Exploring Ecosystem Services

How stakeholders perceive, understand and prefer ecosystem services

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This report has been written by MSc students from the joint degree master programme Industrial Ecology of Leiden University (LU) and Delft University of Technology (TUD) in partial fulfilment of their course requirements. This is a student report, intended to serve solely the purpose of education. TUD and LU do not take responsibility for the contents of this report.

Preface

Each of us began the MSc Industrial Ecology with a different academic background, but with a shared ambition: to contribute to more informed and sustainable decision-making at the interface of society, economy and nature. After months of developing theoretical and analytical skills in the classroom, the Sustainability Challenge offered us the opportunity to apply this knowledge to a real-world policy context. In our case, this meant working closely with the Netherlands Environmental Assessment Agency (PBL) on a challenge central to contemporary sustainability governance: understanding how ecosystem services (ES) are perceived, valued, and used in decision-making.

This project was conducted as part of PBL's contribution to the Horizon Europe BAMBOO project, which aims to develop models that quantify human impacts on biodiversity. PBL's specific challenge lies in translating the abstract concept of ES into modelling approaches and policy guidance that resonate with stakeholders in practice. To support this ambition, our team focused on exploring how policymakers, industry professionals and researchers understand ES, what barriers and enablers they encounter in integrating them into decision-making, and which actions and policy levers are currently considered.

Using an applied and exploratory research approach, we designed and implemented a survey complemented by qualitative insights to capture stakeholder perceptions across sectors. Throughout the past five months, we worked collaboratively to translate these insights into actionable reflections and recommendations for PBL, with the aim of informing future modelling efforts and policy advice.

We would like to express our sincere gratitude to our commissioners at PBL, Vassilis Daioglou and Alexandra Marques, for their trust, guidance, and constructive feedback throughout the project. Their openness and engagement helped us continuously sharpen the relevance and focus of our work. We also thank our supervisors, Jinhui Zhou and Ingeborg Klutz, for her thoughtful feedback and support during key moments of the project, and for encouraging us to critically reflect on both our methods and findings.

Finally, we reflect on collaboration as both a central theme of our research and a key lesson from the project itself. Each team member brought distinct perspectives, skills and strengths, and it was through aligning these differences that we were able to deliver a more comprehensive and robust outcome than any of us could have achieved individually. This experience reinforced for us that interdisciplinary collaboration is not only essential for addressing sustainability challenges in practice, but also fundamental to the process of doing meaningful research.

We hope that this report provides useful insights for PBL's ongoing work and contributes, in its own way, to bridging the gap between ecological knowledge and societal decision-making.

Lyka Ocampo, Yasemin Kural, Giorgio Moretti, Sofia Salvador and Julia Tieleman

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Popular Summary

In the last decades the impact that human activities have on nature has become increasingly central in the public debate. However, it is far less recognised how societies also depend on nature to thrive: for example, humans need pollination and clean water for their activities. These kinds of benefits that nature offers to humans are referred to as ecosystem services (ES). To ensure long-term security of supply chains, it is necessary to implement the concept of ES in decision-making processes of governmental organizations, academia and industry actors. To do so, it is crucial to support them with useful indicators and models developed by organisations like PBL (Netherlands Environmental Assessment Agency). This is why PBL asked our team to investigate the perceived relation between stakeholders and ES. Our results show that collaboration between stakeholders is key and that awareness of the importance of ES is not sufficient to unlock actions that preserve ES.

Executive Summary

It is increasingly recognised how human activities increasingly impact ecosystems. Still, the dependence on nature for essential functions such as pollination, water purification, and climate regulation. These benefits, known as ecosystem services (ES), are critical for long-term societal and economic resilience. However, governmental organisations, researchers, and industry actors struggle to integrate ES into their decision-making processes.

To improve the integration of ES in decision-making, ecological models (e.g. Impact Assessment Models) and indicators created by organisations such as PBL (Netherlands Environmental Assessment Agency) must be aligned with how stakeholders perceive, depend on and impact on ES and the policy tools they prefer. This study, conducted within the context of the EU Horizon Europe BAMBOO project and commissioned by PBL addresses this knowledge gap and help shape future research on the models and indicators.

The study had several objectives: investigating stakeholders' familiarity with ES; assessing perceived dependence and impact on ES (also known as double materiality relation); identifying barriers and enablers that influence the integration of ES into decision-making; and investigating if and how stakeholders are currently integrating ES in their decision-making. Lastly, the study aimed at comparing perceptions across the targeted stakeholder groups: governmental organisations, academia, and industry and business.

A mixed-methods approach was used. It combined a global online survey for a quantitative analysis, and semi-structured interviews to qualitatively support the insights of the surveys. The survey covered familiarity, dependence, impact, actions, barriers, and enablers related to ES. Given the exploratory nature of the research, a purposive and convenience sampling was considered appropriate.

The results of the survey show that familiarity with ES varies widely across stakeholders and that respondents do not perceive the degradation of ES as a risk to the resilience of their organisations. Interestingly, stakeholders report high perceived dependence on ES but low perceived impact on them, which may indicate a gap between perceived and actual familiarity with ES. In terms of actions and policy levers, collaboration with other stakeholders emerged as the most frequently indicated lever across all organization types, followed by adopting sustainable product or service designs, and developing tools, guidance or assessment methodologies. Furthermore, participants rated stakeholder or client demand as the strongest enabler, followed by financial incentives and the availability of tools and models. This pattern suggests that respondents expect external drivers, such as demand, funding, and practical instruments, to play a key role in enabling ES integration. In contrast, unclear regulatory or policy frameworks, limited financial and human resources, and availability and quality of data and metrics were most frequently rated as barriers. Consequently, a key finding is that awareness alone is not sufficient: stakeholders may recognise ES importance but still fail to integrate them in decision-making without incentives, tools, or regulatory pressure.

These findings can help PBL steer future research that intends to align biodiversity and ES models and indicators with stakeholders' realities in the context of the BAMBOO project. Future research should aim for a larger and more representative global sample, investigate the interplay between risk perception and proximity and scale of ES, and examine the gap between perceived and actual knowledge of stakeholders regarding ES, as this may also influence their risk perception and decision-making.

1. Introduction

1.1 Background and Context

Ecosystem services (ES) are the direct and indirect contributions of ecosystems to human well-being such as pollination, provision of drinking water, and carbon sequestration (Wageningen University & Research, n.d.; UNECE, n.d.). Major frameworks group ES into three broad categories:

- **Provisioning services** (e.g. food, fresh water, raw materials).
- **Regulating and maintenance services** (e.g. pollination, carbon sequestration, climate regulation).
- **Cultural services** (e.g. recreation, aesthetic enjoyment, cultural heritage).

ES benefit society regardless of whether they are explicitly recognised or quantified. For governmental organisations, researchers, and organisations involved in planning and decision-making, understanding and, where possible, quantifying ES is important to make these benefits visible, comparable, and actionable (Lant et al., 2008; Martinez-Harms et al., 2015). Without such understanding, ES risk being undervalued or overlooked in economic assessments, policy design, and organisational strategies, particularly when trade-offs with short-term economic objectives arise.

Assessing human interactions with ES is challenging. The large number of ES, their interdependencies, and their operation across spatial and temporal scales make them difficult to represent in quantitative models and indicators (Hein et al., 2005; Mace et al., 2015). When measured data are lacking, models can provide useful information. More than 80 ES modelling tools exist, but their utility depends on selecting tools that match the decision context and available data (Bullock et al., 2018).

In addition, the relevance of specific ES is highly context- and stakeholder-dependent. For example, businesses, governmental organisations, and researchers often prioritise different services depending on their sectoral responsibilities, geographic scope, and decision-making objectives (Schleyer et al., 2015; Zoderer et al., 2019). This complicates the development of policy-relevant ES models, as generic approaches risk failing to capture the services that are most relevant for specific stakeholders and decisions (Congreve & Cross, 2019).

