*. 62:135–146

2.- **Rozas-Vásquez D**, Fürst C, Geneletti D, Almendra O (under review). Integration of ecosystem services in strategic environmental assessment across spatial planning scales. *Land use policy*.

3.- **Rozas-Vásquez D**, Fürst C, Geneletti D (under development). Participatory identification and prioritization of ecosystem services for scenario development in regional planning.

These scientific papers present the main methodological aspects, results and conclusions obtained during the PhD research. They are arranged in chronological and logical order, following the steps in Figure 1.2. To facilitate the readability of the thesis, the complete version of each published article or under development manuscript, is provided in Appendix 1.

2 METHODOLOGY

2.1 Study area

Chile is located on the south-west border of South America with a length of 4400 km, and with a latitudinal gradient that includes a range of landscapes and climates from subtropical to sub-Antarctic (Squeo et al. 2012). The country is bounded by the Pacific Ocean on the west, the Andes cordillera on its eastern margin, the Atacama Desert in the north and the Chilean Antarctic in the south. These natural barriers make Chile a biogeographic island with a high concentration of unique autochthonous biodiversity (Moreira-Muñoz 2011). Figure 2.1 provides a map of Chile indicating the regions where analyses of SEA reports and/or application of questionnaires were carried out. La Araucanía region is shown with greater detail since it was used for the case study (section 2.2.3). This region is located in the southern part of the country, with an area of 31,842 km^2 and a population of 890,000 where almost 30% live in rural areas (Geneletti 2013).

Chile has a highly centralized structure for decision-making that is responsible for considerable territorial inequalities, especially in economic, cultural and ethnic terms (OECD 2013). The administrative scheme is organized in four hierarchical levels: national, regional, provinces (territorial units within a region that include a number of municipalities) and municipalities (OECD 2013). However, in practice the spatial planning process is mainly performed at regional, inter-municipal and municipal scales. The national level is only considered under broad principles, and the provincial level is not included in spatial planning.

The assessment of the impacts generated by the implementation of any spatial planning instrument was traditionally only through a standard EIA. However, since 2010 this has been replaced by SEA, which is currently mandatory for the development of any policy or plan with the aim of integrating environmental objectives and criteria for promoting a more sustainable planning process (Rojas et al. 2013; Rozas-Vásquez et al. 2014). SEA is included in spatial planning instruments at different scales from regional to municipal, as well as for zoning of the coastal areas

and integrated watershed management plans (MMA 2012). Table 2.1 provides an overview of the most relevant spatial planning instruments applied in Chile.

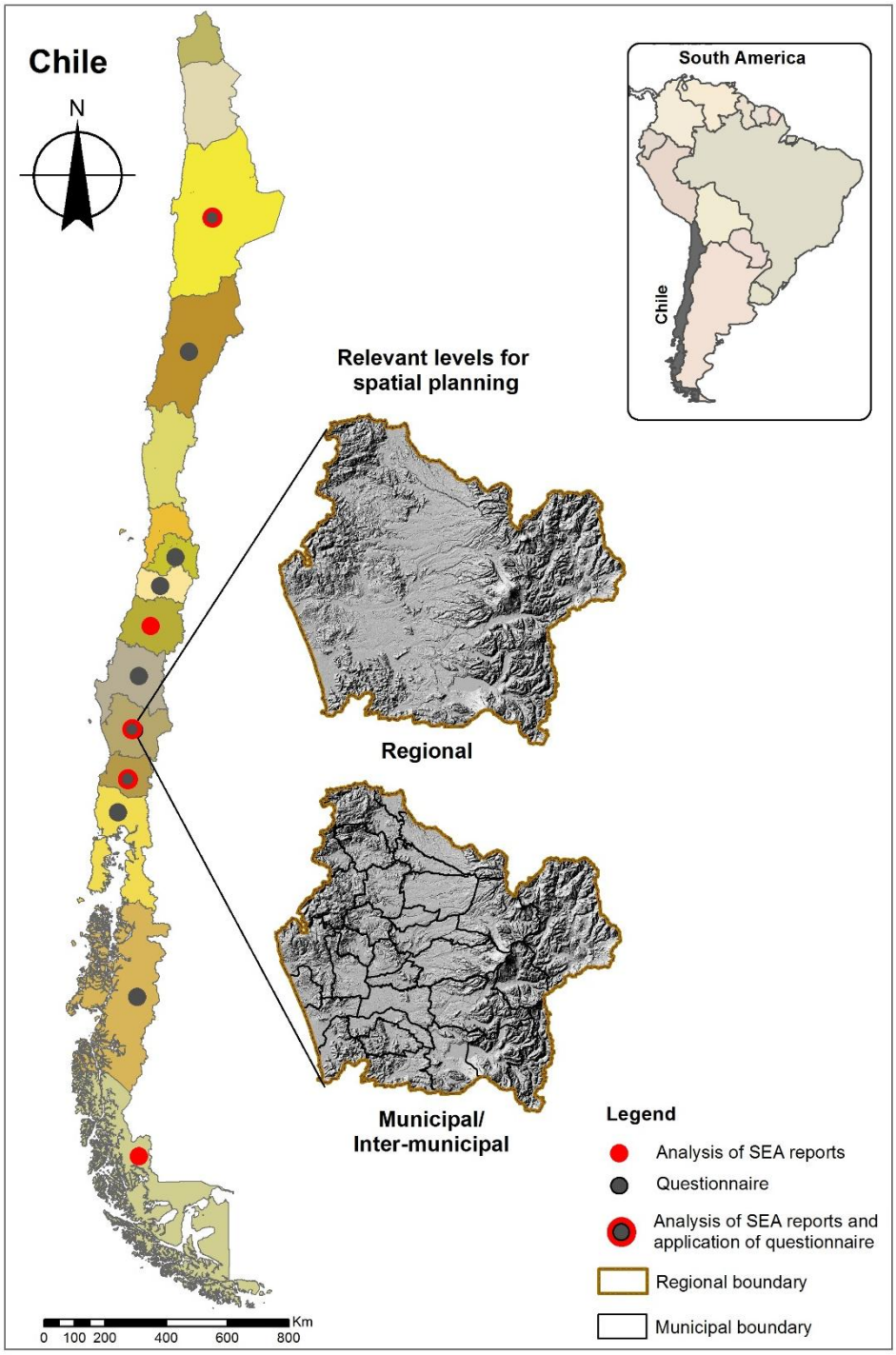

Figure 2.1 Main spatial planning levels in Chile with La Araucanía region as an example showing the municipal and inter-municipal scales.

Table 2.1 Relevant spatial planning instruments in Chile

Planning Level	Instrument	Role
Regional	Regional Land-Use Plan (RLUP)	Considers the whole region. Defines potentials and constraints for development in a spatially explicit way, involving economic, social and environmental objectives according to the guidelines defined by the Regional Strategy of Development[1].
Inter-municipal	Inter-Municipal and Metropolitan Regulating Plan (IMRP)	Regulates urban development within the urban-rural space which connects neighboring municipalities. It may include two or more municipalities.
Municipal	Municipal Regulating Plan (MRP)	Regulates infrastructure location, urban limits and population densities according to the proposed zonification. It also involves connectivity to improve functional relations on the municipal area, but only under an urban view.

Source: own elaboration based on MINVU (2011) & OECD (2013).

[1] *The Regional Strategy for Development (RSD) is an official document with broad guidelines for a desirable future based on a regional diagnosis. It identifies priorities, potentials and challenges and defines strategic objectives in the region, but does not consider a detailed spatial representation.*

2.2 Methods

2.2.1 Case study 1: Multi-actor involvement for integrating ecosystem services in strategic environmental assessment of spatial plans

Through this case study the research questions related to Objective 1 (Chapter 3) are addressed.

This case study was conducted in three main steps: 1) identification of key actors, 2) questionnaire development and application, and 3) data processing. A multi-method approach was adopted, which involves the integration between qualitative and quantitative analysis aimed at a more comprehensive view of the subject under study.

1) Identification of key actors

Throughout this case study the term “actor” refers to people who belong to an official entity with a verifiable affiliation and known location or contact, and whose work/research is related to ES, SEA and spatial planning or an integrated framework. The term “institution” refers to the entity where an actor is affiliated. The analysis focuses on actors from the government, consultants and research institutions because they are the most relevant for conducting and/or supporting SEA and spatial planning. There is naturally a range of other actors such as NGOs, stakeholders, indigenous communities, among others, however, they were not included given the broader scope of this work.

The identification of key actors was based on three information sources: 1) current legislation in spatial planning and environmental assessment where the involvement of specific actors is explicitly indicated, 2) analysis of national scientific databases from the Ministry of Environment (non-public database) and relevant papers published by Chilean researchers on SEA, ES and spatial planning, and 3) the application of a snowball approach as described by Scolozzi et al. (2012) where each participant was asked to mention another person they considered relevant for the topics of interest. This approach started with the actors indicated in the legislation, recognized researchers in the field, and expert recommendations, and ended once the names began to be repeated.

2) Questionnaire development and application

As a first step, a round of interviews was conducted with a reduced set of experts and experienced practitioners in order to collect perceptual, technical and contextual information for the subsequent development of the questionnaire. This was based on thoughts by Fisher et al. (2009) and Geneletti (2015), who argue that planning and policy-making contexts play an essential role at the moment of considering scientific recommendations into real practice.

The participants of the interviews were selected by identifying the most renowned actors from the previous application of the snowball approach. Afterwards, a semi-structured interview was elaborated given its suitability for addressing specific

issues and questions under a limited amount of previous information (Taylor and Bogdan 1998). The interviews were applied during October and December 2015, and included a total of 13 actors: government (7), consultants (3), and research institutions (3). The focus of the interview considered the following aspects: 1) a general view on sustainability issues in Chile and the role of spatial planning for achieving this goal, 2) the view about the current state of SEA in Chile, including methodological aspects and the possibilities for including the ES approach, 3) institutional constraints for implementing this integrated framework of SEA-ES and spatial planning, and 4) critical aspects in the science-policy dialogue for integrating ES in spatial planning.

A questionnaire was thus developed which considers theoretical information extracted from the literature review but also individual/institutional perceptions from the case study context.

In a second step, the questionnaire was elaborated taking as reference previous works on the relation theory, understanding and practice (e.g. Noble et al. 2012; Lobos & Partidario 2014). It comprised 13 questions and included open-ended, multiple-choice, and questions based on the Likert scale to explore the following main aspects: 1) network relations among the different actors involved, based on their understanding of SEA and ES, 2) perception about the current possibilities and challenges of integrating ES in SEA and spatial planning, 3) familiarity with different methodological approaches for SEA and ES analysis, and 4) critical links and gaps in the science-policy relation as well as the channels for communication and information recognized by the actors. Table 2.2 presents the structure of the questionnaire, indicating the type of questions and the specific analysis performed in each case.

Table 2.2 Structure of the questionnaire

Question	**Type of question**	**Analyses**
1. What is your definition of SEA? Give a short description considering your keywords.	Open-ended	- Text analysis - Network analysis of keywords and actors
2. What is your definition of ES? Give a short description considering your keywords.	Open-ended	- Text analysis - Network analysis of keywords and actors
3. Do you think the integration of the ES	Open-ended	- Text analysis and

approach is relevant for SEA in the spatial planning process? Why?		categorization - Statistical analysis
4. What do you consider the most appropriate way for integrating ES in SEA and spatial planning?	Multiple alternatives	- Statistical analysis
5. How do you consider ES should be integrated in SEA and spatial planning?	Multiple alternatives	- Statistical analysis
6. In the following statements, indicate your level of agreement or disagreement.	Likert	- Likert scale - Statistical analysis
7. Do you think the integration of ES in the SEA of the spatial plans could be an obstacle to a quicker and more open decision-making process?	Open-ended	- Text analysis and categorization - Statistical analysis
8. Which are the most challenging issues for the integration of ES in SEA and spatial planning?	Multiple alternatives	- Statistical analysis
9. Which of these methods are you aware of or have you used in SEA?	Multiple alternatives and ranking of 3 first	- Statistical analysis
10. Which of these methods do you consider are shared in both SEA and ES analysis?	Multiple alternatives	- Statistical analysis
11. How important do you think is the science-policy coordination in relation to ES, SEA and spatial planning?	Open-ended	- Text analysis and categorization - Statistical analysis
12. What do you consider is the role of research institutions/universities in supporting the integration of ES, SEA and spatial planning?	Open-ended	- Text analysis and categorization - Statistical analysis
13. How did you learn about the concepts of SEA and ES?	Multiple alternatives	- Statistical analysis

The questionnaire was applied to 56 actors identified in the previous step. The application was conducted principally online, however, in cases when it was feasible and the contacted person was available, we also proceeded with face-to-face application with the aim of developing a working network. In all cases the same questionnaire was used, and particularly in the face-to-face applications any additional discussion was carried out after finishing the questionnaire to ensure transparency and neutrality in the answers.

3) Data processing

The analysis of the questionnaire was performed using a mixed approach given the different type of questions. In the case of open-ended questions, the answers were categorized and keywords were identified and codified in order to generate quantitative information for subsequent statistical and network analysis. Throughout this work, a "keyword" is understood as a word or phrase that describes a concept or any specific dimension of all the components of such a concept. For instance, the ES concept includes also dimensions such as classification schemes, different types of assessment, among others. In the case of closed questions and Likert scale, the frequency of each answer was registered for statistical analysis.

I) Open-ended questions related to conceptual definitions for SEA and ES (questions 1, 2)

The analysis was performed according the structure proposed by Dierckx de Casterlé et al. (2012) and Noh et al. (2015), and assisted by QDA miner 4, a text analytic software available at http://provalisresearch.com. Through this process, keywords were identified in the answers as an input information for analyzing the network relations between actors/keywords and actors/actors. The identification of keywords was carried out under two different approaches. The first was based on an extensive literature review on SEA and ES, and aimed to identify keywords from the mainstream definitions in scientific journals and international guidelines (e.g. MA 2005; Haines-Young & Potschin 2009; Lamarque et al. 2011; Partidario 2012; Nahlik et al. 2012; Fürst, Frank, et al. 2013; da Silva et al. 2014; Geneletti 2015). In this way, an initial list of keywords was created with their associated dimensions for each concept such as goals, functions, target, and timing, among others. The second approach consisted of a detailed screening of the answers in order to identify additional keywords that could be more related to the specific context of application but nevertheless significant. This process was implemented using a frequency-based keyword extraction approach as described by Noh et al. (2015).

After performing these two steps consecutively, a final list of keywords was obtained and used for codification and subsequent network analysis. Figure 2.2

presents an overview of the coding process taking as example one of the SEA definitions. The original language of the questionnaire is in Spanish.

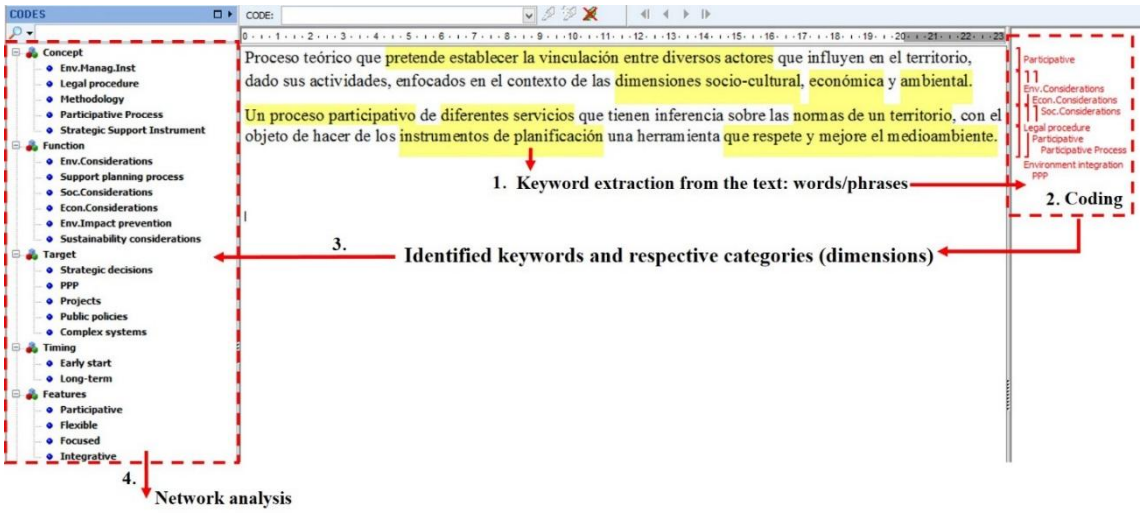

Figure 2.2 Overview of the coding process and category generation

The coding process starts with the keyword extraction from the text, and these are then codified and grouped in larger categories according to the dimension of the concept they represent. Later, this information was used as input to perform a network analysis.

Network analysis is founded on the graph theory, a mathematical approach where nodes (or vertices) and arcs (or lines) are the central components of the network (de Nooy et al. 2005). This approach was implemented given its effectiveness for detecting and interpreting patterns of relations between different entities, in this case actors v/s actors and actor v/s keywords. In this research, actors and keywords are represented by “nodes” and the interactions among them by “arcs”.

The analysis was carried out in the free software “Pajek” for calculating different metrics of centrality. The metric *indegree* represents the number of arcs connected with one single node (keyword). In our case, which actor (node) and how many of them (*indegree*) mentioned (arc) a specific keyword (node). The metric *outdegree* represents the number of arcs sent by one single node (actor). In our case, which keyword (node) and how many of them (*outdegree*) are recognized (arc) by a

specific actor (node). Finally, we also calculated the metric *betweenness* but only in the case of actors, since this is an indicator of the relevance of one specific actor (node) within the network for connecting other actors., It then might represent a possible "bridge actor" (de Nooy et al. 2005; Bodin and Crona 2009). Figure 2.3 illustrates the process of the network analysis and the role of nodes and arcs for calculating the utilized metrics.

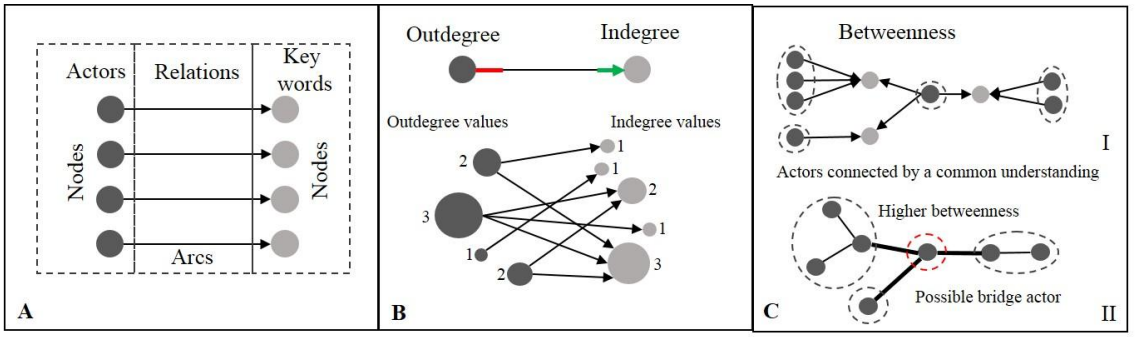

Figure 2.3 Network analysis for calculation of centrality metrics. Dark circles are actors, grey circles are keywords. A) structure of nodes and arcs representing keywords mentioned by actors, B) simplified calculation of *outdegree* and *indegree* metrics, where the size of the nodes depends on the metric value, C) metric *betweenness* where in I) different actors are related by a common understanding based on the keyword analysis, and in II) a possible bridge actor that connects different groups is identified. Source: Rozas-Vásquez et al. (2017).

II) Open-ended questions related to perceptions of the participants (questions 3, 7, 11, 12)

For each of the above questions, the actor's perceptions and the reasons for them were identified through a text analysis approach. Following Taylor & Bogdan (1998) broader categories of responses were created to facilitate the subsequent statistical analysis.

III) Closed questions and Likert scale-based questions (questions 4, 5, 6, 8, 9, 10, 13)

The first type of questions consisted of alternatives with previously defined responses. Therefore, the frequency of each was calculated and statistical analyses performed. In the Likert-scale-based questions, the level of agreement of each participant for a set of statements was obtained. This level of agreement moves in a scale of five steps from strong disagreement to strong agreement. Afterwards, a statistical analysis of the frequencies was performed.

2.2.2 Case study 2: Integration of ecosystem services in strategic environmental assessment across spatial planning scales

This case study addresses the research questions related to Objective 2 (Chapter 3).

A set of SEA reports at different scales of spatial planning was analyzed, i.e. regional, inter-municipal, municipal. For that we utilized a content analysis approach implemented at the different stages of the SEA process.

I) Framework for analyzing SEA reports

In order to explore the explicit and implicit consideration of ES within the SEA process, and to find out whether ES are more relevant or consistently included at any particular scale of spatial planning, an analytical framework was developed (Table 2.3). Given the diverse terminology currently used to make reference to the ES concept (Lamarque et al. 2011; Rozas-Vásquez et al. 2017), related terms were also included such as “environmental services”, “environmental functions” and “natural capital”. This, enhanced the analytical power of the study.