New European policies demand greater transparency on businesses' environmental and societal impacts on ES. The "Corporate Sustainability Reporting Directive" (CSRD) (Netherlands Enterprise Agency, RVO, n.d.) requires companies to report not only how sustainability issues affect their financial performance but also how their activities impact the environment and society (CISL Marketing, n.d.). This approach based on the principle of "double materiality" recognizes the two-way relationship between business and nature, so how organizations depend on ecosystems, and at the same time how they influence them.

The need to make informed decisions on ES has therefore grown. However, the diversity and complexity of interactions with ES hinders their integration into policy, limiting policymakers' ability to make informed decisions. Therefore, research is needed to develop modelling approaches that can support policymaking.

1.2 Commissioner Introduction

The commissioner of this project is the Netherlands Environmental Assessment Agency (PBL), a government research institute that conducts independent policy analysis on environmental and spatial challenges in the Netherlands. PBL contributes to the Horizon Europe BAMBOO project, which develops modelling approaches for assessing biodiversity impacts. Within BAMBOO, PBL leads work on ES:

- **Work Package 2 (WP2):** Scoping stakeholder needs for biodiversity and ES indicators.
- **Work Package 5 (WP5):** Applying and testing ES indicators in case-study contexts.

This student project directly supports these tasks by gathering empirical evidence on how stakeholders perceive, depend on and impact ES, and how these perceptions translate into requirements for ES models and indicators. Because BAMBOO employs integrated assessment models and other quantitative tools, understanding which ES stakeholders prioritise, and why, is critical for adapting these models to decision-makers' needs.

1.3 Study Aim and Approach

To address PBL's challenge, this sustainability challenge adopts an exploratory and applied research design. Rather than testing predefined hypotheses, the project aimed to generate insights into how ES are perceived, prioritised, and used by different stakeholder groups in practice.

The study follows a mixed-methods approach, combining a structured online survey with optional qualitative follow-up (i.e. interviews) to capture both broad patterns and contextual explanations. The survey focuses on stakeholders' perceptions on dependencies and impacts on ES, and the barriers and enablers influencing their integration into decision-making.

The objective of this study is not to develop a new ES model, but to inform PBL's modelling work in the BAMBOO project by clarifying which ES stakeholders consider most relevant and why.

1.4 Problem Statement

PBL's challenge lies in translating the abstract concept of ES into actionable guidance for policy and industry. ES are increasingly referenced in sustainability reporting and corporate strategies, yet stakeholders use and prioritise them differently. As highlighted by PBL, it is often unclear which ES matter most in real decision-making, making it difficult to design policy-relevant models that reflect stakeholders' needs. This explorative sustainability challenge, therefore, addresses a concrete problem: PBL must understand how stakeholders perceive, depend on and impact ES so that it can build models and guidance that resonate with practice.

The challenge can be summarised as follows:

- **Diverse priorities:** Stakeholders across policy, research and industry understand and prioritise ES differently.
- **Lack of clarity:** little consensus exists on which ES matter most in real-world decision-making.
- **Modelling difficulty:** Without a shared understanding of priorities, designing policy-relevant models and tools becomes challenging.

By investigating these issues empirically, the project aims to bridge the gap between conceptual discussions of ES and the practical needs of those responsible for implementing sustainable policies and strategies.

2. Objectives and Research Questions

This study aimed at investigating ES perception and integration in decision-making of stakeholders at the global level rather than a restricted geographical area. There were three main aspects that we intended to contribute to: perceived familiarity with ES, the perceived dependence and impact on ES of the targeted stakeholders (i.e. researchers, government, industry & business), and the enablers and barriers to the implementation of ES in decision-making processes.

To achieve such objectives, we defined the following main research question:

"How do stakeholders perceive ecosystem services (ES), and how do these perceptions shape the integration of ES into their decision-making processes?"

To answer it, we decomposed it into three sub-research questions:

- How familiar are different stakeholders with ES, and how do their perceptions of risks, dependencies, and impacts differ across stakeholder groups?
- What actions and policy levers are stakeholders considering to implement in their decision-making process?
- What factors hinder or support the integration of ES into decision-making processes?

3. Theoretical Background

Given such objectives and research questions, we analysed relevant aspects connected to ES in the existing literature.

Before discussing existing literature about ES, it is important to mention why the concept of ES has the potential to steer societal actors towards more sustainable behaviours. Some academics like Washington (2020) argues that the term "ecosystem services" carries an underlying anthropocentric view of nature, seen only as an entity to be preserved because it provides useful services for humans, rather than because non-human life forms have equal rights than humans to survive and thrive. Other academics such as Schröter et al. (2014) and Abas et al. (2019) argue that the concept remains useful as it highlights the interdependence between people and nature, fostering responsibility and better conservation outcomes. Additionally, as a counterargument that the concept of ES reduces ecological values to monetary terms, Schröter et al. (2014) argue that ES encompasses multiple value types (i.e. economic, cultural, aesthetic, ethical), so the monetisation of services is only one aspect of ES. Furthermore, Abas et al. (2019) argued that the concept of ES can support modern environmentalism by facilitating the development of multi-lateral environmental agreements such as the Paris Agreement. We therefore conclude that the concept of ES is useful and investigating how stakeholders relate to them can offer valuable insights.

ES are crucial to human activities and yet the current economic system fails to recognise their importance (Lant et al., 2008; Mooney, 1997). In the last decades, ES have become increasingly central in sustainability policy and modelling, especially in the context of biodiversity loss \and double materiality reporting (Mooney, 1997; Kolk, A., 2005; Herzig et al., 2011; Adams et al., 2021; Baumüller & Sopp, 2021). However, while ES are widely discussed in academic and policy contexts, much less is known about how different stakeholders perceive, value, and use them in practice. The literature review therefore investigates what has been studied about aspects relevant to the integration of ES in decision-making processes.

3.1 Familiarity with ES

Rey-Valette et al. (2017) investigated the perceived value of ES and familiarity across stakeholder groups, although limited to a restricted geographical area, namely Lorraine (France). Another study highlighted how spatial distribution influences the knowledge of ES supply and demand that stakeholders with high and low influence on ES have (García-Nieto et al., 2014). They concluded that stakeholders with different levels of influence also have different technical and experiential knowledge.

Nunes and Van Den Bergh (2001) argue that lay respondents often lack sufficient knowledge on ecosystem functions, influencing their perception of dependence and impact on ES, so that stated preference methods might not be a suitable tool to investigate ES valuation. However, Barkmann et al. (2008) counter-argue that while this may be true, the little familiarity of lay respondents with ecosystem functions does not necessarily affect respondents' ability to value ES, but only ecosystem functions. Drawing on this conclusion, this study made use of a survey to investigate the perceived familiarity, dependence and impact on ES, as it will be described in Chapter 4. However, Alfonso et al. (2016) also showed that improvement of subjective well-being due to external factors may affect people's perception on the quality and availability of ES. Indeed, in their study they found out that respondents with improved subjective well-being perceived also an improvement in

water quality and availability while ecological indicators indicated otherwise. Therefore, respondents' views should be analysed critically.

3.2 Dependence on ES

Existing literature shows that stakeholders experience a spatial mismatch between the supply of ES in different landscapes and their demand for ES bundles, leading to management conflicts (Zoderer et al., 2019). ES bundles refer to sets of associated ES that occur together in time and/or space, so increases in one service tend to come with increases in others (Reader et al., 2024; LIFE Viva Grass, n.d.). Zoderer et al. (2019) concluded that such mismatch hinders ES preservation as well as the security of ES supply.

Also, although the target group were households rather than organisations, Amin et al. (2015) found that dependence on ES has a positive relationship with preference for preserving nature via protected areas. Linking back to the objectives of this study, this is why in the survey respondents were asked both about perceived dependence and perceived risk of ecosystem degradation, as it will be detailed in the following chapter.

Additionally, Abson and Termansen (2010) suggest that framing the degradation of ES as a monetary risk for stakeholders' organisations can encourage actors to act in the preservation of nature.