The analysis of the SEA reports was performed under a modified version of the approach proposed by Geneletti & Zardo (2016), who used a direct content analysis. This type of content analysis follows a more structured process that the traditional one, including existing theories and previous research on the subject. In contrast with the traditional content analysis that avoids the use of predetermined categories, direct content analysis takes advantages of the available knowledge for helping to identify key concepts or variables present in the documents as well as for facilitating the definition of more accurate research questions (Hsieh and Shannon 2005). In

congruence with Geneletti & Zardo (2016) a “keyword-based analysis” was not included because in the field of ES and SEA, standard terminologies are not yet available (Braat and de Groot 2012; da Silva et al. 2014).

The implementation of the content analysis considered four main stages that represent relevant methodological steps at the moment of integrating ES in SEA. In most of the cases, these stages are not clearly defined throughout a traditional SEA report. However, for practicality the reports were divided in 1) context and objectives, 2) scoping and ES prioritization, 3) strategic analysis of alternatives, and 4) follow-up, based on previous reflections made by OECD & DAC (2008); Partidario & Gomes (2013) and Geneletti (2015, 2016). In each stage, it was investigated how ES had been included by applying an analytical framework based on questions formulated in concordance with the focus and scope of the respective stage (Table 4.3). Then, each stage was described according to the type of ES identified, their frequency, how they were included and at which planning scale.

For a consistent and standard classification of ES, the framework proposed by CICES V4.3 was applied (http://cices.eu/).

Table 2.3 Framework for exploring the integration of ES at different SEA stages

SEA stage	ES questions
1. Context and objectives	- Does the SEA process recognize the dependency on ES for the achievement of the environmental objectives of the plan? Which ES? Are ES explicitly mentioned? - Are the main ecosystem types identified in the SEA report? Do they allow evaluating the ES context? - Does the SEA report include a link with other strategic actions or legal instruments with potential influence on ES? Which type of strategic action or legal instrument?
2. Scoping and ES prioritization	- Which ES are the most relevant for achieving the environmental objectives of the plan? - Are the environmental problems identified in the strategic diagnosis related to the performance of any ES? Which

	ones? Are they explicitly mentioned? - Does the SEA process include an assessment of ES values (social, economic or ecological)?
3. Strategic analysis of alternatives	- Does the SEA process consider ES in the strategic analysis of alternatives of the plan? Which ES? Are they explicitly mentioned? How are they included?
4. Follow-up	- Does the SEA process propose any measures for monitoring and managing ES? Which measures? Which ES are included? Are they explicitly mentioned?

II) Selection of SEA reports

The selection of SEA reports considered all available spatial plans in Chile at regional, inter-municipal and municipal levels based on four criteria: 1) online availability in the national information system of SEA (http://eae.mma.gob.cl/index.php/ficha), 2) timeliness: reports elaborated after 2010 were selected because in this year SEA became mandatory in Chile for the elaboration of any spatial planning instrument (Rozas-Vásquez et al. 2014) and also the ES concept was mentioned for first time in a national document (Figueroa 2010), 3) level of progress of the reports: approved SEA reports or those in an advanced level of progress were selected, where only few changes are expected in relation to the final version, 4) multi-scale representation: regions that presented availability of SEA reports at regional, inter-municipal and municipal level were considered.

In addition, reports were included that illustrate different contexts in terms of geographic conditions as well as social and cultural settings instead of only concentrating the analysis on one specific region. In this sense, with the aim of standardizing the number of reports in each planning scale and selected region, a standard number of one report per scale of planning per region was defined.

2.2.3 Case study 3: Participatory identification and prioritization of ecosystem services for scenario development in regional planning

This case study addresses the research questions related to Objective 3 (Chapter 3).

This case study was carried out in La Araucanía region in three consecutive steps that are a modified version of those proposed by Geneletti (2015): 1) identification of key actors and regional strategic objectives for territorial development, 2) determination of the ES context, and 3) prioritization of ES for a subsequent mapping and scenario development.

I) Identification of key actors and regional strategic objectives for territorial development

Since this research has not been implemented under a real elaboration of a Regional Land-Use Plan (RLUP), a reduced set of key actors was involved for testing the proposed method and supporting the strategic analysis for the updating process of the coming RLUP. In this research, a key actor is understood as a specific government institution highly relevant for the development of the spatial plan and/or with a significant role in the decision process.

According to the national regulations for spatial planning, the regional government (known in Chile as GORE) is the institution in charge of coordinating and taking the final decision for approving the RLUP document (Law N° 19.175). Therefore, GORE was asked for an initial set of key actors to be included in the identification and prioritization of ES.

The regional strategic objectives to be evaluated under an ES approach were selected from the Regional Strategy of Development (RSD). The initial selection was carried out during an expert meeting and afterwards those objectives were validated in a workshop involving the key actors. The selection focused on objectives directly related with 1) use and management of natural resources, 2) sustainability issues, and 3) regional identity, particularly in relation to cultural and ethnic heritage. Regional objectives related to other issues such as infrastructure development, education, administrative strengthening, etc., were not included in the analysis.

II) Establishing the ecosystem services context

This step was implemented through three expert meetings followed by two workshops with the key actors for discussion and validation, which included the support of a team of scientists also involved in this research. During this process, three main contextual aspects were addressed following those proposed by Geneletti (2015): 1) identification of the main ecosystem types present in the region, 2) definition of the ES provided by those ecosystems, and 3) identification of the benefits and beneficiaries of those ES.

For the identification of the main ecosystems, the original land-use map of the region was generalized. The aim of this procedure was 1) to avoid confusions between very similar land-use classes, where differentiation does not mean a great contribution at the regional level (e.g. dense scrubland, semi-dense scrubland, open scrubland, and others land uses with a similar differentiation), and 2) to concentrate the strategic analysis on significant ecosystems for the regional context in terms of their economic, cultural and ecological relevance, including also their spatial representativeness (area) (Partidario and Gomes 2013). A first version of the generalized land-use/land-cover map of La Araucanía region was elaborated in an expert meeting and then discussed and validated in a workshop with the key actors. Finally, 14 land-use classes were considered for the subsequent analysis of identification and prioritization of ES (Figure 2.4)

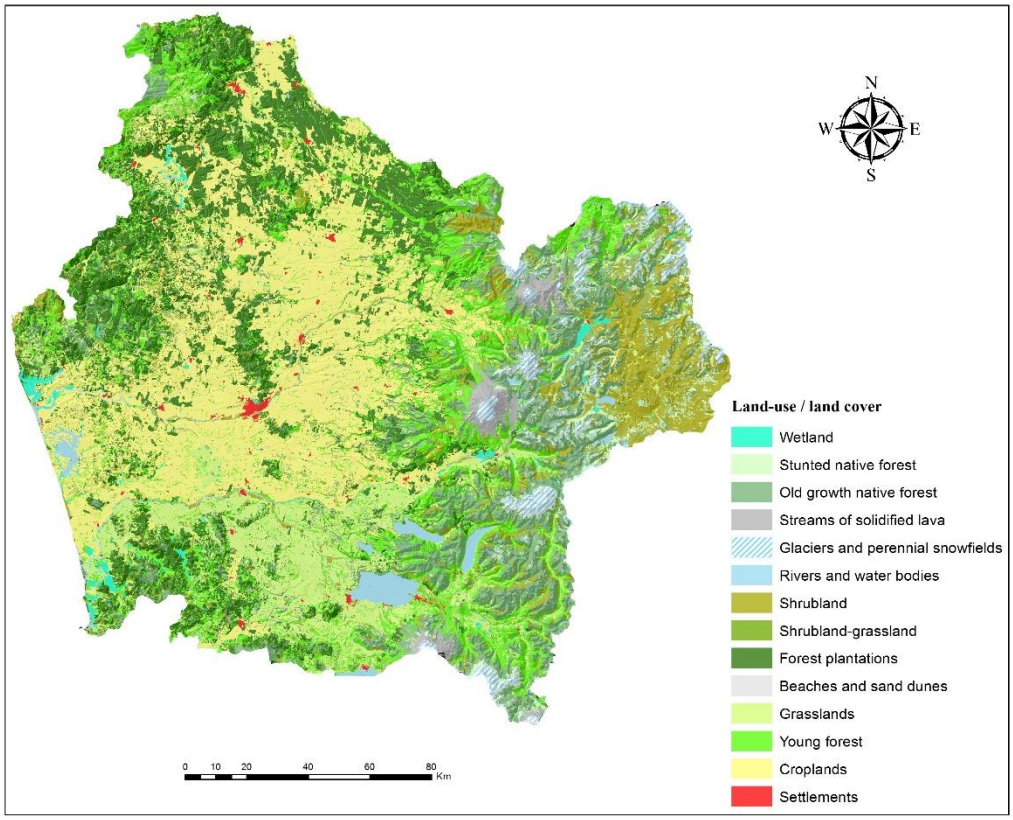

Figure 2.4 Generalized land-use/land-cover map of La Araucanía region

The ES provided by the identified ecosystems were defined using the framework proposed by CICES (Haines-Young and Potschin 2013). All suggested ES at the CICES class level were considered and their presence in each of the 14 representative land uses of the region analyzed. The first evaluation was carried out in an expert meeting, and later discussed and validated in a workshop with the key actors taking advantage of their sectoral and contextual information about the region. In this analysis, benefits and beneficiaries were also included, but under a more general view than in the case of ES identification. This was because the perceptions of benefits and the potential beneficiaries might vary under specific cultural or geographic conditions within the region.

Based on this information, a matrix of land uses and the identified ES, benefits and beneficiaries was elaborated, which was used for statistical analysis.

III) Prioritization of ecosystem services in the regional context

The definition of priority ES is a key task for an effective strategic analysis in concordance with the planning context and determined regional objectives for development (Geneletti 2015). Additionally, a prioritization process is also needed given the frequent constraints of time, budget and information that make the consideration of all the ES present in the whole region unfeasible. Then, a prioritization process will help in identifying the most important and vulnerable ES.

From the extensive list of ES obtained in the previous step, the prioritization was performed based on two criteria. For each, a qualitative indicator was preferred because it allows a more flexible and strategic approach based on the dialogue among the involved key actors, which is also supported by previous works in the field (Partidario 2012; Partidario and Gomes 2013).

The first criterion was the "relevance" of each identified ES for the achievement of a particular regional strategic objective under a pairwise comparison. The scale of evaluation considered the levels "null, "very low", "low", "high" and "very high", where the frequency of each ES was indicated under the corresponding level. The second criterion was the "impact" of each regional strategic objective on the performance of each ES, also in a pairwise comparison. This criterion indicates the potential negative or positive effects generated with the implementation of a specific regional objective in terms of increasing or decreasing the quality and quantity of a specific ES. Thus, a negative or very negative impact of an ES makes its or their prioritization more urgent. The scale of evaluation considered the levels "very negative", "negative", "neutral", "positive", and "very positive", indicating the frequency of each ES as in the previous case.

The assessment of both criteria was carried out using a linear weighted combination (LWC), where each level within a criterion obtained a relative importance until achieving 100 %. This method was preferred given its simplicity of implementation and easy understanding for decision makers (Malczewski 2000). The relative relevance for each level was elicited during an expert meeting where an initial ranking for prioritization was also proposed.

After performing the LWC, the "impact" and "relevance" values were standardized in order to make them comparable, thus obtaining a final priority value. Two approaches were applied as described by Malczewski (1999) in order to compare the stability of the ranking. The first was the maximum score approach (MSA), which consists of a proportional (linear) transformation that maintains the proportions among the numbers. The second was the score range approach (SRA), where the original values are rescaled to cover the complete range from 0 to 1.

As a last step, both standardized criteria were aggregated in a final priority value assigning a relative importance of 50% to each criteria, which certainly needs to be revised and validated in the forthcoming process of updating the RLUP. Figure 2.5 shows an overview of the valuation scheme, where the linear weighted combination as well as the standardized values by using the maximum score approach and the score range approach are displayed.

Ecosystem services	Impact					Relevance					LWC Impact	LWC relevance	MSA impact	MSA relevance	SRA impact	SRA relevance
	Very negative	Negative	Neutral	Positive	Very positive	Null	Very low	Low	High	Very high						
Surface water for drinking	0	3	2	0	1	1	1	0	2	2	1.15	1.7	0.3833	0.57627	0.26	0.47917
Surface water for non-drinking purposes	0	3	2	1	0	1	0	0	0	5	1.15	2.55	0.3833	0.86441	0.26	0.83333
Animals from in-situ aquaculture	0	3	0	2	1	4	0	0	1	1	1.05	1	0.35	0.33898	0.22	0.1875
Wild animals and their outputs	0	3	2	1	0	4	0	1	1	0	1.15	0.6	0.3833	0.20339	0.26	0.02083
Buffering and attenuation of mass flows	0	1	5	0	0	4	0	0	2	0	0.8	0.8	0.2667	0.27119	0.12	0.10417
Chemical condition of freshwaters	0	3	3	0	0	2	0	0	1	3	1.2	1.9	0.4	0.64407	0.28	0.5625
Flood protection	0	0	6	0	0	3	0	0	1	2	0.6	1.45	0.2	0.49153	0.04	0.375
Mediation of smell/noise/visual impacts	0	0	6	0	0	4	0	0	2	0	0.6	0.8	0.2	0.27119	0.04	0.10417
Educacional	0	0	6	0	0	0	0	4	2	0	0.6	1	0.2	0.33898	0.04	0.1875
Physical use of land-/seascapes in different environmental settings	0	0	4	1	1	3	0	2	0	1	0.5	0.85	0.1667	0.28814	0	0.125
Aesthetic	0	2	3	1	0	5	0	0	0	1	0.95	0.75	0.3167	0.25424	0.18	0.08333
Filtration/sequestration/storage of pollutants	0	1	5	0	0	5	0	0	1	0	0.8	0.55	0.2667	0.18644	0.12	0
Scientific and academic interest	0	0	4	1	1	0	0	0	1	5	0.5	2.8	0.1667	0.94915	0	0.9375
Materials from plants, algae and animals from agricultural use	0	0	5	5	2	5	0	0	6	1	0.85	2.55	0.2833	0.86441	0.14	0.83333
Fibres and other materials from plants, algae and animals for direct use or processing	0	1	10	1	0	11	0	0	1	0	1.35	0.85	0.45	0.28814	0.34	0.125
Experiential use of plants, animals and land-/seascapes in different environmental settings	1	0	4	0	1	5	0	0	0	1	0.95	0.75	0.3167	0.25424	0.18	0.08333
Heritage, cultural	0	4	1	1	0	5	0	0	0	1	1.35	0.75	0.45	0.25424	0.34	0.08333
Plant-based resources	0	1	11	0	0	11	0	0	1	0	1.4	0.85	0.4667	0.28814	0.36	0.125
Wild plants, algae and their outputs	0	1	5	0	0	5	0	0	1	0	0.8	0.55	0.2667	0.18644	0.12	0
Tsunami and storm protection	0	0	6	0	0	5	0	0	1	0	0.6	0.55	0.2	0.18644	0.04	0
Maintaining nursery populations and habitats	1	5	8	3	1	15	0	0	1	2	3	2.05	1	0.69492	1	0.625
Entertainment	0	2	7	1	2	10	0	0	0	2	1.45	1.5	0.4833	0.50847	0.38	0.39583
Global climate regulation by reduction of greenhouse gas concentrations	0	1	4	0	1	5	0	0	1	0	0.75	0.55	0.25	0.18644	0.1	0
Micro and regional climate regulation	0	1	3	2	0	2	0	0	1	3	0.7	1.9	0.2333	0.64407	0.08	0.5625
Sacred and/or religious	0	4	1	1	0	5	0	0	0	1	1.35	0.75	0.45	0.25424	0.34	0.08333

Figure 2.5 Overview of valuation scheme. LWC = linear weighted combination for both criteria, MSA = maximum score approach, SRA = score range approach.

3 RESULTS

3.1 Case study 1

3.1.1 Questionnaire application

A total of 56 actors were identified and contacted for the questionnaire. Among these, 36 were able to participate representing 30 institutions distributed in 9 regions in the country (Figure 3.1).

Region	Actors
	Ministry of the Environment (Regional office)
II	Universidad Católica del Norte (University)
III	Ministry of Housing and Urban Planning (Regional office)
	Fundación Chile (Consultant)
	Ministry of the Environment (National office)
	Sub Secretary of Regional and Administrative Development (National office)
	Universidad Central (University)
RM	Universidad de Chile (University)
	Ministry of the Environment (Regional office)
VI	Regional Government
	Ministry of Housing and Urban Planning (Regional office)
	Ministry of the Environment (Regional office)
	Regional Government
VIII	Universidad de Concepción (University)
	Laboratorio de Planificación Territorial. Universidad Católica de Temuco (Consultant-University)
	Centro de estudios TerritorioMayor. Universiad Mayor (Consultant)
	Instituto de estudios del Hábitat. Universidad Autonoma (Consultant)
	Ministry of Housing and Urban Planning (Regional office)
	Ministry of the Environment (Regional office)
IX	Regional Government
	CECPAN (Consultant)
X	Ministry of Housing and Urban Planning (Regional office)
	Ministry of Housing and Urban Planning (Regional office)
XI	Ministry of the Environment (Regional office)
	Ministry of Housing and Urban Planning (Regional office)
	Ministry of Public Works (Regional office)
	Ministry of the Environment (Regional office)
	Regional Government
XIV	Universidad Austral de Chile (University)

Figure 3.1 Actors involved in the case study and their geographical distribution in Chile.

3.1.2 Network relations among actors based on their associated conceptual understanding of SEA and ES

The networks between actors and keywords show differences in both SEA and ES in terms of the common keywords recognized by the actors that led to different arrangements of relations among them. In SEA, the three types of actors were organized as a single group (Figure 3.2), while in the case of ES, we observed two different groups. Here, research institutions were located separately in relation to government and consultants (Figure 3.3).

The metric outdegree shows a higher average value in SEA, but at the same time with a higher variability in relation to ES (SEA: $\bar{X}$ = 6,4; σ = 3,8 / ES: $\bar{X}$ = 5,7; σ = 2,3). Government institutions are the dominant actors in both cases, particularly in SEA with a total outdegree of 141 in comparison with 104 for ES.

The metric indegree shows only a small number of keywords that were considered as dominant given their frequency of mention by the actors. In SEA, a total number of 35 keywords were identified. "PPP" and "environmental considerations" show the highest indegree values (24 and 17, respectively), i.e. more than three times higher than the average of 5,5. In contrast, keywords such as "participative process", "scenarios" and "analytic tool" were hardly ever mentioned, and show an indegree value of only 1.

The ES network shows a similar situation with a total number of 32 identified keywords. "Benefits", "ecosystems", "goods and services ", "society" and "human being" show higher indegree values (19, 15, 15 and 13, respectively), again with numbers close to three times the average of 5.3. In this network, the number of keywords with a very low indegree was larger than in SEA. Keywords such as "conservation", "sustainability", "natural landscapes", "social" "non-economic", "socio-ecological integration" and "environmental functions", were almost not recognized by the actors and show an indegree value of only 1.

In the case of the different categories or dimensions associated with each conceptual definition, most of the recognized keywords in the case of SEA belong to "functions (25%)", "target (25%)" and "goals (13%)". For ES, this keywords belong to

the categories “classification (30%)”, “concept (22%)” and “source of ES generation (18%)”.

Figures 3.2 and 3.3 show a simplified version of the complete networks in SEA and ES (complete networks and keywords in Appendix 2). In this version, not all the keywords are present, and the cut-off criterion was the minimum indegree value that made it possible to include all categories related to each conceptual definition. In the figures, the size of the pie charts illustrates different ranges of indegree values. The maximum value is 30 (total number of actors who mentioned a keyword) while the minimum is 1 when the keyword was mentioned only once. At the same time, the pie charts show the proportion in which the different actors mentioned such a keyword. In the case of outdegree values, they are represented by the size of the circles in the center, where each color means a different actor. In addition, the dashed red line illustrates the proximity of the actors in relation to the keywords they recognized. The grey squares correspond to the different categories or dimensions associated with each keyword.

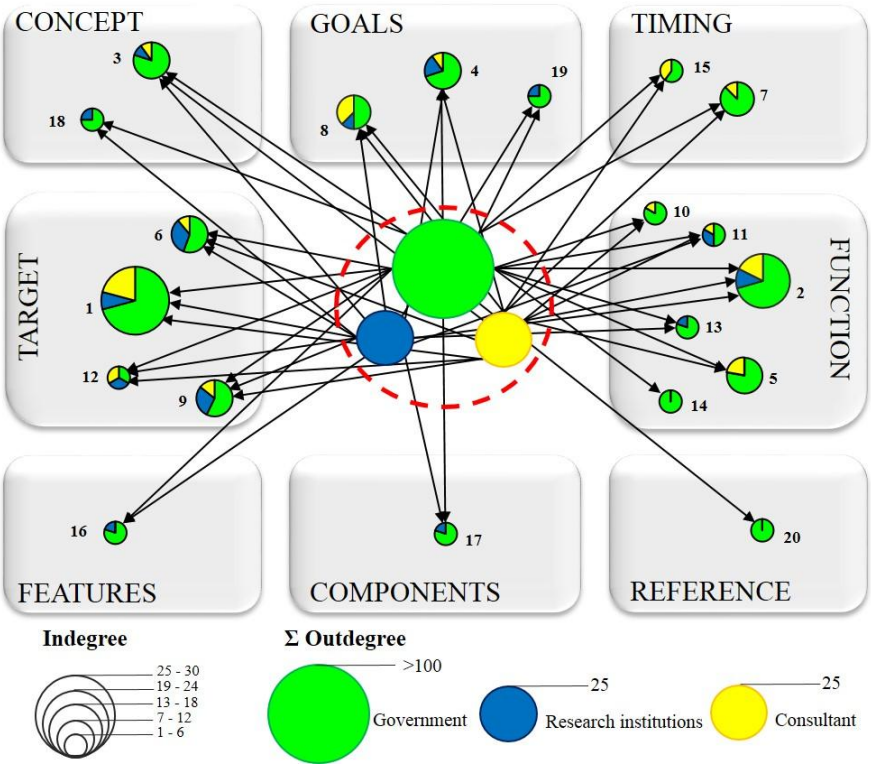

Figure 3.2 Simplified network of the relations between actors and keywords in SEA.

1: PPP; 2: Environmental considerations; 3: Environmental management instrument; 4: Sustainability; 5: Sustainability considerations; 6: Public policies; 7: Early start; 8: Environment integration; 9: Strategic decisions; 10: Social considerations; 11: Environmental impact prevention; 12: Projects; 13: Support planning process; 14: Economic considerations; 15: Long-term; 16: Participative; 17: Social actors; 18: Strategic support instrument; 19: Support decisions; 20: Environmental Law

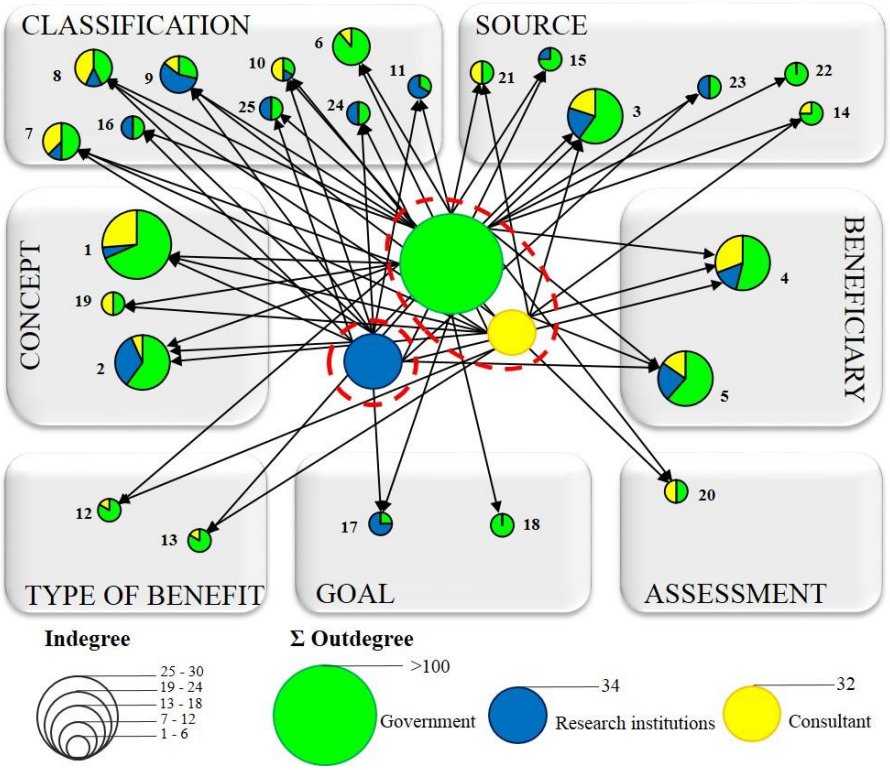

Figure 3.3 Simplified network of the relations between actors and keywords in ES.

1: Benefits; 2: Goods and services; 3: Ecosystems; 4: Human being; 5: Society; 6: Unknown; 7: Regulating; 8: Cultural; 9: TEEB; 10: Provisioning; 11: MEA; 12: Direct; 13: Indirect; 14: Natural ecosystems; 15: Natural resources; 16: CICES; 17: Well-being; 18: Support development; 19: Economic approach; 20: Economic; 21: Ecosystem functions; 22: Environmental components; 23: Nature; 24: Supporting; 25: FEGS

The metric betweenness shows a higher average value in SEA but at the same time a larger variability in relation to ES (SEA: $\bar{X}$ = 2,3; σ = 1,7 / ES: $\bar{X}$ = 1,6; σ = 0,6). In SEA, the higher values are associated with government institutions, while in ES they

are more related to consultant teams. In contrast, the lowest values for betweenness in both SEA and ES are for actors from research institutions (Table 3.1).

Table 3.1 Average values of the metric betweenness and variability by type of actor

Type of actor	SEA_Average	SEA_St. Desv	ES_Average	ES_St. Desv
Estate	2.57	1.71	1.65	0.74
Consultant	2.4	2.07	2	0.66
Research	1.54	1.44	1.28	0.34
All the actors	2.33	1.71	1.63	0.68

When individual values of this metric are considered, government institutions show the higher level of betweenness in both SEA and ES (5.8 and 2.7, respectively).

3.1.3 Integration of ES and SEA in spatial planning

The results show that more than 90% of the actors have the perception that integrating ES in SEA might strengthen the spatial planning process. The main reasons provided by the actors are that the ES approach has the potential for enhancing the value of territorial resources (20.5% of the actors) as well as the value of nature for the society (15.4% of the actors). They also relate the ES approach with the possibility to combine conservation and development (10.3%), the protection of ecosystems (10.3%), and as a support for decisions that involve land-use conflicts (5.1%), among others (Table 3.2).

In this regard, most of the actors believed that the integration of the ES approach for supporting decisions in SEA and spatial planning should be first included in a social assessment of ES (61.5%), and second through an economic assessment such as the well-known scheme of payment for ES (17.9%).

Table 3.2 View of the actors regarding the integration of ES in SEA and spatial planning.

Do you think the integration of the ES approach is relevant for SEA in the spatial planning process? Why?	**%**

It is relevant	92.3
It is not relevant	2.6
Reason	**%**
Enhances territorial resources	20.5
Adds value to the nature for the society	15.4
Combines conservation and development	10.3
Allows the protection of ecosystems	10.3
Helps to identify impacts on the territory	7.7
Considers the carrying capacity of the territory	7.7
Includes sociocultural and ecological dimensions	5.1
Supports the decision-making process	7.7
Helps to solve conflicts in land-use	5.1
No answer	10.3

When exploring the perception of how ES should be included in SEA and spatial planning in more detail, it can be seen that the integration of the ES approach within the sustainability analysis of the plan ranks first (33.3%). Second, the actors mentioned the modeling of socio-ecological systems (25.6%), and third the elaboration of maps for supporting decisions (23.1%) (Table 3.3).

Table 3.3 View of actors regarding the most appropriated way for integrating ES in SEA and spatial planning.

Integration of ES in SEA and spatial planning (general view)	**%**
Social assessment of ecosystem services	61.5
Payment for ecosystem services	17.9
Biophysical assessment of ecosystem services	5.1
Other	15.4
How ES should be integrated in SEA and spatial planning (specific view)	**%**
Sustainability analysis of the spatial planning instrument	33.3
Models of socio-ecological systems	25.6
Maps to support the decisions	23.1
Other	7.7
No response	10.3

The results of the questions based on the Likert scale are presented in Table 3.4 and expressed in percentage of participants. These questions addressed three critical aspects for integrating ES in SEA and spatial planning: 1) the presence of a

bundle of ES for the territorial development versus promoting the most dominant productive activities, 2) the consideration of spatial, institutional and stakeholder scales, and 3) planning boundaries. In order to offer a spatial context to the actors, the questions were asked based on a regional perspective.

An important fraction of the actors (65%) disagreed or strongly disagreed with the idea that territorial development and well-being is mainly based on the encouragement of productive activities (e.g. agriculture and forestry) without considering the maintenance of a bundle of ES. Nevertheless, a group of actors agreed on that aspect, or took a neutral position (30%). The idea that this integrated framework requires the consideration of multiple scales in order to better include perceptions, values and priorities for a range of ES was agreed or strongly agreed on by the majority of actors (74%). With regard to the planning boundaries, most of the actors agreed or strongly agreed (85%) that the spatial planning process should consider natural boundaries, especially at regional level.

Table 3.4 View of the actors on a Likert scale in relation to the integration of ES in SEA and spatial planning under a regional perspective

Key aspect	Strongly agree (%)	Agree (%)	Neither agree nor disagree (%)	Disagree (%)	Strongly disagree (%)
The regional economic development and the community well-being do not depend on the maintenance of a bundle of ES but rather on the encouragement of productive activities like agriculture, forestry, livestock, mining and others.	0	10.3	20.5	23.1	43.6
SEA in regional planning should consider different spatial, institutional and stakeholder scales in the ES analysis given the possible variation in the perceptions and value for determined ES through these scales.	46.2	28.2	10.3	7.7	5.1

The spatial planning process should consider natural boundaries as a unit of analysis in order to improve the provision of relevant ES for human activities and regional development.	59.0	25.6	2.6	5.1	5.1

Finally, the actors identified a series of advantages and challenges for this integrated framework (Table 3.5). For most of them, the integration of ES in SEA and spatial planning does not pose an obstacle for a quick and free decision-making process (56.4%). However, in contrast 33.3% of the actors perceived this framework as an obstacle, while 10.3% did not answer.

The main arguments for supporting this integrated framework are related to the enhancement of the spatial planning process (23.1%), and the strengthening of the associated strategic decisions (20.5%). In contrast, the actors skeptical about this framework mentioned reasons such as a lack of widely accepted methods (7.7%), high complexity in real applications (7.7%) and a lack of experts in SEA and ES (5.1%).

Regarding the most challenging issues, aspects such as a lack of institutional guidelines (53.8%) and a lack of information and available methods (46.2%) were the most relevant.

Table 3.5 View of actors regarding the advantages and challenges for integrating ES in SEA and spatial planning

Do you think the integration of ES in SEA and spatial planning could be an obstacle for a quicker and free decision making? Why?	**%**
It is not an obstacle	56.4
It is an obstacle	33.3
Reasons (general view)	**%**
Improves and strengthens the spatial planning process	23.1
Strengthens the decision-making process	20.5
Raises the value of the ecosystems	10.3
Allow considering socio-ecological systems	5.1
Lack of widely accepted methods	7.7
Theoretical and technical issues still under development	7.7
Complexity in real applications	7.7
Lack of experts in both ES and SEA	5.1

No answer	12.8
Most challenging issues for the integration of ES in SEA and spatial planning (specific view)*	**%**
Lack of institutional guidelines	53.8
Lack of information/methods	46.2
Lack of awareness	38.5
Deficient regulatory framework	35.9
Low applicability and usefulness	5.1
Other	10.3

** This question is based on alternatives where the participant was free to select those he/she considered relevant. Therefore the relative total is more than 100%.*

3.1.4 Methods identified for SEA and ES analysis

The most frequent methods recognized by the actors at the moment of performing SEA were participatory technics, GIS, multicriteria analysis and key actor analysis. Among them, participatory approaches were the most relevant. Quantitative-oriented methods such as SWOT and cost-benefit analysis were considered less relevant. In relation to the method indicated as shared with the analysis of ES, the most representatives were scenario modeling, participatory technics and spatial modeling (Table 3.6).

Table 3.6 View of the actors regarding the advantages and challenges for integrating ES in SEA and spatial planning.

Most frequent method identified in SEA	**Ranking (%)**			**Methods shared with ES analysis**	**%**
	1	**2**	**3**		
Participatory techniques	30.8	23.1	7.7	Participatory techniques	71.8
GIS	10.3	12.8	28.2	Spatial modeling	64.1
Multicriteria analysis	12.8	20.5	15.4	-	-
Key actor analysis	17.9	12.8	10.3	-	-
Vulnerability analysis	5.1	10.3	5.1	-	-
SWOT analysis	5.1	7.7	12.8	-	-
Cost-benefit analysis	2.6	0	5.1	Trade-offs analysis	30.8
Sensitivity analysis	2.6	0	5.1	-	-
Network analysis	0	0	0	-	-
Checklist	0	5.1	0	-	-
Other	5.1	0	2.6	Scenario development	76.9
No response	2.6	2.6	2.6	No relation observed	2.6

3.1.5 Connections and gaps between science and policy and channels of communication and information

The results show a general positive perception regarding the relation science and policy where an effective coordination is particularly seen as a key aspect (35.9%) (Table 3.7). Many actors believed that science complements the spatial planning process (23.1%) and at the same time strengthens the decision process (23.1%) leading to a more informed development of public policies (15.4%).

The actors also defined the main role of research institutions/researchers as mainly offering methodological support (30.8%) and generating a conceptual basis (17.9%), while being part of the decision-making process was almost not mentioned (7.7%).

Table 3.7 View of the actors regarding the science-policy relation and channels of communication/information for integrating ES in SEA and spatial planning.

How important do you think is the science-policy coordination in relation to ES, SEA and spatial planning?	**%**
An effective coordination between science and policy is needed	35.9
Science complements the spatial planning process	23.1
Science strengthens the decision-making process	23.1
Science improves public policies generation	15.4
No answer	2.6
Which do you consider is the role of research institutions/universities in supporting the integration of ES, SEA and spatial planning?	**%**
Offers theoretical and methodological support	30.8
Generates a conceptual basis	17.9
Carries out applied research	17.9
Supports the decision-making process	7.7
Education in spatial planning, SEA and ES	7.7
Disseminates the knowledge and environmental education	5.1
Provides institutional objectivity	2.6
No answer	10.3
Most common channels of communication/information in ES and SEA*	**%**
In the exercise of the profession	71.8
Formal studies: Bachelor's degree, Diploma, Master, PhD, others	59.0

Courses/workshops at the workplace	56.4
Attendance in workshops/conferences/seminars	53.8
Self-taught	33.3
Others	5.1

Regarding the channels of communication and information used by the actors for improving their understanding and knowledge, the most common were associated with the exercise of the profession (71.8%) and formal studies such as master, diploma etc. (59%).

3.2 Case study 2

3.2.1 Content analysis of SEA reports

A total number of 15 SEA reports were considered for implementing the content analysis, which involved five regions in the country (Table 3.8).

Table 3.8 Selected SEA reports for each involved region and planning scale. RLUP: Regional Land-Use plan; IMRP: Inter-Municipal Regulating Plan; MRP: Municipal Regulating Plan.

SEA report	**Region**	**Planning Scale**	**Year**
RLUP Región de Antofagasta	II	Regional	2015
RLUP Región del Maule	VII	Regional	2015
RLUP Región de La Araucanía	IX	Regional	2014
RLUP Región de Magallanes	XII	Regional	2014
RLUP Región de Los Ríos	XIV	Regional	2015
IMRP Oasis Andinos	II	Inter-municipal	2012
IMRP of Curicó	VII	Inter-municipal	2014
IMRP Villarrica-Pucón	IX	Inter-municipal	2015
IMRP Punta Arenas - Río Verde	XII	Inter-municipal	2011
IMRP Borde Costero y Sistema Fluvial Región de Los Ríos	XIV	Inter-municipal	2014
MRP of Mejillones	II	Municipal	2011
MRP of Teno	VII	Municipal	2015
MRP of Cunco	IX	Municipal	2015
MRP of San Gregorio	XII	Municipal	2013
MRP of Río Bueno	XIV	Municipal	2015

3.2.2 Consideration of ES across the SEA process

The findings indicate that ES were present in all the examined SEA reports, independent of the spatial context or the scale of planning. However, the presence of specific types of ES, their frequency and their explicit or implicit recognition show differences across the SEA stages.

In the SEA stage “context and objectives”, the predominant CICES section was cultural ES, which included 53% of all the identified ES groups across the three scales of analysis. The most representative groups in this section were “intellectual and representative interactions” and “physical and experiential interactions”. Second were regulation and maintenance ES representing 33.3% of all ES. This section shows the higher variety of ES groups (6), compared with cultural and provisioning ES (3 each). Some examples of environmental objectives extracted from the SEA reports and related with the performance of ES are “identification of locations for the development of non-conventional renewable energy”, “improvements in the management and protection of water resources” and “preservation of relevant areas for natural and cultural heritage”.

In this SEA stage, it was also evaluated whether relevant ecosystems (expressed as land covers) were considered during the process, and if such information was consistent to be used as a proxy for analyzing the ES context at each planning scale. The results show that only at the regional scale information included in the SEA reports was adequate for a further evaluation of the ES context, mainly as land-use maps (40% of the plans). Regarding inter-municipal and municipal scale, these only provided partial information and in some cases even without any spatial reference.

A final critical point evaluated also at this stage for characterizing the ES context was the link between the SEA report and a set of strategic actions or legal mechanisms considered during the planning process and with potential influence on the performance of ES. The analysis shows that all reports included a range of mechanisms with influence on ES (Table 3.9). The most relevant mechanisms identified across the planning scales were “spatial planning” and “regional strategy for development”.

Table 3.9 Legal mechanisms and strategic actions included by SEA with potential influence on ES at different scales of planning

Policy instrument and strategic actions in SEA reports	Frequency at different scales		
	Regional (%)	Inter-municipal (%)	Municipal (%)
Regional strategy for development	100	80	80
Spatial planning instruments	100	100	100
Municipal development plan	20	0	0
Regional strategy of biodiversity	100	60	60
Regional policies	80	20	80
International agreements	40	40	0
Sectoral policies	40	100	40
Regulation for protected areas	60	60	20
Normative for natural disasters	40	0	0
National environmental policy	20	0	0
Sectoral studies	60	100	60
Indigenous law	0	20	0
Local plans and programs	0	0	40

In the SEA stage “scoping and ES prioritization”, the ES section “regulation and maintenance” was the most frequently identified (61%), particularly within the strategic diagnosis of environmental problems. Moreover, this section presented the highest variety of groups (9) in relation with cultural (4) and provisioning services (5). Some illustrations of environmental problems associated with the performance of regulating and maintenance ES are “water pollution”, “floods and landslides” and “soils with contaminants”. On a lower level of relevance, cultural ES (24.1%) and provisioning ES (15%) were identified.

In this stage, the presence of a formal assessment of ES performance in the reports was also investigated as baseline information for subsequent prioritization. However, even though in some reports ES were explicitly mentioned, no type of ES assessment was found. Only one report presented information on the identification of a set of freshwater ES at the regional scale (RLUP region del Maule).

In the stage “strategic analysis of alternatives”, the consideration of ES in the formulation of alternatives for future development was explored. Here, 100% of the

plans included at least one ES group in the strategic analysis, which was mainly conducted under a scenario assessment approach. In this way, different elements such as sustainability criteria, environmental problems, critical decision factors, and environmental objectives were considered for the development of the scenarios and where ES were included. The use of an assessment matrix instead of the most predominant scenario analysis was only found in one SEA report (MRP of San Gregorio).

In relation with the ES consideration at this stage, the section "regulation and maintenance" showed the highest representation across the scales with 41% of all ES along with the greatest variety of groups (7). The most important group in this section was "liquid flows", while others such as "gaseous/air flows" and "lifecycle maintenance, habitat and gene pool protection" were rarely present. Within the strategic analysis, the section cultural ES was also relevant with 35.5%. Here, the three ES groups present, namely "physical and experiential interactions", "intellectual and representative interactions" and "spiritual and/or emblematic" were equally considered. Provisioning services (23.7%) was less relevant, even though this section showed a higher diversity of ES groups (4) in relation with cultural ES.

In the stage "follow-up", the results indicate that all plans included at least one or more ES in their monitoring and management scheme. "Regulation and maintenance" ES was the predominant section at this stage (42%), as well as the most diverse in terms of groups (7). Here, "liquid flows" was the most important group. The section cultural ES was second (33%), where "intellectual and representative interactions" and "physical and experiential interactions" were the most important groups. Finally, the section provisioning ES represented 25% of all the identified ES, where "biomass" was the most frequently considered group.

Regarding the explicit consideration of ES across scales of planning and SEA stages, in most of the cases ES were mentioned rather implicitly within SEA components such as environmental objectives, environmental problems, among others. For instance, an environmental objective such as "…protection of relevant areas for hydrological regulation such as basin headwaters and wetlands, through

identification and zoning of these spaces...” makes clear reference to regulation and maintenance ES but without an explicit mention.

In terms of explicit mention, the SEA stage “context and objectives” was predominant at the regional scale (23.1%), followed by the inter-municipal scale (11.8%). In contrast, in the stage “scoping and ES prioritization” the explicit mention decreased dramatically (5.3% at the inter-municipal scale), while in all the subsequent stages ES were not mentioned at all, even though ES were included to achieve the targets.

Table 3.10 shows the percentage of explicit consideration of ES in each of the SEA stages and scales of planning.