3.3 Impact on ES

To investigate double materiality, this study examined perceived impact of stakeholders on ES Jericó-Daminello et al. (2021) found a gap between self-perceived role of stakeholders regarding ES conservation and their role attributed by other actors and concluded that they differ greatly across stakeholders. This gap may be considered an additional barrier to the implementation of ES conservation into decision-making of organisations. It also concludes that future-looking governance should deal with power imbalances and facilitate the collaboration between stakeholders.

3.4 Policy Levers and Actions

Jericó-Daminello et al. (2021) also researched on the challenges to be addressed for a more inclusive and flexible governance as for example the providers and beneficiaries of ES are highly dispersed both vertically in terms of governance levels and horizontally in the different sectors of society (Loft et al., 2015). They highlighted the importance of balancing actors' interest and values, which again points at the direction of collaboration between stakeholders as a pillar of ES preservation for a secure supply chain.

3.5 Enablers on ES

Schleyer et al. (2015) found out that the concept of ES offers several opportunities to create policies that promote both biodiversity conservation and their provision. It can explicitly show the relation between nature and society, increasing the awareness of actors. Additionally, Congreve et al. (2018) have identified partnerships across stakeholders as a main enabler, as proved by projects such as Upstream Thinking and SCaMP, the support of regulatory systems that allow for localised decision-making as well as lower uncertainty for businesses that want to adopt a future-looking strategy with regard to ES integration in their activities. Congreve et al. (2018) also mention the resourcefulness of professionals with different expertise, as well as the co-production of knowledge as enablers from the side of human resources. They also investigated the role

of risk-based assessments of service provision (Mace et al., 2015), or tools like the "traffic light" system that informs on the relative importance of social, economic and environmental factors to inform decision-makers.

3.6 Barriers on ES

The need for a joint effort among stakeholders is seen as a challenge for ES governance and sustainability in general (Jericó-Daminello et al., 2021). Schleyer et al. (2015) also insisted on the importance of vertical and horizontal policy integration, plus the involvement of stakeholders in policy-making. They concluded that ensuring that the ES concept is well understood by actors is not sufficient to ensure their integration in decision-making processes. Additionally, they stress how participatory strategies can be useful only for policy integration at the local level, as well as the communication between policy fields. In fact, they are likely to fall short on addressing the integration of vertical policy, as well uneven distribution of power and conflicting interests on the side of horizontal policy integration. Further barriers found by Congreve et al. (2018) are temporal and spatial mismatches between actors' interests and influences, once more the poor communication between policy and industrial actors, and the low compatibility of market-based mechanisms that are rather short-term oriented, with long-term preservation of ES and security of supply.

3.7 Research Gaps

Previous studies have investigated the perception of specific stakeholder groups like farmers (Teixeira et al., 2018) as well as the influence of socio-cultural factors on such perception (e.g. education level) (Thiemann et al., 2022) and the difference between genders in the perception of ES (Yang et al., 2018), but there seems to be a lack of studies that comprehensively attempt at analysing the perceived familiarity, dependence and impact on, as well as the challenges and opportunities (that we named barriers and enablers) in relation to ES in decision-making processes. From the literature reviewed, there seems to be a lack of studies that carried such an analysis at a global level and in a comparative way with respect to different stakeholders, namely governmental organizations, academia, and industry and businesses. This is precisely the focus of the present study.

This is a critical gap for organisations like PBL, who develop models meant to inform real-world decision-making. Such a gap guided the definition of the sub research questions and the scope of the present study, and consequently the research methods, for example in the definition of the questions of the survey as it will be explained in the following chapter.

4. Methods

For this project, we followed a mixed-methods approach. For the data collection, we conducted a quantitative online survey. This was our main source of information for the posterior data analysis. In addition, we conducted qualitative semi-structured interviews with five stakeholders. We chose this approach together with the commissioner (PBL). This methodology was useful to combine results from the survey and the interviews, and it allowed us to identify patterns in stakeholder perceptions of ES but also more in-depth insights into how these perceptions play a role in decision-making.

Mixed methods are well suited for exploratory research when the goal is to identify broad patterns in perceptions across diverse stakeholders and get insights into how these perceptions influence decision-making processes. Exploratory research designs, as described in social science research literature, aim to study a phenomenon and generate initial insights through data-collection and the follow-up interpretation of it (Bhattacherjee, 2012).

The general methodological approach was defined with the project commissioner (PBL). Together we made sure that the results align with the objectives of BAMBOO and delivered the results the project description asked for.

4.1 Survey

Survey Design and Data Collection

The main data collection method was an online survey, which we conducted using the Qualtrics platform. This survey-based approach was selected as it is an efficient way to gather perceptions form a diverse and dispersed group of stakeholders within the limited time we had to conduct the research. As mentioned in the previous chapter, Barkmann et al. (2008) argued that the little familiarity of lay respondents with ecosystem functions does not affect respondents' ability to value ES. Additionally, as this study intends to help shape future research of PBL that aims at informing policymaking about the integration of ES decision-making, we deemed it important to investigate the opinions of the targeted stakeholders as perceptions shape behaviour as largely proved by existing literature (Schoenfeld & Cumming, 2004). Additionally, building a short and accessible survey was a priority for this study in order to maximize the completion rate of the survey. For all these reasons, this study investigated the perceived knowledge and relations that stakeholders have with ES.

The survey consisted of closed-ended questions (except the possibility of answering "other" in some questions), including Likert-scale, multiple-choice, and matrix-style rating questions. The full survey we distributed can be found in Appendix A.

To encourage participation, the survey was designed to take approximately 10 minutes to complete. To organize responses into valuable information to answer our research questions, we divided the survey into four sections:

(1) Respondent background and organizational information: including questions about organization type, sector, geographic scope of activities, and where they are based. This information was useful to classify respondents into stakeholder groups and conduct a comparative analysis.

(2) Understanding and familiarity with ES: we provided the participants with an adapted definition of the term and used self-assessment questions to assess their familiarity.

(3) Relevance and impacts of ES: the questions in this section were to explicitly look at double materiality, as we asked respondents to assess both dependence and impacts, they perceived their organization has on ES.

(4) Integration of ES into organizational decision-making: we included questions on perceived barriers, enabling factors, and actions or policy levers that are in place or under consideration.

Scope, Sampling and Survey Distribution

We aimed for a global outreach and broad participation across sectors and organizational roles. This implies that rather than focusing on reaching a single stakeholder group, we sought answers from anyone currently working, with the aim of capturing general stakeholder perceptions of ES across sectors and roles.

This study used a non-probability, purposive sampling strategy, supplemented by convenience sampling, which is appropriate for exploratory research aimed at understanding perceptions and trends across groups rather than achieving statistical representatives (Nikolopoulou, 2022). Stakeholder contacts were collected from multiple sources. PBL provided a list of relevant stakeholders associated with their professional networks, and academic staff from Industrial Ecology also were contacted to complete the survey. Additionally, we (the group members) also used personal and professional work contacts from working experiences. Finally, the survey was also published via our LinkedIn accounts, to reach beyond the mentioned networks. This sampling approach is appropriate for the exploratory study we conducted to understand perceptions, priorities and knowledge gaps across different stakeholder groups. The set of limitations that this strategy implies are discussed further in section 6.6, as a limitation of the research.

These limitations do not undermine the value of the research, but they indicate that findings should be interpreted as indicative of patterns and trends in stakeholder perceptions rather than representative of the entire population.

4.2 Interviews

In the survey, we asked participants if they would be interested in participating in follow-up activities such as interviews. We reached out to those indicating they would like to engage further with the study. From all the people contacted, we ended up conducting five semi-structured interviews with participants who voluntarily agreed to do so. We used these to complement the survey findings by providing more detailed qualitative insights into how ES and double materiality are perceived and implemented in practice. The semi-structured format was useful for flexibility to let interviewees elaborate on different issues. Except for one interview that was conducted in person, the other ones were online.

The interview questions were structured around several core themes: (1) the interviewee's role and organizational context; (2) perceived dependencies and impacts on ES; (3) barriers and enabling factors into the organizational process; and (5) actions, policy tools, and knowledge needs related to ES. Where relevant, we tailored questions to the interviewee's sectors, to get specific answers in each case. We also allowed for the interviewee to talk about anything they considered that was not covered during the interview. The full interview script can be found in Appendix B.

4.3 Data Analysis

We analysed the survey data using a descriptive statistical approach. To do so, we used the built-in analysis tools of Qualtrics to generate descriptive statistics and get insights of the responses. To support clearer presentation and interpretation of results, we used Microsoft Excel to create graphs and visualisations.

Additionally, we also did a comparative analysis across the three stakeholder groups from which we obtained more answers (policy/government, business/industry, and research/academia). Although we collected the answers of the other groups, we did not use them in our comparative study. This was because the number of answers was too low to get relevant insights from them, and after looking at the ratio of answers per sector, the commissioner was most interested in the three groups mentioned about. We focused the comparison on the differences in familiarity, perceived relevance and risks, and perceived barriers and enabling factors for integration. Due to the exploratory nature of the study and the working sample size, the analysis was focused on identifying patterns and trends rather than delving deeper into testing causal relationships.

For simplification purposes and to get more significant results with the analysis, we grouped ES into three broader groups: provisioning services, regulation and maintenance services, and cultural services. The classification of ES into these can be seen in Table 1.

Table 1: Grouping of ES into 3 groups

Provisioning Services	Regulation and Maintenance Services	Cultural Services
• Renewable & non-renewable energy • Food, water & raw materials	• Clean air & climate regulation • Waste treatment & purification • Biodiversity & pollination • Healthy soils & nutrient cycles • Water systems & hazard protection	• Health & wellbeing contributions • Cultural & recreational values

The interview data was analysed qualitatively by reviewing and identifying themes and insights that helped contextualize and interpret the survey results. These insights were used to contextualize and enrich the quantitative results, providing depths and explanation beyond the survey findings, and giving the research group the opportunity to try a new method and interact with stakeholders.

4.4 Ethics

This study involved human participants, and we therefore explicitly considered ethical aspects throughout the research design and data collection process. We addressed ethical considerations by embedding informed consent and data protection measures directly into our methods.

For the online survey, we included a consent form at the start of the questionnaire. This form informed participants about the purpose of the study, the voluntary nature of participation, and the anonymous and confidential handling of their responses. Participants could only proceed with the survey after actively providing

their consent. The consent form was developed following ethical guidelines used within the BAMBOO project and by PBL (Appendix C).

For follow-up interviews, we obtained verbal informed consent from all participants prior to starting the conversation. At the beginning of each interview, we explained the aim of the research, how the information would be used, and assured participants that participation was voluntary and that they could withdraw at any time. We did not record any personal identifiers, and we treated all interview data confidentially.

5. Results

This chapter describes all the results from the survey and the interviews. It starts with an explanation of the background of the 53 respondents. Then, the results of the survey are analysed on several different topics: Familiarity, perception of risk to the organisation if ES would degrade, perceived impact and dependency on ES of their organisation, the current implementation of ES into organisation's decision-making, the actions they are considering or taking to implement ES into their decision-making and the barriers and enablers to implement ES into their organisation's decision-making. The insights from the interviews are integrated into the results per section. The full interview insights are described in Appendix D.

5.1 Participant Background Profile

Of the 165 participants who began the online survey, 53 completed all questions. Only these completed responses were included in the analysis. Two-thirds of respondents are from the Netherlands (66.0%), 15.1% are from elsewhere in Europe, and the remaining 18.9% are from the rest of the world.

Sector representation was balanced: 30.2 % from industry, 24.5 % from research or academia, 15.1 % from government, 15.1 % from consultancy, 9.4 % from NGOs and 5.7 % from other sectors. Roles ranged from researchers/analysts (≈ 31 %) and middle management (≈ 28 %) to specialists/advisors, top management and others. Figure 1 gives an overview of the respondent's profile.

The survey question distinguished between five organization size groups: 1-9, 10-50, 51-100, 101-500, and 501+. For the data analysis, we grouped them into three groups: Small (1-9 and 10-50), with a sample size of 12; Medium (51-100 and 101-500), with a sample size of 12; and Big (501+), with a sample size of 29.
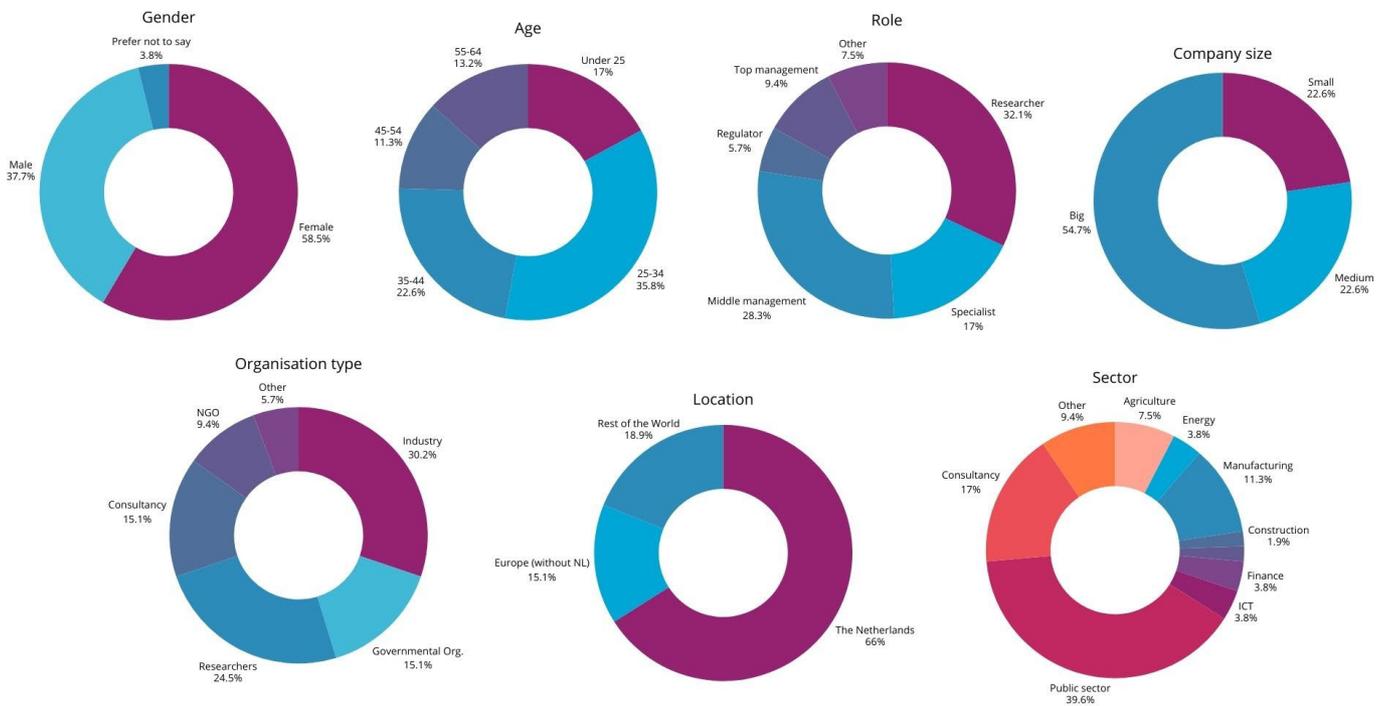
Figure 1: Overview of participants' background