Table 3.10 Explicit consideration of ES across the SEA stages and scales of planning

SEA stage	Spatial planning scale	Explicit consideration (%)
Context and objectives	Regional	23.1
	Inter-municipal	11.8
	Municipal	0
Scoping and ES prioritization	Regional	0
	Inter-municipal	5.3
	Municipal	0
Strategic analysis of alternatives	Regional	0
	Inter-municipal	0
	Municipal	0
Follow-up	Regional	0
	Inter-municipal	0
	Municipal	0

3.2.3 Consideration of ES across spatial planning scales

Similar to the previous section, the results show that ES were also considered in all spatial planning scales with no exception. Figure 3.4 provides a general view of the consideration of the different ES sections (explicit and implicit integrated) grouped by scale of planning and SEA stages.

Throughout the SEA reports, ES mentions were most frequent at the inter-municipal scale. Cultural ES was the most important section, mainly present in the stage “context and objectives”. The most frequently mentioned CICES groups here

were “physical and experiential interactions” and “intellectual and representative interactions”.

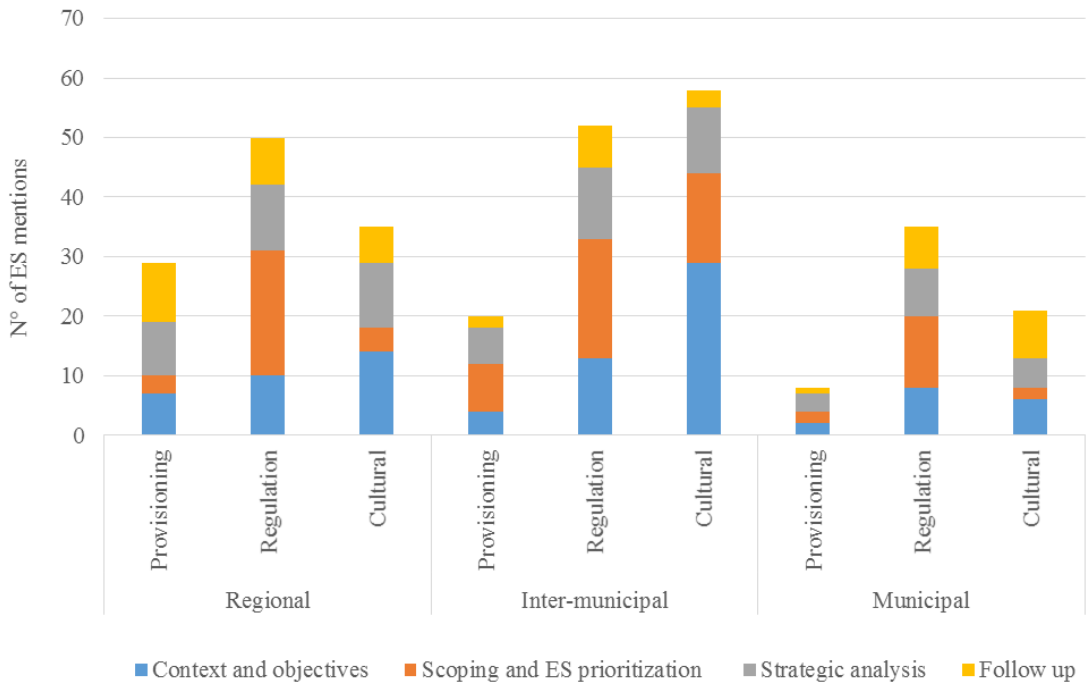

Figure 3.4 ES sections considered at different scales of spatial planning and SEA stages

At this scale, regulation and maintenance ES were also important, mainly included within the environmental problems identified in the stage “scoping and ES prioritization”. Representative groups in this section were “mediation by ecosystems”, “mediation by biota” and “mass flows”. Provisioning ES were less relevant in all scales of planning, where “biomass” and “water provision” were the most important ES groups.

Regarding the regional scale, this shows a clear predominance of regulation and maintenance ES, which were mainly included in the stage “scoping and ES prioritization”. Here, “liquid flows”, “mediation by ecosystems” and “mediation by biota” were the most representatives ES groups. The sections cultural and provisioning

ES were also present, but in a clear lesser frequency than regulation and maintenance ES.

Finally, ES showed the lowest relevance at the municipal scale. The section regulation and maintenance was again the most relevant, with “liquid flows” as the most important group. Cultural ES were second, while provisioning was almost not associated with this level of planning at all.

3.3 Case study 3

3.3.1 Key actors and regional strategic objectives for territorial development

A total of four government institutions were involved as a key actors and six regional objectives for territorial development were addressed which were related to the core topics of the analysis (Table 3.11).

Table 3.11 Key actors and regional strategic objectives included in the case study

Key actor	Regional strategic objective	Core topic of the objective
• Regional Government	• Increasing agricultural productivity	•Natural resources
• Ministry of housing and urban planning (regional office)	• Increasing fisheries and aquaculture productivity	•Natural resources
• Ministry of environment (regional office)	• Increasing irrigation coverage	•Natural resources
• The National Indigenous Development Corporation (national office)	• Increasing water availability	•Natural resources
	• Promoting tourism, ethno-tourism, scientific activities and heritage routes	•Regional identity
	• Promoting the use of non-conventional renewable energy	•Sustainability

3.3.2 Definition of the ecosystem services context

As a first step in the definition of the ES context, the regional land-use was generalized as described in section 2.2.3. Table 3.12 presents the 14 most representative land-use categories and their share of land within the region.

Table 3.12 Regional land-use and contribution per hectare (Ha)

Land-use	Area (ha)	Share of land (%)
Wetland	26,503	0.8
Stunted native forest	87,233	2.7
Old growth native forest	403,404	12.7
Streams of solidified lava	39,556	1.2
Glaciers and perennial snowfields	64,676	2.0
Rivers and water bodies	57,739	1.8
Scrubland	270,443	8.5
Scrubland-grassland	1,086	0.03
Forest plantations	566,920	17.8
Beaches and sand dunes	1,950	0.1
Grasslands	341,076	10.7
Young native forest	491,405	15.4
Croplands	815,756	25.6
Settlements	13,660	0.4
Total	**3,181,405**	**100.0**

The results suggest that mainly ecosystems related to agricultural or livestock areas exist in the region, particularly croplands and grasslands (36,3 %), followed by young and old growth native forest (28%), and finally forest plantations related to species such as *Pinus sp.* and *Eucalyptus sp.* (17.8%).

Regarding the ES associated with each of these land uses, the actors involved identified a total of 27 different types of services according to the CICES typology at class level. The most important land uses in terms of supplying a range of ES were wetlands (22 different ES), young native forest (17 ES) and old growth native forest (16 ES). Figure 3.5 illustrates the distribution of ES by land-use and grouped by ES section for a more comprehensive view.

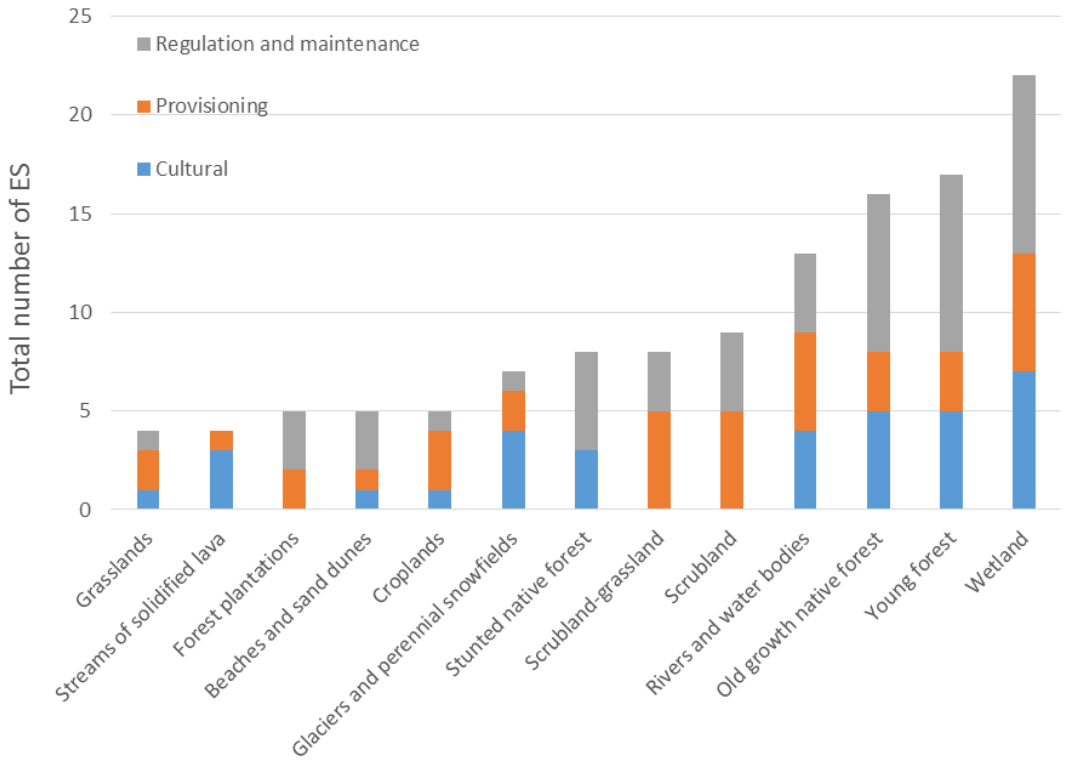

Figure 3.5 ES sections associated with land-use at regional scale

Regulation and maintenance ES was the predominant section (41.5%) followed by provisioning (30.9%) and finally cultural ES (27.6%). In terms of the different ES groups within each section, again regulation and maintenance as well as provisioning were the most diverse (9 groups each), while cultural ES presented only 7 groups.

In addition, the actors also evaluated the contribution of each land-use in terms of the benefits and beneficiaries they provide in the regional context. Thus, 49 different types of benefits were mentioned, where employment (40 times mentioned), personal welfare (23), leisure and recreation (22), scientific (15), nutrition (15) and soil quality (13) were the most relevant in term of frequency. Once again, wetlands (36 different benefits), old growth native forest (30 different benefits) and young native forest (26 different benefits) were the land uses with a more significant contribution (full list of benefits in Appendix 3).

With respect to the beneficiaries, 39 different types were recognized. The most frequently mentioned was local population (94 times mentioned) associated with ES

such as surface water for drinking and non-drinking purposes, flood protection, and holy places, among others. Second was regional population (50 times mentioned) and associated with ES such as hydrological cycle and water flow maintenance, cultivated crops, and biomass-based energy, among others. Finally, third was the industrial sector (19 times mentioned) related to ES such as bio-remediation, fibers and other materials for direct use or processing, and water for non-drinking purposes, among others (full list of beneficiaries in Appendix 3).

As in the previous case, the major contributions to the beneficiaries were related to old growth native forest (28 different beneficiaries), wetlands (27 different beneficiaries), and young native forest (22 different beneficiaries).

3.3.3 Prioritization of ecosystem services for regional planning

Out of the list of 27 ES, the most important were prioritized based on their relevance in order to achieve the regional objectives and the impacts of such objectives over determined ES or a bundle of them.

Table 3.13 lists the evaluated ES along with their respective prioritization scores under both approaches for standardization.

Table 3.13 Prioritization scores for evaluated ES. MSA = maximum score approach, SRA = score range approach.

Ecosystem service	Priority MSA	Priority SRA
Surface water for drinking	0.480	0.370
Surface water for non-drinking purposes	0.624	0.547
Animals from in-situ aquaculture	0.344	0.204
Wild animals and their outputs	0.293	0.140
Buffering and attenuation of mass flows	0.269	0.112
Chemical condition of freshwaters	0.522	0.421
Mass stabilization and control of erosion rates	0.800	0.760
Flood protection	0.346	0.208
Hydrological cycle and water flow maintenance	0.515	0.415
Mediation of smells/noise/visual impacts	0.236	0.072
Educational	0.269	0.114

Physical use of land-/seascapes in different environmental settings	0.227	0.063
Aesthetic	0.285	0.132
Filtration/sequestration/storage of pollutants	0.227	0.060
Scientific and academic interest	0.558	0.469
Materials from plants, algae and animals from agricultural use	0.574	0.487
Fibers and other materials from plants, algae and animals for direct use or processing	0.369	0.233
Experiential use of plants, animals and land-/seascapes in different environmental settings	0.285	0.132
Heritage, cultural	0.352	0.212
Plant-based resources	0.377	0.243
Wild plants, algae and their outputs	0.227	0.060
Tsunami and storm protection	0.193	0.020
Maintaining nursery populations and habitats	0.847	0.813
Entertainment	0.496	0.388
Global climate regulation by reduction of greenhouse gas concentrations	0.218	0.050
Micro and regional climate regulation	0.439	0.321
Sacred and/or religious	0.352	0.212

A comparison of the performance of both approaches for standardization revealed no significant differences among them (P-value = 0,3020), therefore both are a proper indicator of the priority values.

From this dataset a ranking was generated with the first 10 ES, where “maintaining nursery populations” and “mass stabilization and control of erosion rates” were the most relevant, both contained in the regulation and maintenance section. In the first case, the major contribution to the aggregated score was a high value of “impact”, which increased its priority. In the second case, the ES presented the highest score for relevance, increasing also its overall priority. The ES with the lowest priority value were “micro and regional climate regulation” and “surface water for drinking”, the first included in the regulation and maintenance section and the second in the provisioning section.

Figure 3.6 shows the priority values for each of the first 10 ES, including the impact and relevance scores. Since both approaches of standardization are suitable, the results of MSA were used.

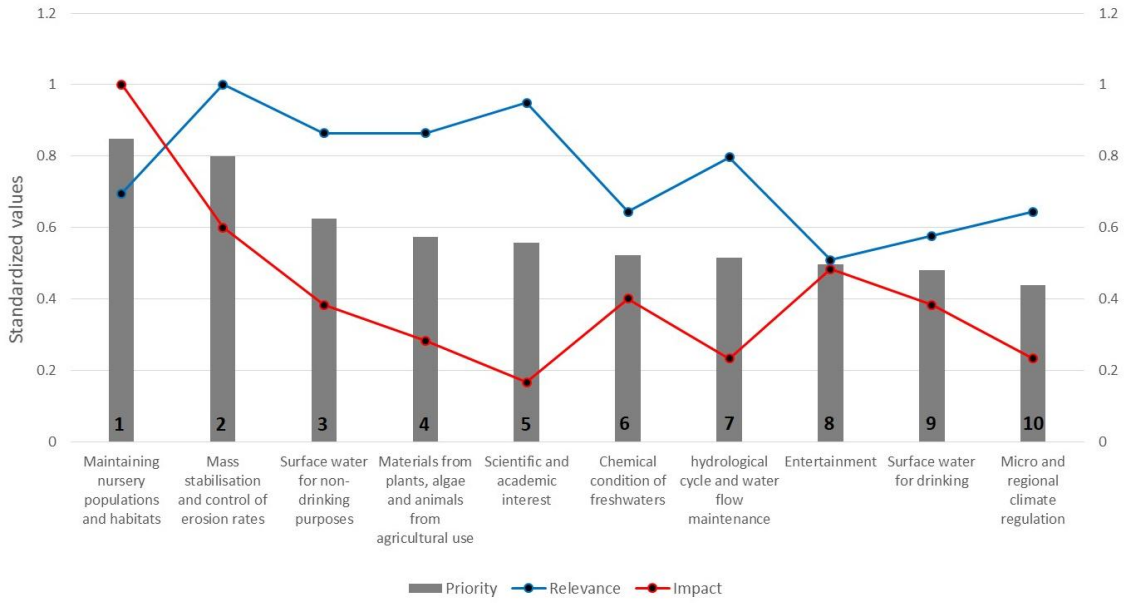

Figure 3.6 Performance ranking of first 10 ES in terms of priority values. The numbers at the bottom indicate the position of the ES in the ranking of priority.

The criterion “relevance” represents the greatest contribution to the overall score in all the cases, except in the ES “maintaining nursery populations”, where the criterion “impact” is the most relevant.

Additionally, provisioning was the most representative section, with 50% of all 10 ES. However, the first two positions in the ranking correspond to the regulation and maintenance section, which represents 30% of the 10 ES. In the cultural ES section, this is represented by only 20%, with prioritization values from moderate to low.

4 DISCUSSION

4.1 General strengths and limitations of the methodological approach

Throughout this research three main methodological approaches were applied, i.e. 1) one-time survey based on a questionnaire application, 2) content analysis of SEA reports, and 3) participatory work with key actors in spatial planning and environmental assessment. These approaches were selected given a number of advantages such as their quick and easy application over a short period of time, especially in the case of the questionnaire. They also offer a robust but flexible approach, which allows combining both qualitative and quantitative analyses making use of existing knowledge that facilitates focusing in a more accurate way with respect to the objectives. Finally, they are affordable in logistic and economic terms (Hsieh and Shannon 2005; Levin 2006).

Regarding the main limitations, in all the cases a snapshot of the current situation was obtained, but the results might differ if the analyses are implemented at a different time. This is particularly relevant for the questionnaire application and the participatory work, where the participants might quickly change their current role or affiliation. Another limitation is related to possible bias from the researcher side at the moment of performing the content analysis. Some examples of inherent sources of bias are provided by Hsieh & Shannon (2005), who emphasize that evidence supporting the background theory could be considered more strongly by a researcher than the evidence which does not, and also that an analysis purely based on the theory might overlook contextual elements of the object under investigation.

A final but critical limitation in this research is the issue of representation and validation. In the case of the questionnaire application and participatory work, a reduced number of participants was involved given the broader scope of the applied approach. Thus, actors with an important role in real spatial planning and decision-making were excluded such as indigenous people, NGOs, land owner associations, and other sectoral departments from the government (MMA 2015). In relation to the number of examined SEA reports, a similar situation can be described. A reduced

number of reports was selected based on their availability, timeliness, level of progress and spatial representativeness in terms of scales of planning.

Therefore, even though the purpose of the methodological approach was to provide an overall picture of the current state instead of carrying out a representative sample, the revealed limitations should be taken into account in future studies. Previous works have been developed under similar limitations in terms of representation, but providing significant insights on the integration of ES in SEA (Noble et al. 2012; Baker et al. 2013; Partidario and Gomes 2013; Casado-Arzuaga et al. 2013; Mascarenhas et al. 2015). However, in all the cases the results should be carefully interpreted.

Regarding the validation of the results, most of the work was developed in collaboration with the actors involved in this research. However, given time restrictions, it was not possible to validate all results with the actors but instead an expert support team was called in. For instance, the results of case study 3 were generated and validated during the workshops with the participants. Nevertheless, the final prioritization values were obtained and discussed only among the experts and without involving the government actors. The main reason of this was that the research was not carried out within the framework of a real planning process, which makes it more challenging to ensure the participation of all actors throughout the whole study.

In all the cases, in a real planning process it is strongly recommended to engage the participants beyond the identification of ES by also including their visions during prioritization, development of scenarios and validation, as well as in the strategic development and implementation process (Cowling et al. 2008).

4.2 From multi-actor understanding and network relations to the integration of the ecosystem services approach at multiples scales of spatial planning

The network relations among the actors and their understanding of ES and SEA under an integrated framework of spatial planning show clear differences in terms of structure. SEA appears as a more consolidated concept among the involved actors,

who also presented a more cohesive arrangement with respect to the keywords recognized in common. In contrast, the ES concept revealed two separated groups, where research institutions were slightly disconnected from the other type of actors.

One possible reason is that SEA has been included in the compulsory normative for all spatial planning in Chile since 2010 (Rozas-Vásquez et al. 2014), while the integration of ES is still mentioned only as a recommendation in guidelines and strategies (e.g. MMA 2015). Hence, during the last seven years, SEA has involved a range of actors throughout the elaboration of different spatial plans, thus increasing and distributing the knowledge about this instrument throughout the country and at multiple scales.

In relation to the recognized keywords, in most of the cases these were correctly connected with the mainstream concepts in SEA and ES. However, the understanding is clearly unequal among the different actors, and misconceptions about what SEA and ES are or are not still exist. Consequently, a collective multi-actor understanding is a critical need in the Chilean context for promoting and effective adoption of the ES approach and its integration in SEA and spatial planning (Acharibasam & Noble 2014; Grunewald & Bastian 2015).

Regarding the identification of possible bridges actors, in both SEA and ES networks, government institutions were the most relevant. Certainly this type of actor has a stronger influence on the flow of information than others, and therefore is more suitable for connecting a range of actors within the network. In contrast, research institution showed the lowest relevance for the flow of information within both networks.

Even though the ES concept has been only recently included in guidelines for sustainable spatial planning in Chile (MMA 2015), a general consensus by the actors exists regarding the relevance of integrating ES in SEA for enhancing the planning process. This can be confirmed in practice after analyzing the elaboration of SEA reports at different scales of planning, where the ES concept is present in each of the stages of the SEA process and across all the scales, and also when exploring the relations between regional development objectives and their dependence on a range

of ES. In this sense, for most of the actors, development and human well-being are strongly related with an appropriate planning and management of a bundle of ES in a multifunctional landscape, as pointed out also by a number of scholars (e.g. Foley et al. 2005; Laterra et al. 2012). Nevertheless, previous research in Chile suggests a degree of discrepancy between the perceptions of the actors and some subsidies from government, which support productive monocultures for promoting development (Pena-Cortes et al. 2011). Certainly, these discrepancies could be generated by scale issues, since ES supply and demand vary in a range of spatial and institutional levels, where diverse stakeholders might add different values to ES based on their cultural or social background, as well as their economic interests (Hein et al. 2006; de Groot et al. 2010).