5.2 Understanding of ES

Perceived Familiarity

Matching our research questions, we asked how familiar the respondents are with ES. We did not test their knowledge on the subject, rather, the participants could score familiarity with ES on a scale from "not at all familiar" to "Extremely familiar". Overall, 37.7 % of respondents reported being "very" familiar with ES, 20.8 % "moderately" familiar, 18.9 % "slightly" familiar, and 11.3 % "not at all" familiar (Fig. 2). We see that there is a statistical relationship between the organisation type of our respondents and their perceived familiarity (p=0.0066). Researchers demonstrated the highest familiarity, with roughly half reporting moderate to high familiarity. Industry and government respondents exhibited more even distributions, with about half indicating moderate familiarity and the remainder split between low and high familiarity. Other variables, such as company size, location, gender or age did not provide a significant relationship with perceived familiarity. Interviewees noted that terms like "natural capital" and "climate adaptation" were more familiar than the broader concept of ES, suggesting that framing influences understanding.
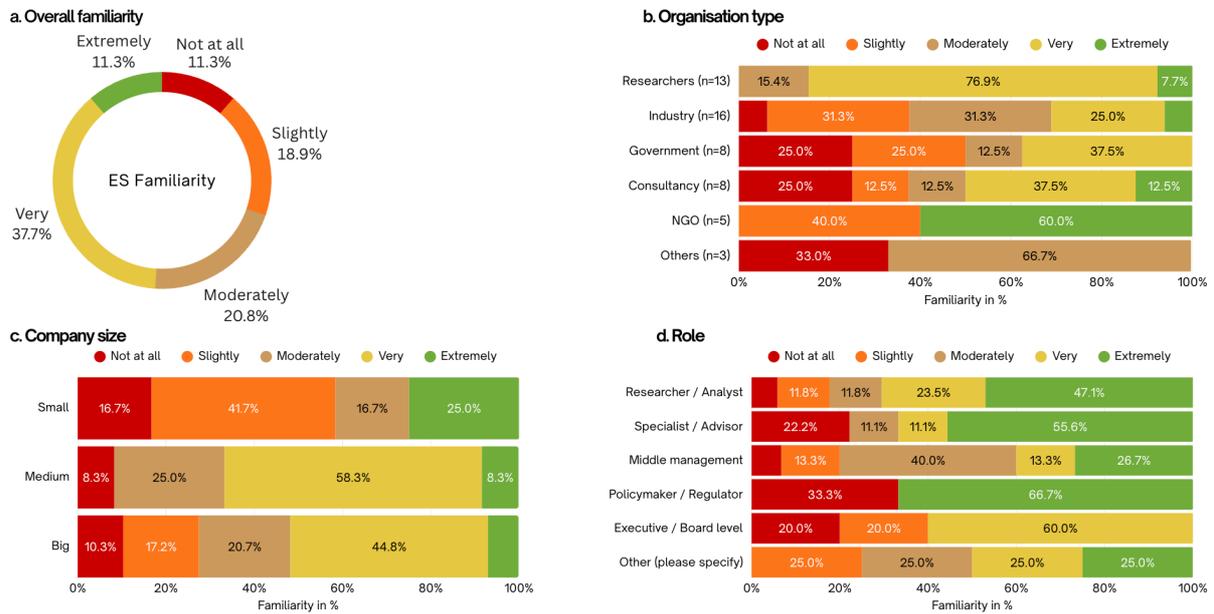
Risk Perception

Figure 2: Perceived familiarity of respondents broken up by organisation type, company size and role.

The participants were asked if they think the degradation of ES is a risk to their organisation, they could choose "yes", "no", or "unsure". When they choose "yes", we asked them to pick the ES that would most impact their organisation if it would degrade. 42% of the respondents recognised ES degradation as a material risk to their organisations. Among industry respondents, 31 % acknowledged the risk, while 54 % of researchers and 50 % of government respondents did so (Figure 3). Those who did not perceive ES degradation as a risk cited a lack of understanding or uncertainty about how ES link to organisational performance. Interviewees noted that risk framing is a powerful lever: translating ES degradation into operational and financial risks can motivate action, particularly in sectors less attuned to environmental issues. From the recipients that see the degradation of ES as a risk, 54.5% see the degradation of water systems & hazard protection as the greatest risk to their organisation. The ES "Cultural and recreational values (recreation, tourism, sense of place)" was seen as the ES with the least risk for our respondents' organisations.
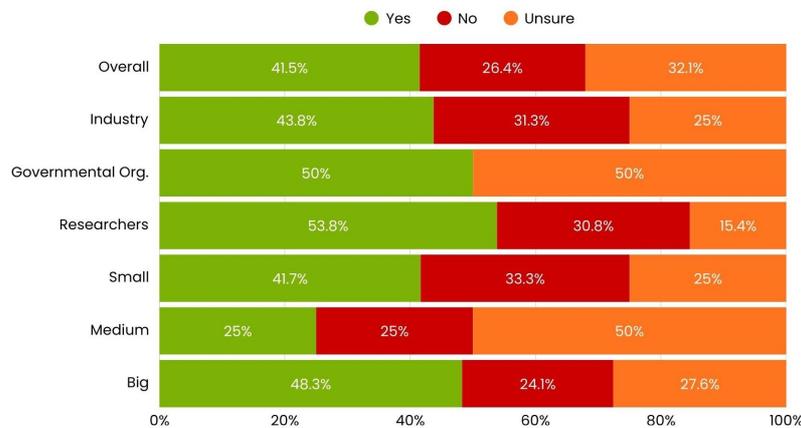

Figure 3: Results to the survey question "Do you think the degradation of ES is a risk to your organisation" - Broken down by the main stakeholder groups and company sizes.

In the medium-sized companies, 50% of respondents are unsure about the risk of ES degradation to their company, while 25% says ES degradation is a risk to their organisation, with all respondents choosing food, water and raw material degradation as the biggest risk to their organisation. The highest number of respondents saying ES degradation is a risk to their company is the respondents from the big companies, with 48.3%. The respondents from small companies 41.7% says ES degradation is a risk to their organisation. 60.0% of these respondents say the degradation of renewable and non-renewable energy is the biggest risk.

5.3 Perceived Dependence and Impact on ES

We investigated which ES the participants say they depend on in their organisation and which their organisation impacts. The analysis of the ES is done based on the groupings explained in Table 1. Across all sectors, respondents perceived greater dependence on ES than impact (Fig. 4).
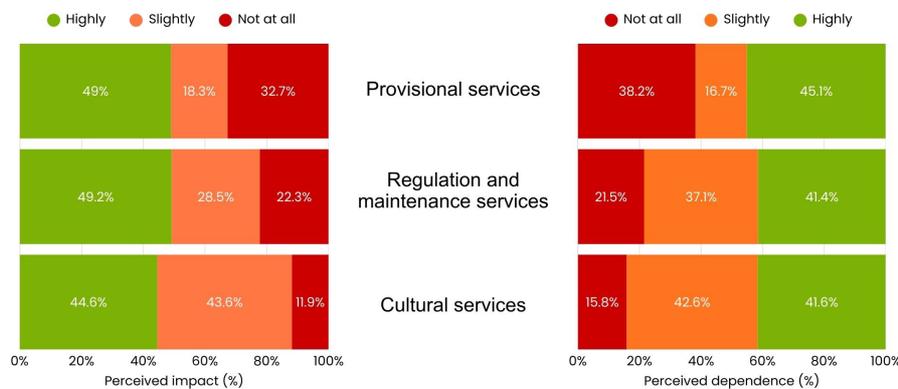

Figure 4: Perceived impact and dependence on three ES groups by all participants.

When asked about provisioning services, most respondents indicated high dependence but only moderate impact. For regulating and maintenance services, dependence and impact ratings were both lower, but the dependence–impact gap persisted. Cultural services elicited high dependence from NGOs and research sectors (Fig. 5), while industry respondents rated their impact as low (Fig. 6). The perceived impact is lower than perceived dependence for all three organisation types, with the perceived impact on cultural services for the industry even being zero. These patterns imply a perception that organisations benefit from ES yet undervalue their own role in degradation. Interviewees reinforced this view, emphasising that their organisations rely on ecosystem health but often view impacts as indirect or negligible.
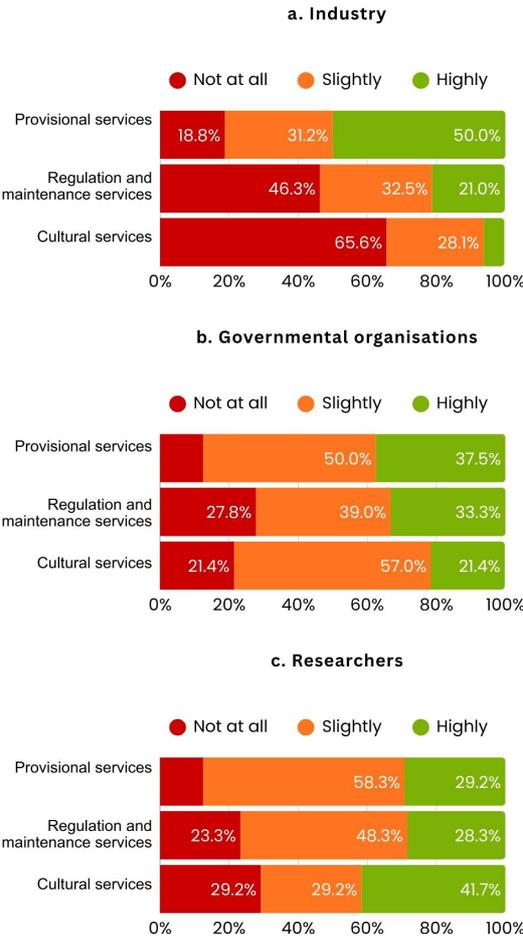
a. Industry

Not at all · Slightly · Highly

	Not at all	Slightly	Highly
Provisional services	18.8%	31.2%	50.0%
Regulation and maintenance services	46.3%	32.5%	21.0%
Cultural services	65.6%	28.1%	

0% 20% 40% 60% 80% 100%

b. Governmental organisations

Not at all · Slightly · Highly

	Not at all	Slightly	Highly
Provisional services		50.0%	37.5%
Regulation and maintenance services	27.8%	39.0%	33.3%
Cultural services	21.4%	57.0%	21.4%

0% 20% 40% 60% 80% 100%

c. Researchers

Not at all · Slightly · Highly

	Not at all	Slightly	Highly
Provisional services		58.3%	29.2%
Regulation and maintenance services	23.3%	48.3%	28.3%
Cultural services	29.2%	29.2%	41.7%

0% 20% 40% 60% 80% 100%

Figure 5: Perceived dependence on ES - broken down into organisation type.

a. Industry

b. Governmental organisations
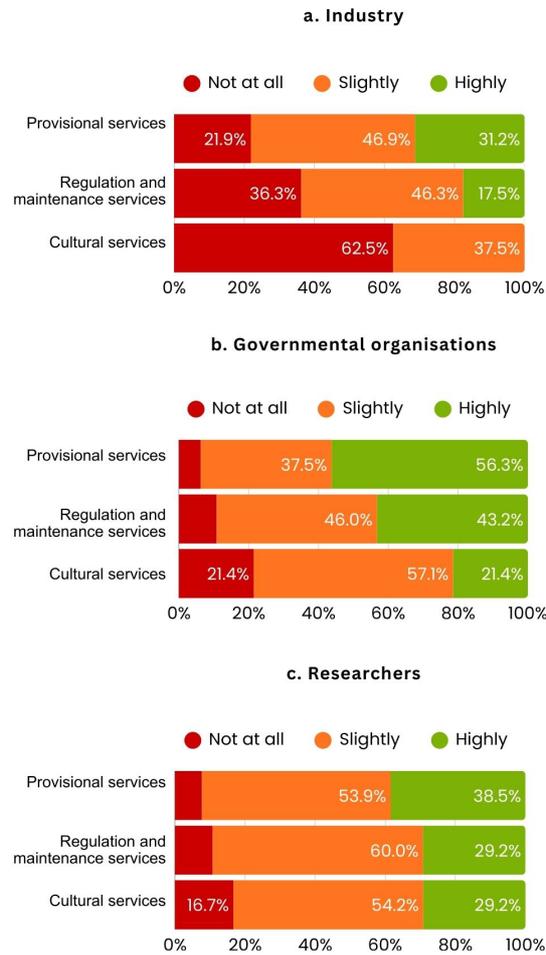

c. Researchers

Figure 6: Perceived impact on ES - broken down into organisation type.

Among small companies, the perceived impact and dependence are overall very low (Fig. 7 and Fig. 8). The participants from the medium-sized companies perceive their impact and dependence on ES as higher than the participants from small companies, except for the cultural services, with 51.3% of respondents saying they do not impact cultural services at all and 56.8% saying they do not depend on the cultural services at all. The perceived impact and dependence are the highest for participants from the big companies.
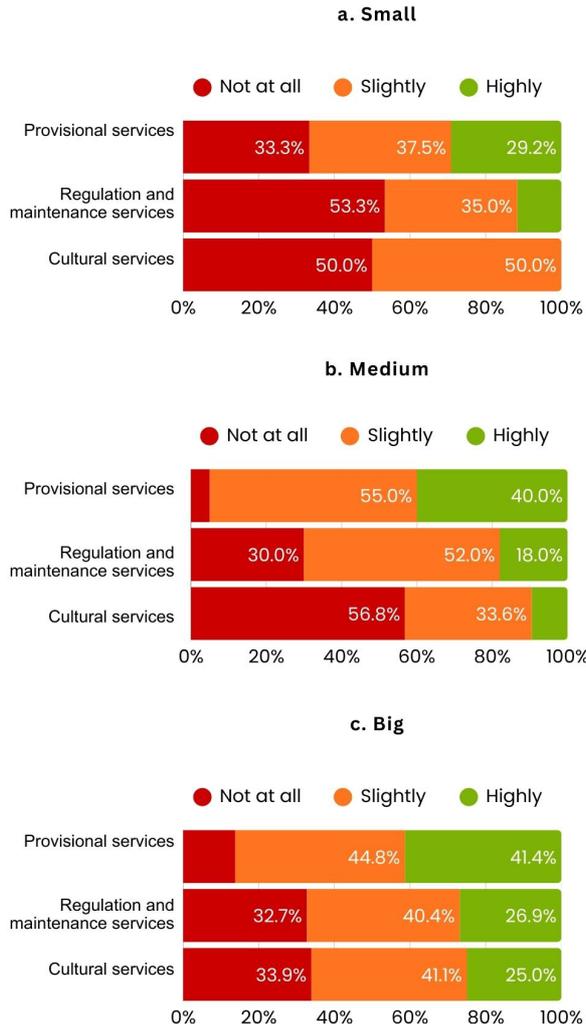
a. Small

b. Medium

c. Big

Figure 7: Perceived dependence on ES - broken down into company size.
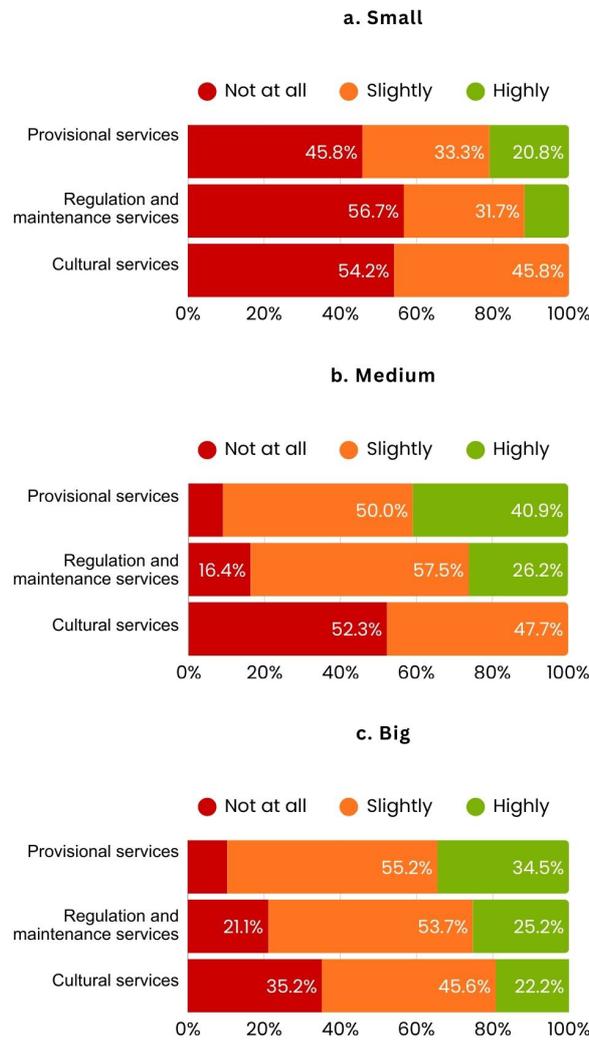
a. Small

b. Medium

c. Big

Figure 8: Perceived impact on ES - broken down into company size.