In addition, a lack of a logic and structured connection was observed between the different SEA stages and the presence of key ES that play the role of linking each of those stages. An effective consideration and management of priority ES for development then becomes unclear, and the possibilities of SEA for integrating ES in spatial planning decrease given this critical aspect (Partidario 2012). However, despite this situation, the overall picture obtained from the main actors involved in the spatial planning and environmental assessment process shows an increasing level of awareness concerning these issues. Hence, this paradigm change might open important opportunities for this integrated framework.

Regarding the planning scales and their relation with specific ES, clear priorities for certain ES sections at different scales were observed, which suggest a connection with the planning scope and focus. For instance, at the regional scale the emphasis is on territorial development. Results show that regulating ES were the most important at this scale, and particularly hydrological services. This is possibly because they provide the basis for a good performance of all the other ES sections (Jin et al. 2015), especially in terms of the quality and amount of benefits provided by provisioning and cultural ES. At the inter-municipal scale, the emphasis is on the urban-rural area that functionally connects neighboring municipalities. Here, the gradient between urban areas mixed with natural and semi-natural landscapes, as well as an important

presence of population and stakeholders, makes cultural ES the most relevant, which is in agreement with MA (2005). Regulating ES were also relevant at this scale, particularly landslide protection and flood regulation, possibly given the need to prevent potential damage to the inter-municipal connectivity and industrial facilities located in the area. Finally, at the municipal scale the focus is entirely on urban areas. Here, regulating services were the most important, especially the ones related to flood regulation in order to prevent damage to the associated infrastructure.

Throughout the analysis, regulating ES were overall the most relevant in all planning scales, in contrast to previous studies that indicated provisioning as the dominant ES (Foley et al. 2005; Rodríguez et al. 2006; Martín-López et al. 2014). On the one hand, these results are consistent with Castro et al. (2014), who reported the relevance of regulating ES for different stakeholders after analyzing the preferences in a range of landscapes. However, on the other hand, in the case study in La Araucanía region, provisioning ES was the most representative section after a prioritization process, though closely followed by regulating ES. A possible explanation is the type of source of information utilized in each case. In the first case, a set of SEA reports was used as input, which are mainly focused on environmental and sustainability issues. Therefore, it is more likely that regulating and cultural ES present a higher importance than provisioning ES. In the second case, ES were identified and prioritized based on the knowledge and views from key actors in spatial planning and environmental assessment. Then, provisioning ES increased its relevance given its contribution to the regional development in economic terms (Rodríguez et al. 2006).

Even though the ES concept seems to be an important approach for enhancing the planning process, there are still some challenges that need attention in order to increase the plausibility of this integrated framework. One critical aspect is a lack of institutional guidelines and methodological support, which means that some actors perceive this integration as an obstacle instead of an advantage for a quicker and effective planning process (Rozas-Vásquez et al. 2017). These perceptions are shared by previous works that mention some critical constraints for moving these ideas from theory to practice. The most important are related to scientific uncertainties and

diverse conceptual understandings from different actors, which result in inconsistent terminologies and definitions (Nahlik et al. 2012; da Silva et al. 2014; Barnaud and Antona 2014), thus hindering the decision-making process.

Another critical aspect is the very low frequency of explicit consideration of ES across the spatial planning and SEA process. Similar findings have been reported by Honrado et al. (2013), Rega & Spaziante (2013), Geneletti (2015), and Mascarenhas et al. (2015), who analyzed a range of policies and programs focusing the attention on the link ES and SEA, as well as in other studies with a more general scope but also oriented to ES (Hauck et al. 2013; Costanza et al. 2014). In this sense, a key task in SEA is to explicitly address potential trade-offs of the development options that could affect the sustainability of the spatial plan (Geneletti 2015). Thus, the explicit integration of ES in SEA might enhance the strategic analysis of the options as well as facilitate the identification of environmental problems (Partidario 2012). In contrast, a lack of explicit consideration might make the contribution of ES unclear and decrease the expected advantages of this integrated framework.

4.3 Contribution for supporting decision-making in SEA and spatial planning

The main findings of this research highlight that: 1) there is a positive global perception about the integration of ES in SEA and spatial planning, 2) the presence and performance of ES were identified as an important requirement for the achievement of development objectives, and 3) a range of ES were present across all the SEA stages and spatial scales. Therefore, the results of this research provide enough evidence to illustrate the contribution of the ES approach for supporting SEA and the spatial planning process.

In this sense, an effective and consistent integration of the ES approach in spatial planning does not rely on a specific planning scale, but rather on the possibilities offered by the existing policy instruments and guidelines for spatial planning and SEA. Similar thoughts are shared by Albert et al. (2014), who mention that a successful integration of ES mainly depends on the flexibility of the planning systems in each country. In rigid systems, a formal integration of ES would require a

political instruction and active support over a long period. In contrast, in planning contexts with the presence of active and committed stakeholders, this integration has many more possibilities.

In a global context, the implications of including ES for supporting SEA are discussed in detail by UNEP (2014). In this guideline, the relevance of SEA in supporting policy makers in the systematic analysis of environmental impacts at high levels of policy and planning processes is emphasized, reducing the need for mitigation through EIA at project levels. Then, the consideration of the ES concept offers a more holistic integration of the socio-ecological system, facilitating communication and understanding by diverse stakeholders and decision makers (Fürst et al. 2013a). In addition, Geneletti (2011) makes explicit the contribution of the ES approach for fulfilling all the performance criteria for a high-quality SEA according to the International Association for Impact Assessment (IAIA 2002). However, despite the advantages offered by the ES approach, there is still a low level of explicit integration in both spatial planning regulations and practical implementation (Honrado et al. 2013; Mascarenhas et al. 2015; Rozas-Vásquez et al. under review).

In the Chilean context, this situation was analyzed by Rozas-Vásquez et al. (2017), where lack of guidelines from government and methodological support are seen as major challenges for implementing this integrated approach. Moreover, the planning system presents a very limited scope for including environmental and sustainability issues, since this is mostly oriented to urban development. The only planning instrument where sustainability takes relevance beyond urbanistic matters is the regional land-use plan (SUBDERE 2011). Nevertheless, to date there are no available examples to our knowledge where ES have been used for supporting planning decisions. Similarly, SEA also does not formally include the ES concept, and examples of their consideration are scarce or nonexistent. Yet, the ES concept is becoming more significant, being recently included in national guidelines and currently considered for the development of policies, thus increasing the interest from SEA practitioners, planners and decision makers (Rozas-Vásquez et al. 2017).

One critical aspect for the success of this integrated framework is the development of an appropriate governance scheme, which includes an inter-and transdisciplinary approach in a context of co-evolution between science, policy and practice (Österblom et al. 2010; Primmer and Furman 2012; Fürst et al. 2013b). In the same way, the establishment of interdisciplinary teams appears crucial for addressing the complexity of socio-ecological systems during the planning process (Ives et al. 2015), thus facilitating a shift from the dominant urbanistic view to one oriented to the sustainable development of cities and regions.

In order to facilitate the understanding of this integrated approach, particularly by practitioners and decision makers, the conceptual framework presented in Figure 4.1. is proposed. This framework shows how the consideration of the cascade model adopted by CICES (Haines-Young and Potschin 2010) might support both spatial planning and SEA at the different stages of development. This model was applied because it provides a clear and general view of the interactions present in a socio-ecological system involving from ecological structures to benefits and values for human well-being. In the upper and lower part of the framework, general steps for the spatial planning and SEA processes are illustrated, which can be adapted according to the specific context of application.

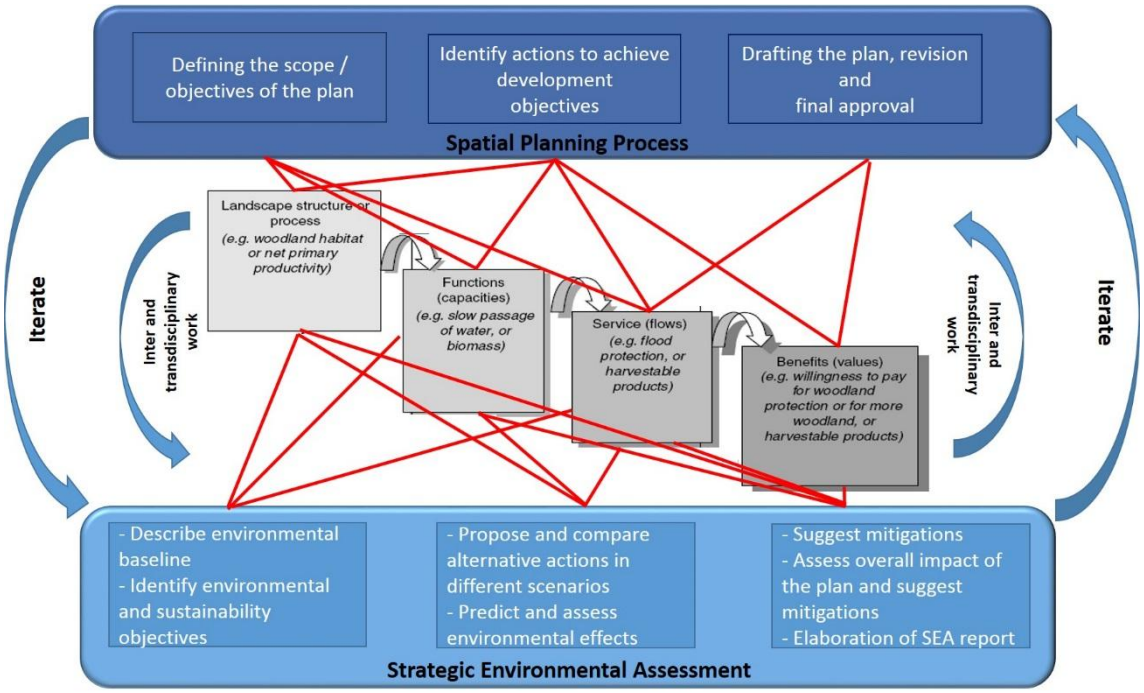

Figure 4.1 Overall view of the integration of ES in SEA and spatial planning. Adapted from Haines-Young and Potschin (2010).

Thus, each step in the cascade can provide valuable information for enhancing both processes, while also facilitating the interaction and avoiding redundancies between SEA and spatial planning.

Finally, since this integrated approach is still in an early stage of development in Chile, a gradual process is recommended, starting with the incorporation of ES at the regional scale. This scale is suggested given advantages such as 1) the regional plan is the only spatial planning instrument that includes sustainability under a territorial concept (SUBDERE 2011), 2) at the regional scale many sectoral polices and strategies for development are established and coordinated, which might promote collaborative work in a multi- and transdisciplinary way (Fürst et al. 2013b), and 3) the regional scale is closely linked with national goals and guidelines, and at the same time it may set orientations for spatial planning at lower levels (Mascarenhas et al. 2015), hence it can promote and facilitate the integration of ES at multiple scales.

4.4 Transferability of the integrated framework in a broader context

At present, explorations on the degree of integration of ES in SEA and spatial planning have been mainly conducted in the European Union (e.g. Honrado et al. 2013; Mascarenhas et al. 2015). Overall, the conclusions indicate a scarcity of this type of analysis and the low level of explicit integration of ES, highlighting the relevance of the planning context, cultures and political realities. Taking into account these last aspects, in regions such as Latin America, SEA has not yet been systematically adopted under a common directive as in the European Union. Each country decides on its own implementation strategy and whether it has a legal basis or not (Loayaza 2012). A direct transfer of the results, conclusions and possible courses of action then becomes unfeasible given the particularities of the different planning and environmental assessment contexts. In addition, even though countries such as Chile, Colombia, Mexico, Brazil, among others, present promising examples in the application of SEA (Fischer and Montaño 2014), there is still disparity in the availability of data within each country as well as among them. A similar situation is also described in other regions such as Africa (Inkoom et al. 2017). In this sense, as pointed out by Kruse (2017), it is not always possible to have a complete dataset for evaluating ES at different scales. Thus, especially in data-scarce regions, value-transfer or look-up tables are a common source of information. In all the cases, this information should be carefully selected and revised for more accurate and plausible results.

Another critical aspect to consider for facilitating the transferability of new knowledge and guidance for supporting decision-making is the need to develop a common understanding along with a set of concepts widely shared by the actors involved in the planning process. For this, it is also crucial to implement standardized ES evaluation processes based on a conceptual framework that is robust and accepted by the practitioners (de Groot et al. 2010; Rozas-Vásquez et al. 2017). Certainly, managing these aspects is not an easy task since this integrated framework still presents many challenges at theoretical and methodological levels. However, important initiatives such as CICES, IPBES, TEEB, and the Ecosystem Services

Partnership (ESP), are working today to provide a global platform for communication and support (de Groot et al. 2010).

In spatial planning, and particularly in regional planning and land-use policies, a successful transferability also demands a cross-sectoral coordination (Fürst et al. 2013b). Here, the need for a common understanding becomes relevant once again, as well as the development of approaches and the definition of suitable indicators beyond a particular case study (Fürst et al. 2014).

The approach proposed in this research presents high possibility of being transferred to different contexts with the aim of exploring the current status of the planning system and the options for implementing an integrated framework of SEA-ES. This because each of the three applied steps is based on widely known and easy to implement methodologies such as network analysis, content analysis, and identification and participatory work with key actors. However, the results must be carefully evaluated in each context by considering physical, environmental socio-economic and institutional factors (Geneletti et al. 2017). Therefore, it is strongly recommended to generate place-specific information that captures important local issues by using the methodological structure proposed in the three-steps approach applied in this research.

5 CONCLUSIONS AND OUTLOOK

The consideration of the ES concept for supporting real-world decision-making is rapidly gaining interest in science as well as in policy development. This research confirms this idea by showing that the integration of the ES approach for supporting decisions is highly appreciated by the actors responsible for the planning and environmental assessment process in Chile. In addition, a range of ES was always implicitly present in all the SEA stages and scales of spatial planning examined as a key requirement for achieving the environmental objectives and addressing the environmental problems of the respective spatial plans. Finally, the presence and performance of ES were identified as crucial for the success of a number of development objectives stated in the case study at the regional level. Therefore, it can be concluded that preconditions exits in Chile for a formal integration of ES in SEA and spatial planning, which is today in an initial stage of progress.

One critical aspect is that this process is still mainly science driven rather than a national initiative driven by the government, even though global platforms such as IPBES provide support to decision-makers for increasing the awareness on the relevance of ES for achieving sustainability goals. The success of this integrated approach strongly depends on an appropriate governance scheme that promotes a close science-policy interaction as well as collaborative work and learning. The latter is particularly relevant for facilitating a collective understanding and thus its plausibility. Another critical aspect is the lack of an explicit consideration of ES when carrying out the SEA and spatial planning process. Therefore, unless this key issue is addressed, the potential advantages offered by this integrated approach might decrease given a deficient practical implementation.

As mentioned earlier, an appropriate governance scheme is crucial for the implementation of this framework. However, important is also the relevance of having informed stakeholders who are able to demand an effective planning and management of ES through a bottom-up process, as well as prepared and conscious decision makers and public officers. Furthermore, interdisciplinary teams need to be

established at the moment of performing the planning and SEA process in order to address more effectively the inherent complexity of socio-ecological systems, thus, preventing environmental problems and social conflicts. With such a scheme, a substantial discussion may be fostered for dealing with the task of moving spatial planning from the traditional urbanistic paradigm to one focused on the sustainable development of cities and territories.

Finally, this work now focuses on exploring the options to represent as explicitly as possible the links between ES and SEA which would facilitate and make more feasible the implementation of this integrated approach for supporting decisions in spatial planning. For that it is considered the use of the ecosystem services cascade suggested in CICES (Haines-Young and Potschin 2010), which offers a complete view of strategic aspects for spatial planning, from the biophysical structures present in a territory to the benefits provided by different ES to the society. In addition, we are also including participatory development of spatial scenarios is also considered as a fundamental step for a more concrete link between ES and SEA.

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7 APPENDICES

Appendix 1: Rozas-Vásquez et al. 2017

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Multi-actor involvement for integrating ecosystem services in strategic environmental assessment of spatial plans

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ABSTRACT

Integrating an ecosystem services (ES) approach into Strategic Environmental Assessment (SEA) of spatial plans potentially enhances the consideration of the value of nature in decision making and policy processes. However, there is increasing concern about the institutional context and a lack of a common understanding of SEA and ecosystem services for adopting them as an integrated framework. This paper addresses this concern by analysing the current understanding and network relations in a multi-actor arrangement as a first step towards a successful integration of ES in SEA and spatial planning. Our analysis focuses on a case study in Chile, where we administered a questionnaire survey to some of the main actors involved in the spatial planning process. The questionnaire focused on issues such as network relations among actors and on conceptual understanding, perceptions and challenges for integrating ES in SEA and spatial planning, knowledge on methodological approaches, and the connections and gaps in the science-policy interface. Our findings suggest that a common understanding of SEA and especially of ES in a context of multiple actors is still at an initial stage in Chile. Additionally, the lack of institutional guidelines and methodological support is considered the main challenge for integration. We conclude that preconditions exist in Chile for integrating ES in SEA for spatial planning, but they strongly depend on appropriate governance schemes that promote a close science-policy interaction, as well as collaborative work and learning.

Appendix 1: Rozas-Vásquez et al. (under review). Journal: Land use Policy

Integration of ecosystem services in strategic environmental assessment across spatial planning scales

Abstract

Spatial planning is a key policy instrument for decision-making which drives future changes to land systems, and subsequently to the quality, quantity and spatial distribution of ecosystem services (ES). Supply and demand of ES vary from local to regional and global scales affecting a wide range of stakeholders. Therefore, a strategic analysis of the potential impacts is highly relevant. Strategic environmental assessment (SEA) is considered a suitable instrument for analyzing these impacts as well as for integrating ES during the planning process given its focus on sustainability and environmental aspects at strategic levels. However, an essential task consists of testing the applicability of the SEA-ES framework in real-world spatial planning. The objective of this research is to explore how ES have been considered in the development of spatial plans at different scales by considering a sample of SEA reports. We focused on a case study in Chile, where we conducted a content analysis of different stages of the SEA process at regional, inter-municipal and municipal planning scales. Our results demonstrate that ES were always present across each SEA stage and planning scale. Additionally, we suggest a relation between specific ES and the scope and focus of the different spatial planning instruments. Although ES are clearly necessary for achieving a number of development objectives and dealing with a range of environmental problems, a critical aspect is the lack of an explicit consideration which might decrease the potential advantages offered by the integrated framework SEA-ES.

Keywords: Spatial planning, strategic environmental assessment, ecosystem services, multiple scales of planning, Chile

1. Introduction

Land is one of the most important and limited resources and provides a range of essential ecosystem services (ES) for human well-being (Fürst et al., 2013). However, increasing human demands for natural resources, cultivable lands, and a variety of ES along with intensive changes to biogeophysical structures and processes might negatively impact the development of societies (Mooney et al., 2009; Sonter et al., 2017). In this context, land management and policy decision-making are recognized as the most important drivers for these impacts and the subsequent losses in the ES supply at multiple scales (Schosser et al., 2010; Verburg et al., 2015). Spatial planning is a key instrument for decision-making in terms of coordinating human activities and their influences on land systems, and subsequently on the quality, quantity and spatial distribution of ES (Geneletti 2011; 2013; Mascarenhas et al. 2015). Including ES in spatial planning is considered to be a suitable approach for informing, communicating and facilitating consensus building among different actors because it provides a basis for multi-sectoral and interdisciplinary collaboration (Albert et al., 2014; Galler et al., 2016).

An essential aspect in the integration of ES in spatial planning is the issue of scale and the multiple levels of decision-making involved. Supply and demand of ES, as well as their interrelations, vary from local to regional and global scales, which at the same time affect a wide range of stakeholders (Geijzendorffer and Roche, 2014; Hein et al., 2006). Thus, spatial planning has the potential to mainstream ES across multiple governance levels, since it provides

an umbrella for coordinating different policy instruments in a more strategic manner (Greiber and Schiele, 2011). As discussed by Geneletti (2011) and Mascarenhas et al. (2014), the integration of ES into spatial planning should consider existing instruments, such as strategic environmental assessment (SEA). This is considered a suitable instrument for integrating ES given its strategic role in the development of policies, plans and programs (Geneletti 2011; Partidario & Gomes 2013; Rozas-Vásquez et al. 2017). The considerable benefits of SEA for including ES in strategic decisions have led to a rapid increase in the number of scientific papers, analyses of legislation and practices (Geneletti, 2015). Similarly, international organizations such as OECD and DAC (2008), UNEP (2014) and World Resource Institute (Landsberg et al., 2013) have developed guidance material focused on the integration of ES in environmental assessment (Baker et al., 2013).