5.4 Current ES Integration and Organizational Actions

After assessing understanding of ES, we examined how ES are reflected in decision-making practices. Participants were asked to what extent ES are integrated into their organisation's strategies or policies.

A statistically significant association was found between organisation type and ES integration (p = 0.0044, Cramér's V = 0.4366) (Fig. 9). Government organisations and industry reported the highest levels of integration, with 62.5% indicating that ES are strongly or partly integrated. Nevertheless, 18% of industry respondents stated that ES are not integrated at all or that they were unsure. Notably, half of the industry participants indicated that ES are only partly integrated.
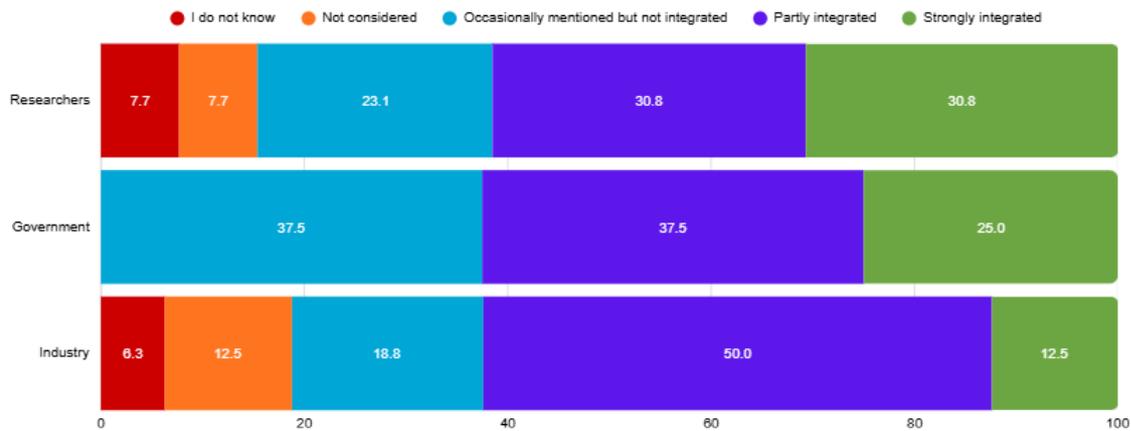
Figure 9: Level of Integration of ES in Organizational Strategies by Organizational Type (in %).

Although no statistically significant relationship was found between an organisation's geographical focus and ES integration, descriptive patterns suggest that global organisations most often reported that ES are "not considered," while regional organisations showed the highest combined levels of partial and strong integration (Fig. 10)
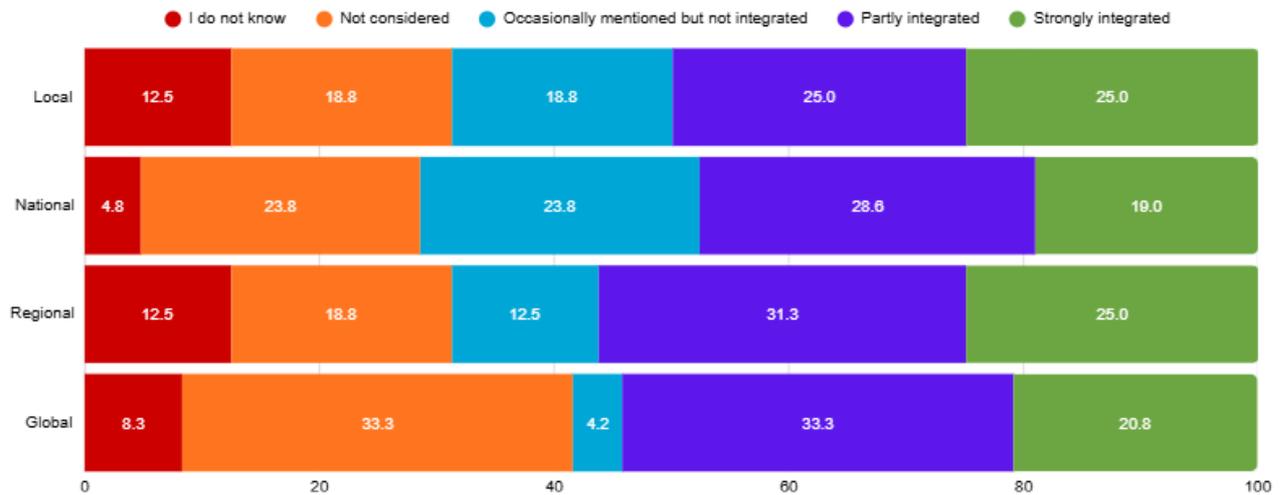

Figure 10: Integration of ES in Organizational Strategies by Organizational Level (in %).

Similarly, no statistically significant association was found between organisation size and ES integration. Nevertheless, descriptive trends suggest that 50% of small organisations (<50 employees) reported that ES are not considered or that they were unsure, whereas 55.2% of large organisations (>501 employees) indicated partial or strong integration of ES into their strategies and policies (Figure 11). The figure suggests a tendency for ES integration to increase with organisation size.
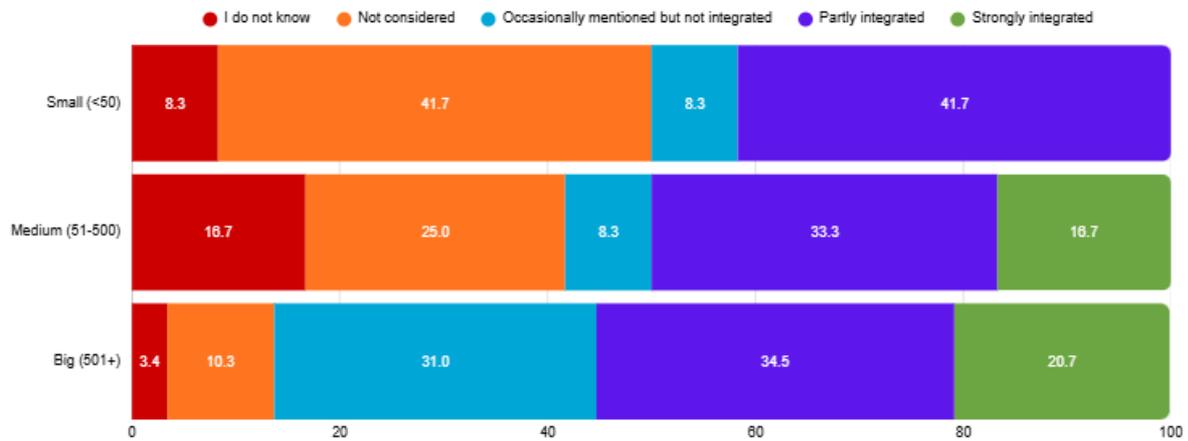
Figure 11: Integration of ES in Organizational Strategies by Organization Size (in %).

We then examined the specific actions and policy levers used by organisations to integrate or promote ES in decision-making. Participants were asked: *"Which of the following actions or policy levers does your organisation currently use or consider for integrating or promoting ecosystem services (ES) in decision-making?"* The question included 15 statements grouped into five thematic categories (Table 2).

Table 2: The actions and policy levers presented to survey participants.