An essential task consists of testing the applicability of the SEA-ES framework in real-world spatial planning and environmental policy making (MA, 2005; Ruckelshaus et al., 2015). Some studies propose the use of content analysis and recommend it for exploring the degree of integration of ES in decision-making (e.g. Honrado et al. 2013; Rosa & Sánchez 2015; Mascarenhas et al. 2015; Diehl et al. 2016). Krippendorff (2004) defines content analysis as a research technique for making replicable and valid inferences of answers to specific research questions from textual information as provided through SEA reports. These inferences are more systematic, explicitly informed and verifiable than a normal read of a text. Consequently, content analysis of SEA reports is a valuable approach for helping to clarify how this process supports the integration of ES in spatial planning. This is highly relevant for evaluating opportunities and challenges for practical implementation. A critical aspect in this approach pointed out by Honrado et al. (2013), is the mainly implicit consideration of ES along the SEA reports. Thus, special attention needs to be paid to this aspect when conducting the content analysis.

The objective of our study is to explore how ES have been considered in the development of spatial plans at different scales of planning. We analyzed a sample of SEA reports in order to answer the following research questions:

- i) How has the ES concept been addressed throughout the SEA process?
- ii) Does the spatial planning scale affect the consideration of specific (groups of) ES?
- iii) Is there a planning scale that appears more suitable for the integration of ES?

Chile was selected as a case study because it meets three fundamental criteria. First, the administrative system is based on a tiered structure with national, regional, provincial and municipal levels (OECD, 2013). This allows exploring the ES integration at different scales of planning. Second, SEA has been mandatory in Chile for all levels of spatial planning since 2010 (Rozas-Vásquez et al., 2014). Hence, a sufficient number of recent SEA reports is available. Finally, the concept of ES has progressively been introduced into the political discourse in Chile to the point that in 2015 it was included in a national guideline for sustainable spatial planning (MMA, 2015).

For a consistent classification of ES, we used the Common International Classification of Ecosystem Services (CICES) (Haines-Young and Potschin, 2013). CICES classifies ES in three sections, mostly in concordance with those ES groups defined by the Millennium Ecosystem Assessment in 2005 and currently also in use by IPBES (Díaz et al., 2015): 1) provisioning, 2) regulation & maintenance, and 3) cultural (supporting ES were excluded in CICES). Each section is hierarchically structured for its assessment into division, group, class, and class type where it is possible to increase the detail of the ES classification in relation to the different spatial and thematic scales under analysis (Haines-Young & Potschin 2013; Díaz et al. 2015).

2. Methodology

2.1. Study area

Chile is located in South America, bounded by the Pacific Ocean in the west, the Andes mountain range in the east, the Atacama Desert in the north and the Chilean Antarctic in the south (Figure 1). It extends over 4,300 km and a it presents a high variety of landscapes and biodiversity with unique autochthonous species given its location as a biogeographic island (Moreira-Muñoz, 2011; Squeo et al., 2012).

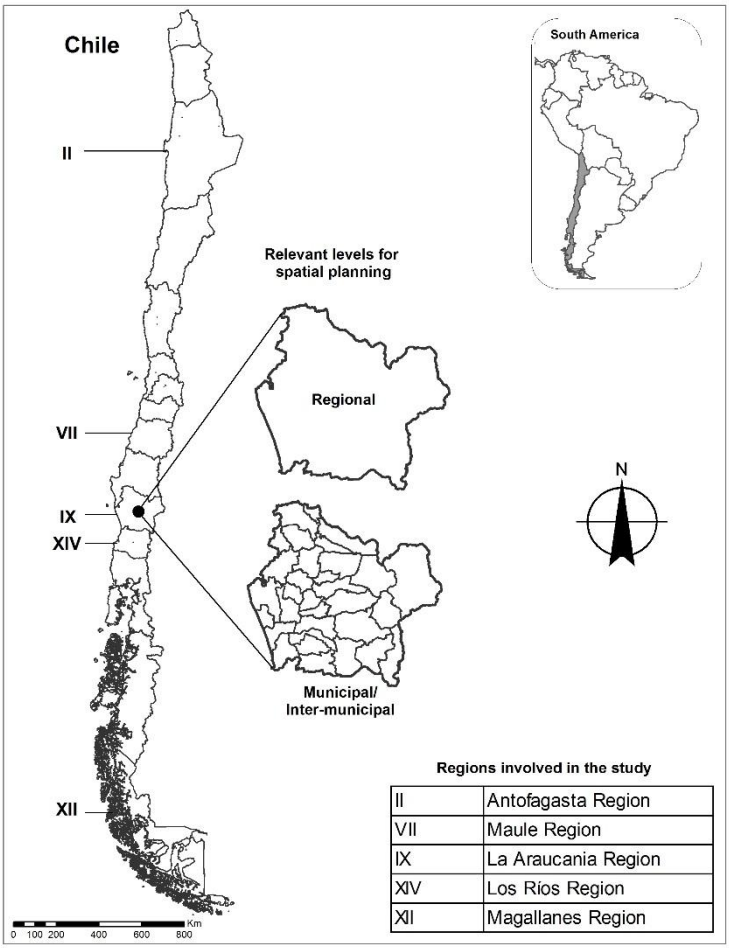

Figure 1. Chile and the main spatial planning levels using La Araucanía region as example. The numeration of the regions is not consecutive because in 2007 two of them were split.

In Chile, until 2009 the integration of environmental objectives and impact assessment in the spatial planning process was included only through a standard environmental impact assessment (EIA). However, in 2010 EIA was replaced by SEA, which is today mandatory for the elaboration of any policy or plan, allowing the incorporation of environmental criteria for sustainable development (Rozas-Vásquez et al., 2014). SEA is applied for spatial planning instruments from regional to municipal level (it also includes some specific sections within the municipal level), as well as for the zoning of the coastal areas and integrated watershed management plans (MMA, 2012). Table 1 provides an overview on the most relevant spatial planning instruments applied in Chile.

Table 1. Overview of spatial planning instruments in Chile and their role.

Planning Level	Instrument	Role
Regional	Regional Land-Use Plan	Involves the complete region; its role is to identify potentials and limits for development by considering the achievement of the economic, social, cultural and ecologic objectives proposed by the Regional Strategy of Development[1] but in a spatially explicit way.
Inter-municipal	Inter-Municipal and Metropolitan Regulating Plan	Regulates the physical development in urban areas between two or more municipalities and the rural space which connects the urban centers.
Municipal	Municipal Regulating Plan	Determines infrastructure location, urban limits and population densities. Promotes functional relations and connectivity across the municipal territory but is focused on urban questions.

Source: own elaboration based on MINVU (2011) & OECD (2013).

[1] The Regional Strategy for Development is a navigation chart with orientations of where to go and how to reach a desirable future based on a regional diagnosis. It states priorities, courses of action and strategic objectives in a region but without explicit spatial considerations.

A major concern in the current SEA application during the elaboration of spatial plans is a lack of approaches which allow combining nature conservation and territorial development by adding value to the nature for the society in the sense of a socio-ecological system (Rozas-Vásquez et al., 2017). For this reason, the ES approach has been formally included in national guidelines for sustainable spatial planning (MMA, 2015), but its real consideration has not yet been analysed.

2.2. Framework for analyzing SEA reports

In this research we analyzed a set of SEA reports at regional, inter-municipal and municipal spatial planning scales. The methodological approach consisted of a content analysis of different stages of the SEA process. For each, we formulated analytical questions aimed to explore both the explicit and implicit consideration of ES and to reveal if they are more relevant or consistently considered at a specific scale of planning. To avoid terminology restricting the explanatory power of our study, we extended the analysis to related terms such as "environmental services", "environmental functions" and "natural capital" usually used interchangeably to make reference to ES (Lamarque et al., 2011; Rozas-Vásquez et al., 2017).

The analysis of the SEA reports was based on a modified version of the approach proposed by Geneletti & Zardo (2016b), where a "direct content analysis" was performed. This type of content analysis is conducted in a more structured process than a traditional content analysis by using existing theories or previous research. While traditional content analysis avoids using preconceived categories, direct content analysis makes use of the available knowledge that helps to focus the research questions as well as to identify key concepts or variables throughout the documents (Hsieh and Shannon, 2005). Consistent with Geneletti & Zardo (2016b), we did not consider a "keyword-based analysis", since in the fields of ES and SEA terminologies are not yet standardized (Braat and de Groot, 2012; da Silva et al., 2014).

For the content analysis, we divided the SEA reports into four stages which represent methodological steps at the moment of coupling ES in the SEA process. In a traditional SEA report, these stages are often not clearly defined. However, for operationalizing the content analysis, we considered the reflections of previous works by OECD & DAC (2008), Partidario & Gomes (2013) and Geneletti (2016a, 2015) and divided the reports in: 1) context and objectives, 2) scoping and ES prioritization, 3) strategic analysis of alternatives, and 4) follow-up.

In each stage, we analyzed how ES have been included in the SEA process by using a set of analytical questions formulated in concordance with the aim of the respective stage (Table 2). We characterized the different stages according to how often one or more specific ES were identified, in which specific manner they were considered, and according to the planning scale.

Table 2. Framework for analyzing the integration of ES in the selected SEA reports.

SEA stages	**ES questions**
1. Context and objectives	- Does the SEA process recognize the dependency on ES for the achievement of the environmental objectives of the plan? Which ES? Are ES explicitly mentioned? - Are the main ecosystem types identified in the SEA report? Do they allow evaluating the ES context? - Does the SEA report make a link with other strategic actions or legal instruments with potential influence on ES? Which type of strategic action or legal instrument?
2. Scoping and ES prioritization	- Which ES are the most relevant for achieving the environmental objectives of the plan? - Are the environmental problems identified in the strategic diagnosis related to the performance of any ES? Which ones? Are they explicitly mentioned? - Does the SEA process include an assessment of ES values (social, economic or ecological values)?
3. Strategic analysis of alternatives	- Does the SEA process consider ES in the strategic analysis of alternatives of the plan? Which ES? Are they explicitly mentioned? How are they included?
4. Follow-up	- Does the SEA process propose any measures for monitoring and managing ES? Which measures? Which ES are included? Are they explicitly mentioned?

2.3 Selection of the sample of SEA reports

We selected SEA reports of all the available spatial plans in Chile at regional, inter-municipal and municipal level according to the following criteria: 1) online availability in the national system of information of SEA (http://eae.mma.gob.cl/index.php/ficha); 2) timeliness: reports elaborated after 2010 because in that year the ES concept was mentioned for the first time in a national document (Figueroa, 2010), and SEA became mandatory for the elaboration of any spatial planning instrument (Rozas-Vásquez et al., 2014); 3) level of progress: reports in an advanced level of progress, where only few changes are expected between the current and the final version, or finished; 4) representation of the three levels of spatial planning: regions with available SEA reports at regional, inter-municipal and municipal level.

Moreover, we aimed to include SEA reports that illustrate different geographic, social and cultural settings in the country to avoid concentrating our analysis on only one specific regional context. In order to standardize the number of selected reports at different scales and in different regions, we used a standard number of one report for level of planning per region.

3. Results

Our analysis included five regions and 15 SEA reports (Table 3).

Table 3. SEA reports and planning levels for each selected region. RLUP: Regional land-use plan, IMRP: Inter-municipal regulating plan, MRP: Municipal regulating plan.

SEA report	**Region**	**Planning Scale**	**Year**
RLUP Región de Antofagasta	II	Regional	2015
RLUP Región del Maule	VII	Regional	2015
RLUP Región de La Araucanía	IX	Regional	2014
RLUP Región de Magallanes	XII	Regional	2014
RLUP Región de Los Ríos	XIV	Regional	2015
IMRP Oasis Andinos	II	Inter-municipal	2012
IMRP of Curicó	VII	Inter-municipal	2014
IMRP Villarrica-Pucón	IX	Inter-municipal	2015
IMRP Punta Arenas - Río Verde	XII	Inter-municipal	2011
IMRP Borde Costero y Sistema Fluvial Región de Los Ríos	XIV	Inter-municipal	2014
MRP of Mejillones	II	Municipal	2011
MRP of Teno	VII	Municipal	2015
MRP of Cunco	IX	Municipal	2015
MRP of San Gregorio	XII	Municipal	2013
MRP of Río Bueno	XIV	Municipal	2015

3.1. Consideration of ES across the SEA process

The results show that ES were considered in all analyzed SEA reports, independent of the type of spatial planning instrument or the local spatial context. However, differences were found across the SEA stages in terms of the type of ES most frequently identified as well as in their explicit or implicit recognition.

In the SEA stage “context and objectives”, cultural ES was the predominant CICES section including 53% of all the identified groups of ES across the three spatial scales of analysis. In this section, “intellectual and representative interactions” and “physical and experiential interactions” were the most representative groups. Regulation and maintenance ES were second representing 33.3% of all ES. However, this section showed the largest diversity of the considered groups (6) compared with cultural and provisioning ES (3 groups per section). Examples of environmental objectives extracted from the SEA reports and related to the performance of ES are “improvements in the management and protection of water resources”, “identification of locations for the development of non-conventional renewable energy”, and “preservation of relevant areas for natural and cultural heritage”, among others.

In this stage, we also analyzed whether the SEA process included relevant ecosystems or land covers in the reports and if such information is useful as a proxy to characterize the ES context in each planning scale. Our results reveal that only the regional scale presented information enough for a further evaluation of the ES context, mainly as land-use maps (40% of the plans). The inter-municipal and municipal scale only provided partial information and sometimes without any spatial reference.

A final aspect addressed in this stage was related to the link between the SEA report and a set of strategic actions or legal instruments included in this process for supporting the plan elaboration and with potential influence on ES. We found that all reports considered a range of instruments with influence on ES, where "spatial planning instruments" and the "regional strategy for development" were the most frequently identified in all the planning scales. Table 4 lists the identified instruments and their relative presence at different scales.

Table 4. Policy instrument and strategic actions considered by SEA at different scales with potential influence on ES.

Policy instrument and strategic actions in the SEA reports	**Frequency at different scales**		
	Regional (%)	**Inter-municipal (%)**	**Municipal (%)**
Regional strategy for development	100	80	80
Spatial planning instruments	100	100	100
Municipal development plan	20	0	0
Regional strategy of biodiversity	100	60	60
Regional policies	80	20	80
International agreements	40	40	0
Sectoral policies	40	100	40
Regulation for protected areas	60	60	20
Normative for natural disasters	40	0	0
National environmental policy	20	0	0
Sectoral studies	60	100	60
Indigenous law	0	20	0
Local plans and programs	0	0	40

In the SEA stage "scoping and ES prioritization", the ES section regulation and maintenance was most frequently identified (61 %) in the strategic diagnosis of environmental problems. In addition, this section also presented the largest variety of groups (9) in comparison with cultural (4) and provisioning (5) services. Examples of environmental problems related to the presence of regulating and maintenance ES are "soils with presence of contaminants", "water pollution", and "floods and landslides". Second were cultural ES with 24.1%, and finally provisioning ES with 15%.

Furthermore, in this stage we searched for the presence of formal assessment of ES values as a baseline information for subsequent prioritization. However, we did not find any type of ES assessment, even though in some cases ES were explicitly mentioned. Only in one SEA report we found an identification of a set of freshwater ES at regional scale (RLUP Región del Maule).

In the stage "strategic analysis of alternatives", we evaluated whether ES are included or not at the moment of defining a set of alternatives for future development. The results show that 100%

of the plans included at least one ES group in the strategic analysis, which was mainly based on scenario assessment. Throughout the SEA reports, different elements were considered for defining scenarios and where ES were included, such as sustainability criteria, environmental problems, critical decision factors, and environmental objectives. Only in one particular SEA report we found the use of an assessment matrix instead of the predominant scenario analysis (MRP of San Gregorio).

Regarding the ES consideration in this stage, the section regulation and maintenance presented the highest presence across the scales with 41% of all the ES as well as the largest variety of groups (7). The most relevant group within this section was "liquid flows", while others like "gaseous/air flows" and "lifecycle maintenance, habitat and gene pool protection" were hardly ever mentioned. Cultural ES were also often considered in the strategic analysis (35.5%), and the three ES groups identified in this section, namely "physical and experiential interactions", "intellectual and representative interactions" and "spiritual and/or emblematic", were equally considered. The least important section was provisioning services (23.7%) even though it showed a higher variety of ES groups in comparison with cultural ES (4 groups).

In the stage "follow-up", we found that all plans included one or more ES in their proposals for monitoring and management. In this stage, regulation and maintenance ES was the predominant section (42%) and also the most diverse in terms of groups (7). In this section, "liquid flows" was the most important ES group. Cultural ES were second most important (33%). "Intellectual and representative interactions" and "physical and experiential interactions" were the most important groups in this section. The section provisioning ES represented only 25% of all the ES with "biomass" as the most frequently mentioned group.

Regarding the explicit consideration of ES across the different SEA stages and scales of spatial planning, in most of the cases ES were mentioned rather implicitly within the environmental objectives, environmental problems, and others SEA components. For instance, an environmental objective such as "…protection of relevant areas for hydrological regulation such as basin headwaters and wetlands, through identification and zoning of these spaces..." is clearly related to regulation and maintenance ES but without an explicit mention.

The SEA stage "context and objectives" at the regional scale was predominant in terms of the explicit consideration of ES (23.1%) followed by the inter-municipal scale (11.8%). In the stage "scoping and ES prioritization", ES were hardly ever mentioned in an explicit way (5.3% at inter-municipal scale), while in the following stages they were not mentioned at all, even when all plans included at least one ES group for the "strategic analysis" and "follow-up".

3.2. Consideration of ES across spatial planning scales

Our analysis indicates that ES were also considered in all the scales of spatial planning. Figure 2 gives an overview of the explicit and implicit consideration of the different ES sections grouped by scales of spatial planning and broken down by SEA stages.

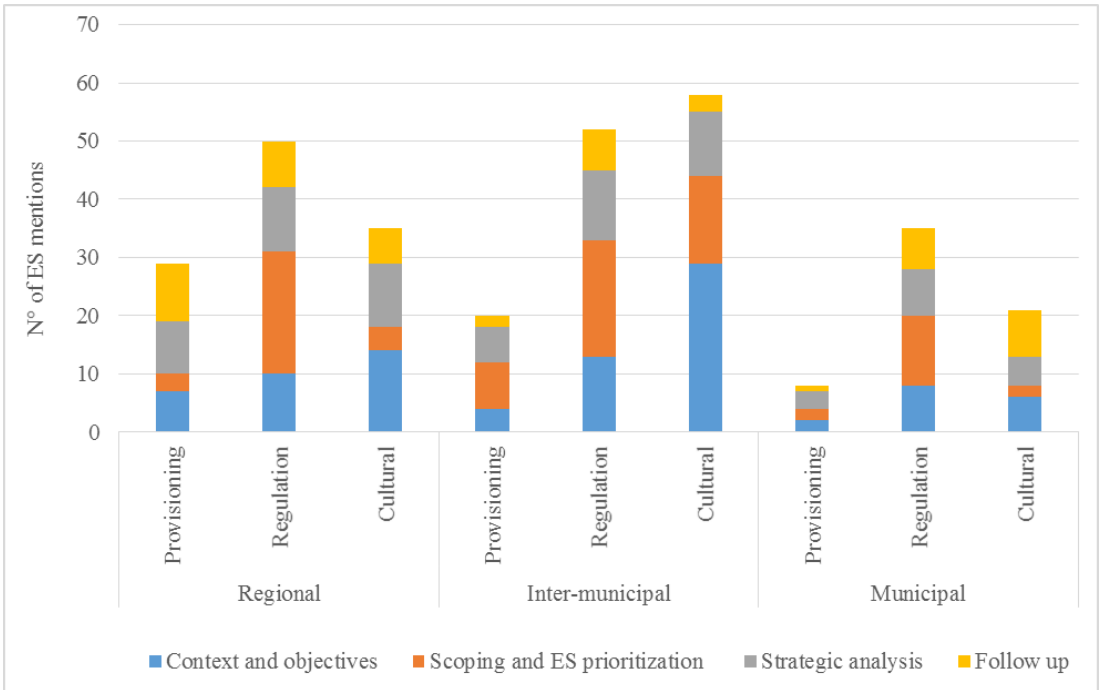

Figure 2. ES sections considered at different scales of spatial planning and SEA stages.

The inter-municipal scale was characterized by the largest number of ES mentions in the SEA reports (Figure 2). The most relevant section was cultural ES, mainly present in the stage "context and objectives". The CICES groups "physical and experiential interactions" and "intellectual and representative interactions" were the most frequently mentioned. Regulation and maintenance ES were also relevant at this scale, mainly addressed within the environmental problems identified in the stage "scoping and ES prioritization". Characteristic ES groups were "mediation by ecosystems", "mediation by biota" and "mass flows". In the case of provisioning ES, these were least relevant with "biomass" as the most important group followed by "water provision".

The regional scale was characterized by a clear predominance of regulation and maintenance ES mainly included in the stage scoping and ES prioritization, with "liquid flows", "mediation by ecosystems" and "mediation by biota" as the most representatives ES groups. The sections cultural and provisioning ES were close to each other in terms of the number of mentions, but were far less often considered than the section regulation and maintenance (Figure 2).

The municipal scale was characterized by the least presence of ES. Here, the section regulation and maintenance ES was the most important (Figure 2). The most representative ES group at this scale was "liquid flows. Cultural ES were second most important, while provisioning ES were hardly ever mentioned.

4. Discussion

4.1. General assessment of the approach

The integration of the ES concept in decision-making has been increasingly promoted in the scientific literature as well as in policy guidelines at different strategic levels (Grêt-Regamey et al., 2016; Posner et al., 2016). However, at present little evidence is available in terms of analyzing its implementation in real-world decision-making contexts and particularly in

instruments oriented to sustainable territorial development as, for instance, in spatial planning and strategic environmental assessment (examples in Geneletti 2011; Honrado et al. 2013; Mascarenhas et al. 2015).

In this study, we carried out direct content analysis to explore the implicit and explicit consideration of ES in a sample of SEA reports at different scales of spatial planning. We consider this method as a valuable approach for supporting this type of analysis, and it has been also used and recommended in previous studies on this matter (Geneletti and Zardo, 2016b; Jacobs et al., 2016; Presnall et al., 2015). The main advantages of this approach are its power and flexibility, since it allows both qualitative and quantitative operations, thus facilitating the analysis of relations between keywords and/or concepts. It also makes use of previous knowledge on the topics, which is relevant for validating or extending an existing framework. At the same time, performing a direct content analysis by using previous theories makes it easier to focus the analysis in a more accurate way with respect to research objectives (Hsieh and Shannon, 2005). In contrast, it present some limitations mainly related to possible bias at the moment of performing the analysis. Hsieh & Shannon (2005) provide some examples of inherent sources of bias: 1) researchers could be more inclined to consider evidence that supports the background theory than the one which does not, 2) in answering the probe questions, some respondent might answer in a way that agrees with the questions or pleases researchers, and 3) an excessive consideration of the theory might overlook contextual aspects of the object under study. For dealing with these limitations, the same authors suggest an audit process before starting the study, which helps to achieve more unbiased results.

Regarding the number of examined SEA reports, an important constraint for obtaining a more precise view of the current situation was given by the limited scope of our study. The reduced number of reports was based on their availability, timeliness, level of progress (many of the currently available SEA reports are at an initial progress level) and representativeness for all planning scales. However, the purpose of those case studies was to illustrate an overall picture of the current state rather than to propose a representative sample. Similar works have been carried out by Baker et al. (2013), Partidario & Gomes (2013) and Mascarenhas et al. (2015), who also focused on a reduced number of SEA reports, but provided significant conclusions on the integration of ES in SEA.

Unfortunately, to our knowledge no works are available that were conducted under the same multi-scale approach that would allow comparison of the results and enhance our conclusions. In further studies on this field, we strongly recommend extending the analysis to the complete population of SEA reports, at least at the regional scale, by considering the selection criteria proposed in this work.

4.2. Integration of ES across SEA and planning scales

In our case study, we found that the ES concept was present in each of the stages of the SEA process as well as across the different scales of spatial planning. However, its presence was not equally distributed.

In the case of SEA, the stages “context and objectives” and “scoping and ES prioritization” were the most related to a range of ES and also the only ones that showed some degree of explicit consideration. Apparently, these stages represent more concrete demands over the territory, and consequently this was expressed by stakeholders and decision makers at the moment of defining environmental objectives and identifying environmental problems. The definition of environmental objectives is the starting point of the SEA process and these objectives also represent concrete intentions of the plan for future development (Abaza et al.,

2004). Similarly, the environmental problems represent a possible degree of risk for human well-being and/or the environment (Ahmed and Sánchez-Triana, 2008), which is clearly perceived by the actors involved in the planning process. We also expected such a relevance in the stage "strategic analysis of alternatives", which is crucial in SEA. However, our results showed a low ES consideration here, the same as in the case of the stage "follow-up". A possible explanation is provided by González et al. (2015) who points out that the development and assessment of alternatives is one of the most poorly conducted stages of the SEA process, including limited participation, lack of systematic approaches for analysis, and inadequate reporting of the "storyline" behind the selected alternatives. In addition, there is also a certain level of abstraction (Selin et al., 2015), which might make the relations fuzzy between ES and future territorial development.

A critical aspect related to this unbalanced consideration of ES along the SEA process is that we found neither a single ES nor a specific ES group linking each SEA stage. This might decrease the possibilities of SEA for integrating ES in spatial planning given this lack of a logic and structured connection, which is crucial for an effective process (Partidario, 2012).

In the case of the planning scales, ES can be supplied to or demanded by the society at a range of institutional levels, from local householders to the national and global community. Stakeholders at each different scale might add different value to ES based on their cultural background, social or economic interests, and the relevance of the ES for their well-being (de Groot et al., 2010; Hein et al., 2006). In our case study, we found that even though in most of the cases the ES concept was not explicitly considered in the development of the SEA, there was a clear demand of specific ES sections across the planning scales.

The different priorities for ES sections at different spatial scales suggest a relation with the planning scope and focus. For instance, at the regional scale the focus is mainly on rural development. Here, regulating ES and herein particularly hydrological ES were the most relevant. One of the reasons could be that they provide the basis for all other ES sections (Jin et al., 2015), which is not acknowledge as such by the planners even though these ES are usually part of or support key objectives. Besides, many regulating ES need to be managed strategically in a larger (catchment/basin) context (Geijzendorffer and Roche, 2014). At inter-municipal scale, the focus is on the urban-rural space which connects neighboring municipalities, i.e. two or more municipalities depending on their functional relations. The gradient between urban and natural/semi-natural landscapes in this planning area and the important presence of population as well as different stakeholders/stakeholder groups might explain the high relevance observed for cultural ES (for more details see MA, 2005). Regulating ES were also relevant at this scale, particularly landslide protection and flood regulation. This could be explained given the need to prevent potential negative effects on the inter-municipal connectivity and damage to industrial facilities. At municipal level, the focus is exclusively on urban areas and the associated infrastructure. At this scale, we found regulation as the most relevant ES section (primarily flood regulation) and cultural ES with a slightly lower priority than at the inter-municipal scale. These results agree with those obtained by Juntti & Lundy (2017), who describe a high potential for delivering regulating and cultural ES in urban areas.

Across the scales, our case study showed a high relevance of regulating ES, which contrast with previous works that indicated a general dominance of provisioning ES (e.g. Foley et al. 2005; Rodríguez et al. 2006; Martín-López et al. 2014). However, our results are consistent with the findings of Castro et al. (2014) who, after an analysis of preferences in a range of landscapes, reported that regulating ES were perceived as the most important by different stakeholders.

While the ES concept was always present across SEA stages and spatial scales, one fundamental concern is the very low frequency of explicit consideration. Similar results can be found in the

analysis of a range of policies and programs by previous studies focused on the link between SEA and ES (Geneletti, 2015; Honrado et al., 2013; Mascarenhas et al., 2015; Rega and Spaziante, 2013) as well as in other studies with a more general scope (Costanza et al., 2014; Hauck et al., 2013). A key role of SEA is to explicitly address possible trade-offs and synergies among different objectives (Geneletti, 2015). Hence, incorporating ES in SEA would enhance a strategic analysis for preventing that the supply of certain ES is favored at the expense of others. Moreover, an explicit ES-based analysis of territorial conflicts and/or strategic problems might help to identify and address the root causes, thus improving the quality of spatial plans and policy decisions (Partidario, 2012). In contrast, a lack of an explicit consideration of ES could decrease the expected advantages of the integration SEA-ES.

4.3. Suitable scales for integrating ES in spatial planning

Based on the evidence obtained through our case study, we suggest that a proper and consistent integration of ES in spatial planning does not rely on a particular scale, but rather on the current possibilities offered by the available policy instruments and guidelines for implementing spatial planning and SEA. This idea is supported by the work of Albert et al. (2014), who point out that integrating ES in planning is highly dependent on the governmental planning instruments and on how rigid or flexible this planning system is. In rigid systems, a formal integration of ES might require a political mandate and active support along with some persistence. In contrast, in planning contexts where stakeholders play a more active role, this integration may have many more possibilities.

In Chile, this situation has been already described by Rozas-Vásquez et al. (2017), who argue that a lack of institutional guidelines and methodological support is considered a critical challenge for implementing this integrated approach. The normative body of spatial planning in Chile, contained principally in the General Law of Housing and Urban Development, presents a very limited scope in terms of environmental issues and sustainability. The only planning instrument which considers sustainability beyond urbanistic issues is the Regional Land-Use Plan (SUBDERE, 2011), however, there are no examples so far where the concept of ES has been considered for supporting planning decisions. In the same way, SEA also does not include explicitly the concept of ES. Nevertheless, as it is described by Rozas-Vásquez et al. (2017), SEA is moving towards a more significant contribution, where the ES concept is now being used in national guidelines (MMA, 2015) and evaluated for incorporation in the current development of policies, and is gaining increasing attention by SEA practitioners and planners. Thus, an interdisciplinary team appears crucial for addressing the complexity of the spatial planning process (Ives et al., 2015) and shifting it from a predominant urbanistic paradigm to one oriented to the sustainable development of cities and regions.

As we have argued, in our case study the integration of ES in spatial planning did not suggest a scale dependency. However, since this new approach is still in an initial development stage in Chile, we recommend a gradual process for incorporating ES starting at the regional scale. The advantages are, for example: 1) the regional plan is the only spatial planning instrument in Chile with an explicit focus on territorial sustainability (SUBDERE, 2011); 2) at this scale many sectoral policies are established and coordinated, therefore this might promote collaborative work in a multi- and transdisciplinary manner (Fürst et al., 2013); and 3) regional scale defines a strategic framework of planning that is linked with the national level and at the same time sets guidelines for spatial planning at local levels (Mascarenhas et al., 2015), therefore it might promote and facilitate the integration of ES at multiple scales.

5. Conclusions

The integration of the ES concept for supporting real-world decisions is increasingly gaining relevance in science as well as in policy and planning. Our case study has shown that SEA is a suitable instrument for including ES at different scales of spatial planning, even though the consideration is not yet explicit in most of the cases. In this sense, the ES concept was always present across each of the SEA stages and planning scales. Regarding the latter, we suggest a relation between specific ES and the scope and focus of the different spatial planning instruments, where regulation and cultural ES were identified as the most important sections according to the CICES classification.

However, although ES are clearly necessary for achieving a number of development objectives and dealing with a range of environmental problems, a lack of an explicit consideration is seen as a great challenge to be addressed when carrying out the spatial planning process. If this critical issue is not considered, the potential advantages offered by the integrated framework SEA-ES could be decreased given a deficient practical implementation. As we stated earlier, the ES concept is increasingly being recognized in decision-making within the Chilean context. Therefore, it is possible that it will be incorporated in some of sectoral laws, and certainly in a range of guidelines from different government departments, e.g. forest, water, indigenous affairs. However, major modifications oriented to include ES in the general legislative body of natural resources, environment or territory, are not expected at least in the short term, which is also in agreement with the findings of Mascarenhas et al. (2015). Thus, we emphasize the importance of having informed stakeholders, able to demand the integration of ES through a bottom-up process of planning and decision-making, as well as prepared and conscious decision makers and public officers. We also encourage the formation of interdisciplinary teams within both the consultant and public office in charge of the plan and SEA elaboration. This is recommended in order to promote a substantial discussion and to deal with the task of moving spatial planning from the traditional urbanistic paradigm to one focused on the sustainable development of cities and rural territories.

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Appendix 1: Rozas-Vásquez et al. (under development).

Participatory identification and prioritization of ecosystem services for scenario development in regional planning.

1. Introduction

Land systems and their diversity across the world are the results of a number of interactions between human and natural environment, which include different uses of land such as socioeconomic, cultural and ecological activities or process that produce benefits and services for the society (Verburg et al. 2015). These land uses activities have significantly modified land systems by generating a range of environmental impacts as it has been corroborated after several decades of research. Some examples are the changes in the global carbon cycle and possibly the global climate, alterations in the hydrologic cycle, increments in the amount of anthropogenic inputs of fertilizers and polluted disposed into the biosphere and atmosphere, among others (Foley et al. 2005). In this regard, human decisions and policy-making are recognized as one of the key drivers for land-use change, which operate at multiple scales including individual decisions from local land owners to regional and national scales as well as international trade agreements (Schosser et al. 2010; Verburg et al. 2015).

In terms of instruments for policy decision making with a multiscale influence over the land system, its users and its land-use change processes, spatial planning arises as the most relevant, and today with legal basis in most of the countries around the world. Spatial planning plays a key role in the coordination and/or integration of the spatial dimensions of sectoral policies in a framework which considers at least three main elements as describes and synthetized by Kidd (2007) & Scott et al. (2013): 1) a sectoral view that aims to a cross-sectoral (public policy domain) and an inter-agency integration (public, private and voluntary activities within a territory); 2) a territorial focus which allows a vertical integration of different scales of planning, and an horizontal integration of planning activities within a same scale of planning; and 3) an organizational view which aims to the cooperation and networks of actors in order to integrate strategies, programs and plans as well as relevant agencies present in the territory in addition with a range of stakeholders and disciplines. At the same time, the spatial planning process is the result of a wide set of values and rationalities that are strongly context-dependent in terms of a specific society in a specific moment of time and under specific institutions and rules (Fisher et al. 2009; Daily et al. 2009; Goncalves & Ferreira 2015).

These context-dependent conditions and the feasibility of an explicitly spatial representation, make the spatial planning a suitable instrument for promoting the integration of the ES approach into the decisional frame of the planning process (Raymond et al. 2013; Polasky et al. 2015). Moreover, land use and land cover (LULC) – the central targets of spatial planning – have the capacity to aggregate complex information about socioeconomic, cultural and ecological interactions which influence the supply and demand of ES (Burkhard et al. 2012). In this way, the link between LULC and the ES provision can be used for facilitating the communication

with and understanding by societal and political actors during the planning process (Burkhard et al. 2012; Scolozzi et al. 2012; Fürst et al. 2013)

Within the key functions of spatial planning, achieving long-term sustainability for social, territorial and economic development as well as integrating environmental issues are essential tasks (UN 2008). In this sense, although integrative approaches are needed for carrying out the above mentioned tasks, environmental and natural resource management actors from government are in most of the cases organized by different administrative sectors (Galler et al. 2016). Here, regional planning gains special relevance since at this scale many sectoral policies are established and coordinated. Additionally, regional planning allows to accomplish a cross-sectoral and inter-agency integration, to establish a territorial focus with a vertical and horizontal view, and an organizational scheme based on cooperation and networks of actors. Finally, the regional level is also considered an appropriate scale for management of natural resources, economic development and cultural identity, and for strategic interconnectivity issues between cities and other regions (Mascarenhas et al. 2014; Galler et al. 2016)

In regional planning, collaborative work among different actors (e.g. decision makers and stakeholders) and sectors in a multi- and transdisciplinary manner is a fundamental issue which need to be considered in the planning process (Fürst et al. 2013). In this case, a concept such as ES provides a framework for this multi- and transdisciplinary work and facilitates the interaction between the actors for the development of integrated land use scenarios (Fürst et al. 2013; Galler et al. 2016). The relevance of collaborative work and scenario building in planning is mainly the dialogue and debate carried out during the process, which contribute to define common values, a shared vision and priorities for the future development of the region (Palomo et al. 2011). Additionally, scenario building also allows to make explicit the trade-offs between different alternatives of development, which open a window of opportunity for informing and support the decision making process and address sustainability challenges (Goldstein et al. 2012).

Scenarios are plausible options about how the future might evolve by considering a consistent set of assumptions that includes key aspects and drivers of change which are considered relevant for decision makers and experts (Carpenter et al. 2006). The use of scenarios is today a frequent practice for addressing the link between land-use and ES in regional planning. It is also considered a fundamental tool for analyzing the consequences of implementing policies, plans and programs as in the case of strategic environmental assessment (SEA) of spatial plans, where scenarios are a key aspect in the sustainability assessment of the plan (Geneletti 2013).

In this research, we conducted a case study with the aim of a participatory identification and prioritization of ecosystem services for supporting the scenario development in the coming updating process of the regional land use plan (RLUP) of La Araucania region in Chile. La Araucania is considered one of the most important regions in terms of natural capital in Chile, but at the same time it presents the lowest indicators of development (Gobierno de Chile 2010). For this reason we used La Araucania as our model region, by integrating the ecosystem services approach in the assessment of different alternatives of future development.

In Chile, the development of a RLUP includes collaborative work of actors from both public and private sector as well as from all the citizens, especially during the territorial diagnosis and the definition of the desired model for future development (SUBDERE 2011). Since this research is not running under the current development of a RLUP, but it is rather intended to support a strategic analysis in the process of updating the plan, we used a reduced set of key actors for testing the proposed method. One significant aspect in the current development of RLUPs in Chile is the increasing concern regarding sustainability issues, which has been translated in the mandatory integration of SEA since 2010 (Rozas-Vásquez et al. 2014) and the

publication of a national guideline for sustainable spatial planning (MMA 2015). For this reason in the discussion section we argue how to couple the scenario analysis of the RLUP with existent instruments for integrating sustainability aspects in planning.

2. Methodology.

2.1. Case study region and basic data

The study area is located in La Araucania region, southern Chile (Figure 1), with a total area of 31,842 km2 and a population of 890,000 where most of the inhabitants are distributed in the rural zone.

In administrative terms, the country is organized in four hierarchical levels which represent different territorial scales: national, regional, provincial and municipal. For spatial planning purposes, national level only indicates policies and broad principles, while provincial is basically an administrative level that is not addressed in spatial terms (SUBDERE 2011). Therefore, spatial planning is mostly conducted at regional, inter-municipal and municipal scales (MINVU 2011), where RLUPs play a fundamental role in coordinating sectoral development policies, lower scales of spatial planning instruments, and integrating the principles of sustainability (SUBDERE 2011). The RLUP involves the complete region, and its role is to identify potentials and limits for development by considering the achievement of the economic, social, cultural and ecologic objectives proposed by the Regional Strategy of Development (RSD) but in a spatially explicit way. At the same time, the RSD is a navigation chart with orientations of where to go and how to reach a desirable future based on a regional diagnosis. It states priorities, courses of action and strategic objectives in a region but without explicit spatial considerations.

The information regarding land uses in the region was obtained from the official register of vegetation resources of Chile (CONAF-CONAMA-BIRF 2009) in a scale of 1:100,000.

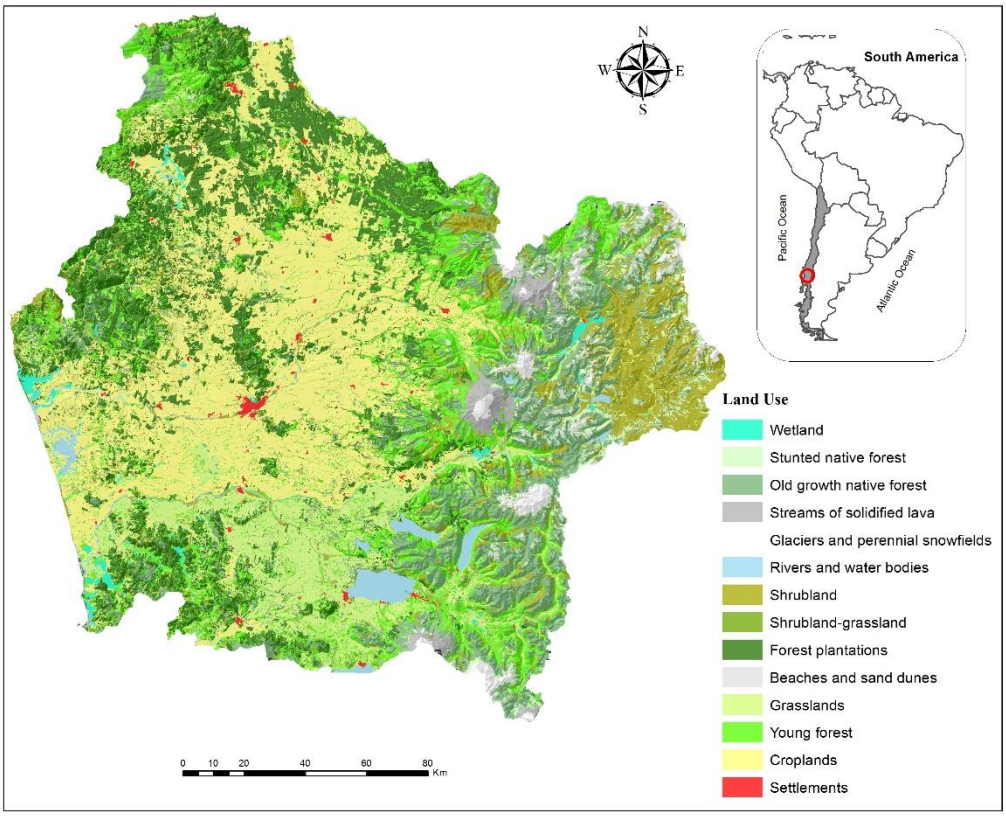


Figure 1. La Araucanía region and its land uses.

2.2. Method

In this research we followed the subsequent methodological steps which are a modified version of the proposed by Geneletti (2015): 1) Identification of actors and regional strategic objectives for development; 2) establish the ES context; 3) determine priority ecosystem services on the regional context; and 4) mapping and scenario assessment. Figure X presents the details within each of the steps.

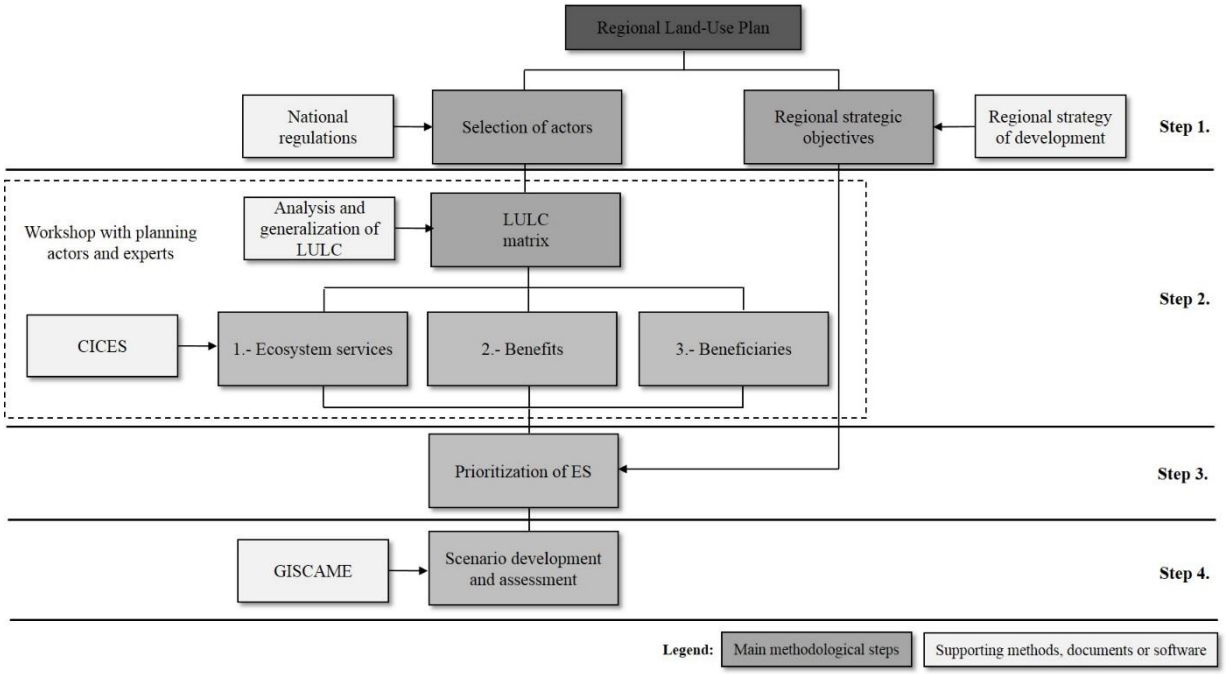


Figure X. Methodological flow.

2.2.1. Identification of actors and regional strategic objectives for development

For this research we used a reduced set of key actors for testing the proposed method, since it is not been carried out under a real elaboration of a RLUP but it is intended to support the strategic analysis of the updating process. A key actor is a person/institution highly interested in the decisional process and/or with a high influence in the final decision. Given the strategic nature of the analysis for the following RLUP, in this initial stage we only considered actors from government in a high hierarchical level of decision making.

According to the national regulations for regional planning, the Regional Government (GORE) is the administrative entity responsible for the coordination and approval of the RLUP (Law Nº 19.175). For this reason we asked them for a preliminary set of key actors that should be included in the process. The actors who finally were able to participate in this research are described in table 1.

The regional strategic objectives to be evaluated by using the ES approach were selected from the RSD in an expert meeting and subsequently validated in a workshop with our key actors. The selection was focused on objectives directly related with the use of natural resources, sustainability issues, and regional identity, specifically with respect to cultural and ethnic heritage. Objectives oriented to infrastructure development, administrative strengthening, social development, and others in this way, were discarded from the analysis. The final list of objectives included is shown in table 1.

Table 1. Key actors and regional strategic objectives included in this research

Key actors	**Regional strategic objectives**	**Core topic of the objective**

• Regional Government • Ministry of housing and urban planning (Regional office) • Ministry of environment (Regional office) • The National Indigenous Development Corporation (National office)	• Increasing agricultural productivity • Increasing fisheries and aquaculture productivity • Increasing irrigation coverage • Increasing water availability • Promoting tourism, ethno-tourism, scientific activities and heritage routes • Promoting the use of non-conventional renewable energy	•Natural resources •Natural resources •Natural resources •Natural resources •Regional identity •Sustainability

2.2.2. Establish the ecosystem services context

This step was carried out through three expert meetings and two workshops with the key actors and a support team of researchers, where three main contextual aspects were addressed as defined by Geneletti (2015): 1) definition of the main ecosystem types present in the region; 2) definition of the ES provided by those ecosystems; and 3) definition of the beneficiaries of those ES.

For the definition of the main ecosystems, we made a simplification of the original land use map in order to 1) avoid confusions between very similar classes whose differentiation makes no too much sense at regional level (e.g. dense scrubland, semi-dense scrubland, open scrubland, and others with similar subclasses), and 2) focus the strategic analysis on relevant ecosystems within the region in terms of their economic, cultural and ecological relevance as well as the spatial representativeness (area) (e.g. Partidario & Gomes 2013). These criteria were evaluated first in an expert meeting, where a simplified land use map was elaborated and afterwards it was presented in a workshop for its validation. After the validation process, 14 land use classes were considered for the subsequent analyses (figure 1).

Regarding the definition of the ES provided by the selected land uses, we used the framework proposed by CICES (http://cices.eu/). For that, we evaluated all the ES at the CICES class level, which are possible to relate to each of the 14 representatives land-uses on the region. This initial evaluation was carried out in an expert meeting but later it was discussed in the workshops for review and validation by our key actors, based on their sectoral and contextual information about the region. After that, we elaborated a final matrix of land uses and all the identified ES in the region in addition with the recognized benefits and beneficiaries. These last, were addressed under a more general view than the ES identification since within the region, the benefits and beneficiaries generated by certain ES might vary according to specific cultural or geographic conditions.

2.2.3. Determine priority ecosystem services on the regional context

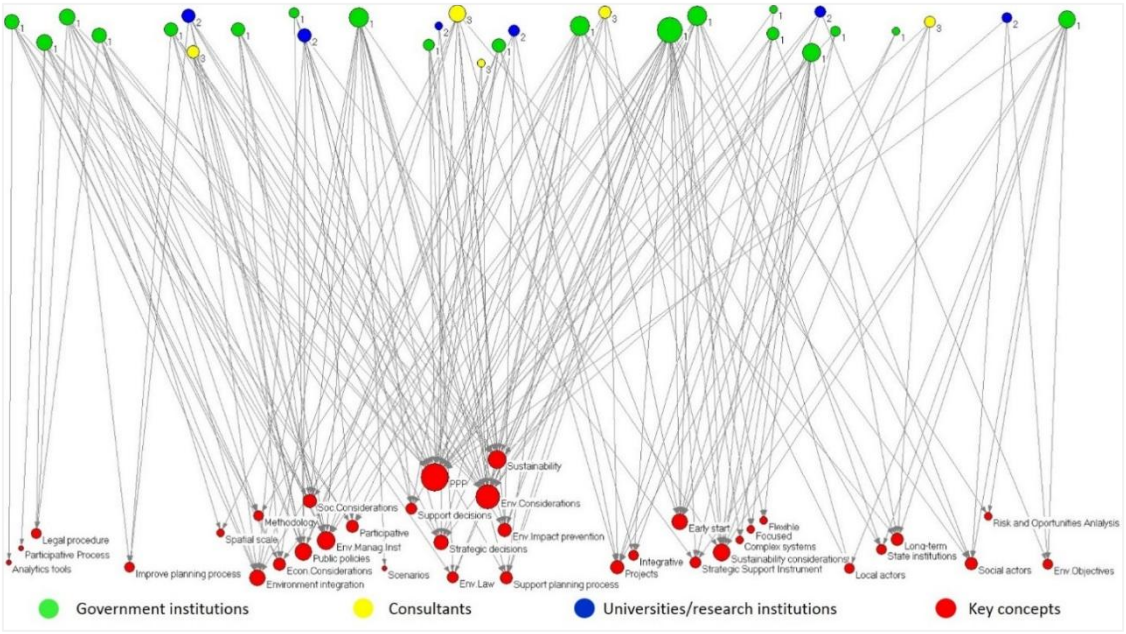
In order to perform an effective strategic analysis and given the typical constraints of time, budget and information, the number of ES to be evaluated should be reduced, by considering only the most relevant according to the planning context and the objectives of the specific RLUP (Geneletti 2015). For this reason, we proceeded to prioritize the ES from an extensive list

obtained in the previous step (2.2.2), based on two criteria. In both cases qualitative criteria were preferred because they allow a more flexible and strategic approach, which is more based on dialogue and collaborative processes with decision makers and stakeholders (Partidario 2012; Partidario & Gomes 2013).

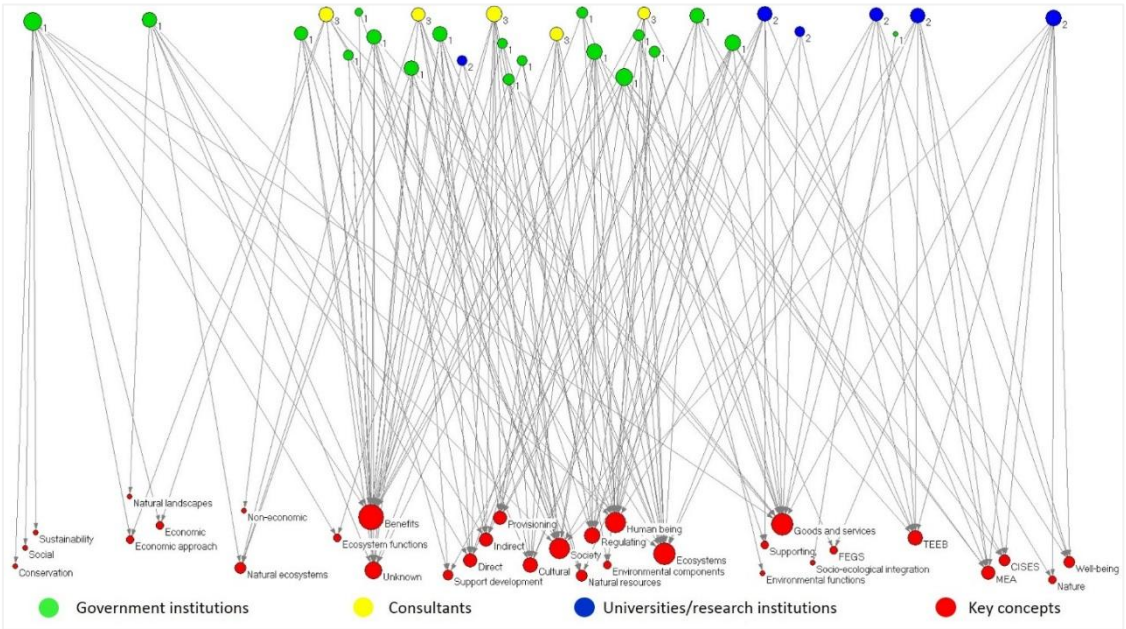
The first criterion was the "relevance" of each ES against each of the selected strategic objectives of the RLUP (table 1), which indicates how necessary is a specific ES for achieving such an objective in a pairwise comparison. The scale of evaluation considered the levels: null, very low, low, high, very high. The second criterion was the "impact" of each strategic objective upon a certain ES also in a pairwise comparison. This criterion indicates the positive or negative effects generated by implementing a strategic objective in terms of increasing or decreasing the quality or quantity of a specific ES. The scale of evaluation considered the levels: very negative, negative, neutral, positive, very positive.

Once all the ES were evaluated in terms of "relevance" and "impact", we proceeded to prioritize the most relevant.

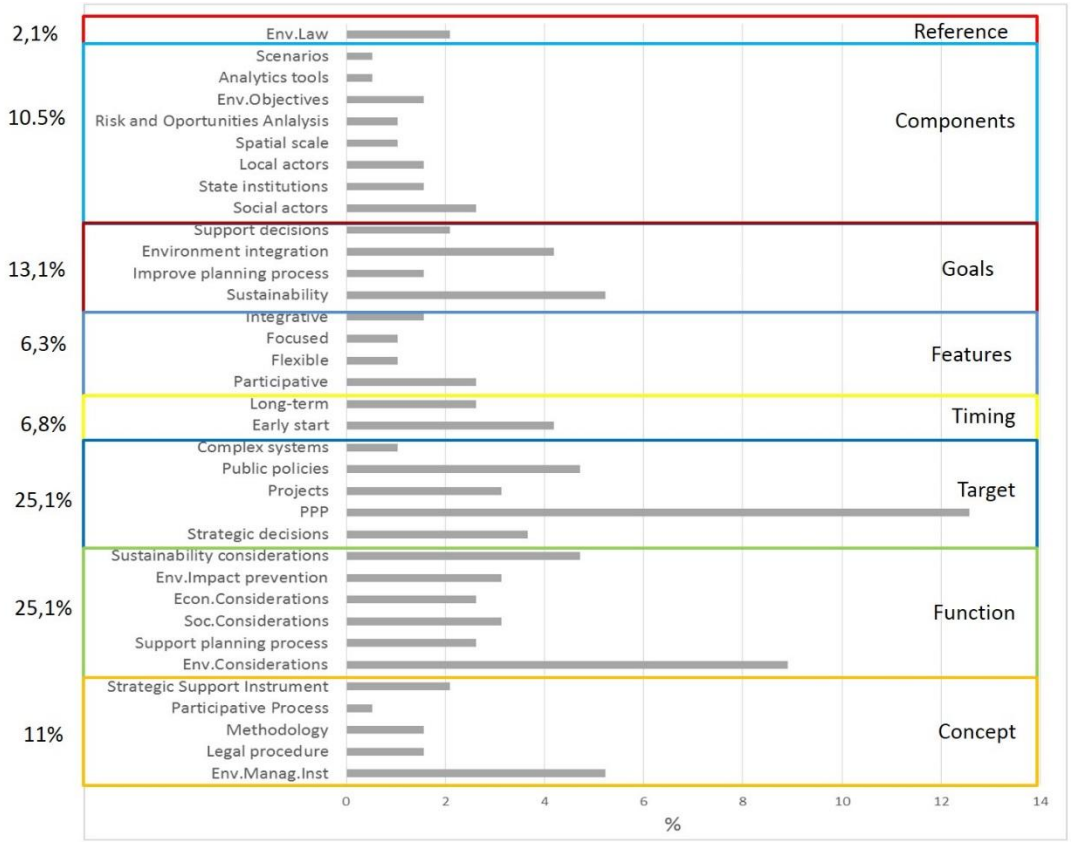
Appendix 2:



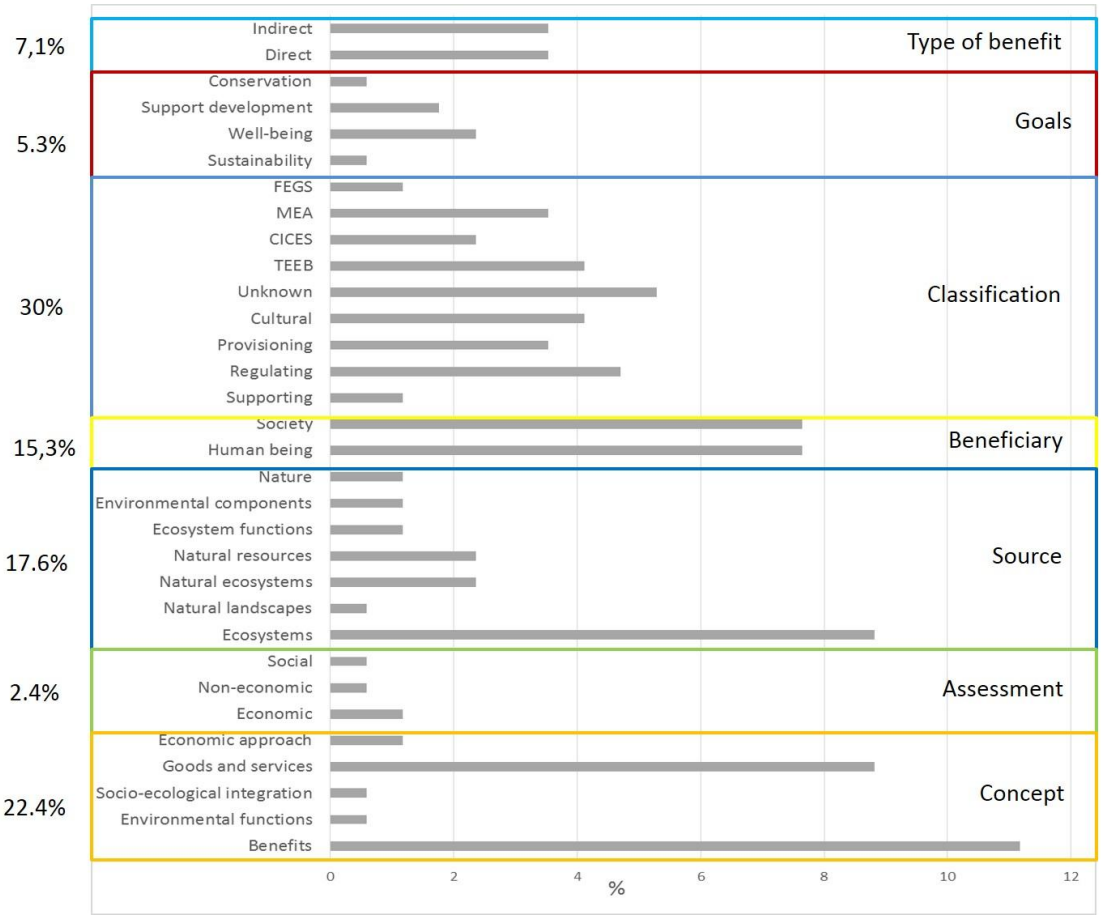
Appendix 2.1. Complete network structure between actors and their associated keywords in the definition of SEA. The size of the circles represent the *outdegree* in the case of the actors and the *indegree* in the case of the concepts



Appendix 2.2. Complete network structure between actors and their associated keywords in the definition of ES. The size of the circles represent the *outdegree* in the case of the actors and the *indegree* in the case of the concepts



Appendix 2.3. Statistics of categories and the associated keywords in SEA



Appendix 2.4. Statistics of categories and the associated keywords in ES

Appendix 3:

Appendix 3.1. Full list of benefits

N°	Benefits	Count
1	Employment	40
2	Personal well-being	23
3	leisure and recreation	22
4	Scientific	15
5	Nutrition	15
6	Soil quality	13
7	Landscape beauty	8
8	Water quality	8
9	Air quality	8

10	Variety and quantity of environments	8
11	Gene banks	7
12	Soil conservation	7
13	Medicine	7
14	Agricultural productivity	7
15	Inputs for heating	6
16	Availability of different ways of education	6
17	energy/combustible	6
18	Regulation of extreme events (rain, temperature, etc)	6
19	Stabilize temperatures	5
20	Maintenance of cultural traditions	5
21	Protection of infrastructure	5
22	Craftwork	4
23	Water quantity	4
24	Availability of water	4
25	Maintenance of cultural heritage	4

26	Construction materials	4
27	Animal nutrition	4
28	Protection of settlements	4
29	Drinking water for animals	3
30	hygiene	3
31	Spiritual enrichment	3
32	Furniture	3
33	Industrial processes	3
34	Irrigation	3
35	Health	3
36	Extraction of sand and gravel	2
37	Singularity of ecosystems and landscapes	2
38	Increment in productivity	1
39	Landscape quality	1
40	Hunting	1
41	cosmetics	1

42	Reduction of odors	1
43	Reduction of noise	1
44	Energy generation	1
45	Maintenance of species of interest	1
46	Maintenance of heritage	1
47	Medicinal plants	1
48	Agricultural processes	1
49	Variety of seeds	1

Appendix 3.2. Full list of beneficiaries

N°	**Beneficiaries**	**Count**
1	Local population	74
2	Regional population	50
3	Industries	19
4	Tourist companies	18
5	International population	16
6	Science and technology	14
7	Farmers	12
8	Private companies	10
9	Small companies	9
10	Researchers	7
11	Adjacent population	7
12	Small and medium companies	7
13	Craftsman	6

14	Pharmaceutical companies	6
15	Cattle breeder	5
16	Fisherman	5
17	Livestock production	5
18	Indigenous communities	4
19	Forestry companies	4
20	Large industries	4
21	Medium Industries	4
22	Public offices	4
23	Transport	4
24	Local tourist companies	3
25	Regional tourist companies	3
26	National population	3
27	Poultry production	3
28	National tourist companies	2
29	Aquaculture production	2
30	Peasants	1
31	Rural communities	1
32	Construction industries	1
33	Property development companies	1
34	International population	1
35	Adjacent population	1
36	Municipal population	1
37	Inter-municipal population	1
38	Inter-regional population	1
39	Agricultural productivity	1

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