Policy & Planning
☐ Include ES in policy planning, land-use, or environmental impact assessments
☐ Apply regulatory instruments *(mandatory reporting, offsets, compliance requirements)*
☐ Use economic instruments *(subsidies, taxes, tradable credits)*
Implementation & Projects
☐ Fund or implement restoration, conservation, or nature-based projects
☐ Conduct pilot projects or experimental initiatives
☐ Adopt sustainable product or service design *(e.g., circularity, resource efficiency)*
Research, Monitoring & Tools
☐ Monitor and report ecosystem services trends *(databases, indicators)*
☐ Conduct ecosystem services or natural capital assessments
☐ Develop tools, guidance, or assessment methodologies
Collaboration & Advocacy
☐ Collaborate with other stakeholders *(businesses, policymakers, NGOs, research institutions)*
☐ Advocate for ecosystem service-related policies or standards
☐ Participate in voluntary standards, certifications, or pledges

Capacity & Knowledge sharing
☐ Raise awareness and provide training on ecosystem services
☐ Provide guidance, capacity building, or tools to other stakeholders
☐ Publish research or case studies to inform practice

Overall, collaboration with other stakeholders emerged as the most frequently indicated lever across all organization types, followed by adopting sustainable product or service designs, and developing tools, guidance or assessment methodologies. (Fig. 12)
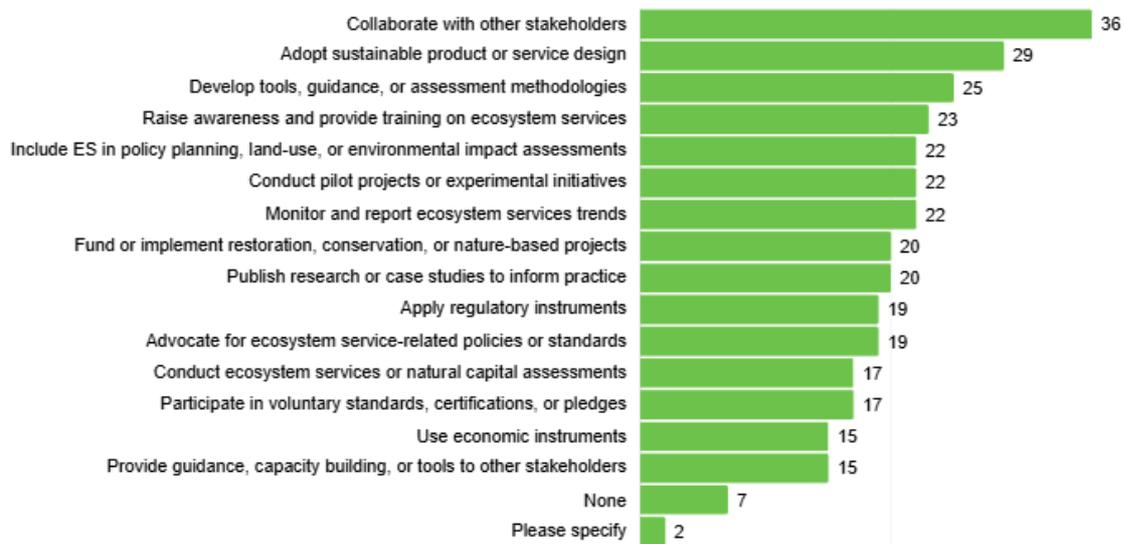
Figure 12: Actions and policy levers considered to Integrate ES in decision-making processes. All participants (n=53).

Collaboration with other stakeholders was consistently identified as a key action across organisations of all sizes (Fig. 13). Although medium-sized organisations also rated it highly, they placed relatively greater emphasis on adopting sustainable product or service design. Within this group, developing tools, guidance, or assessment methodologies emerged as the third most frequently selected action, distinguishing them from other organisation sizes (Fig. 13)
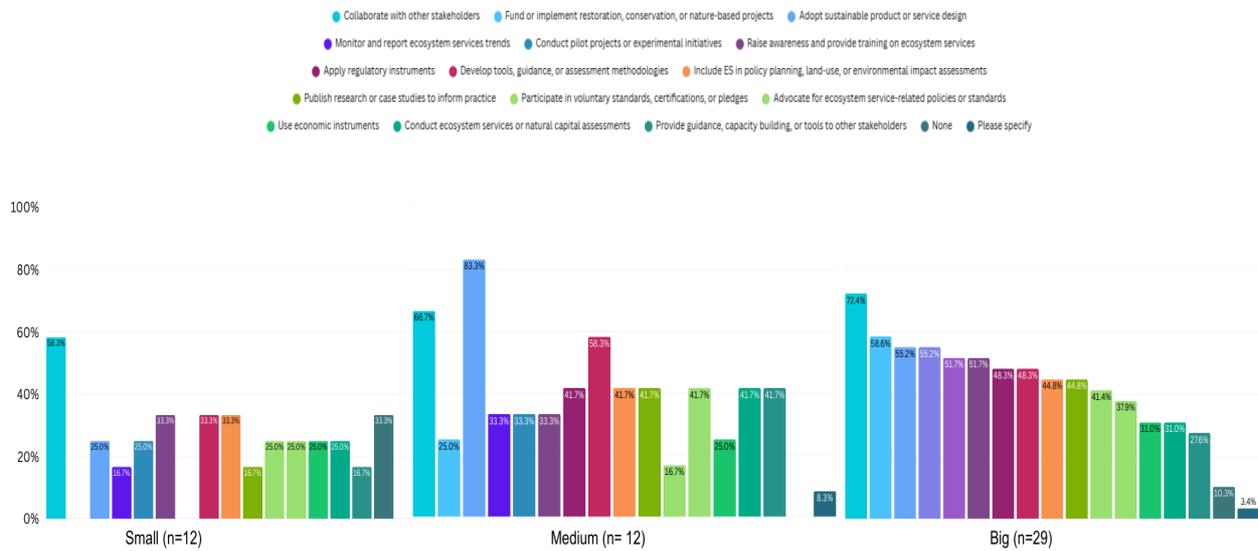
Figure 13: Actions and policy levers considered to Integrate ES in decision-making processes per organization size (n=53).

As shown in Fig. 14, the composition of respondents of our survey in terms of stakeholder type varies by organisation size. Among large organisations (>501 employees), 43.5% were research institutions, 30.4% industry, and 26.1% government organizations. For medium-sized organisations (51–500 employees), the distribution was more balanced, with 37.5% from research, 37.5% from industry, and 25.0% from government organizations. Notably, all small organisations (<50 employees) selecting this action belonged to the industry category.
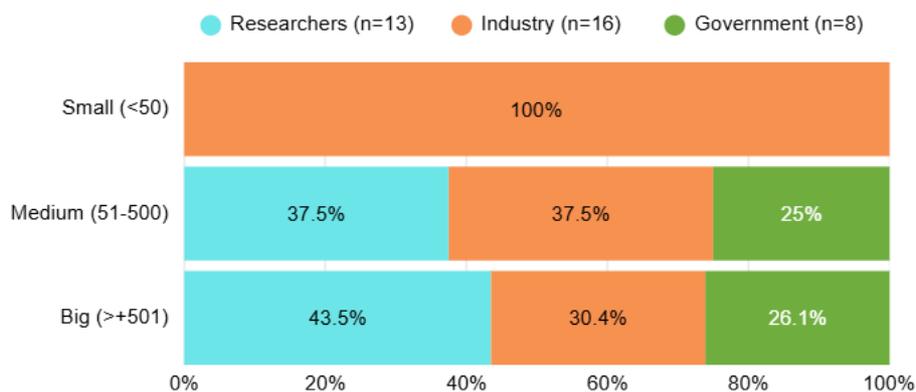
Figure 14: Distribution of survey participants by organisation size and stakeholder type.

Examining organization types more closely revealed differences in the actions identified and their importance. Collaboration with other stakeholders was cited by 88% of government organizations, compared to 77% of researchers and 56% of industry respondents. Moreover, government organizations mentioned Monitoring and reporting ES trends as their second action while researchers mentioned Adopting sustainable product or service design and industry mentioned Include ES in policy planning, land-use, or environmental impact assessments as their second largest action (Fig. 15). Our interviews highlighted that the actions taken by industry are mainly driven by economic logic and business coherence, not by ES as a concept.
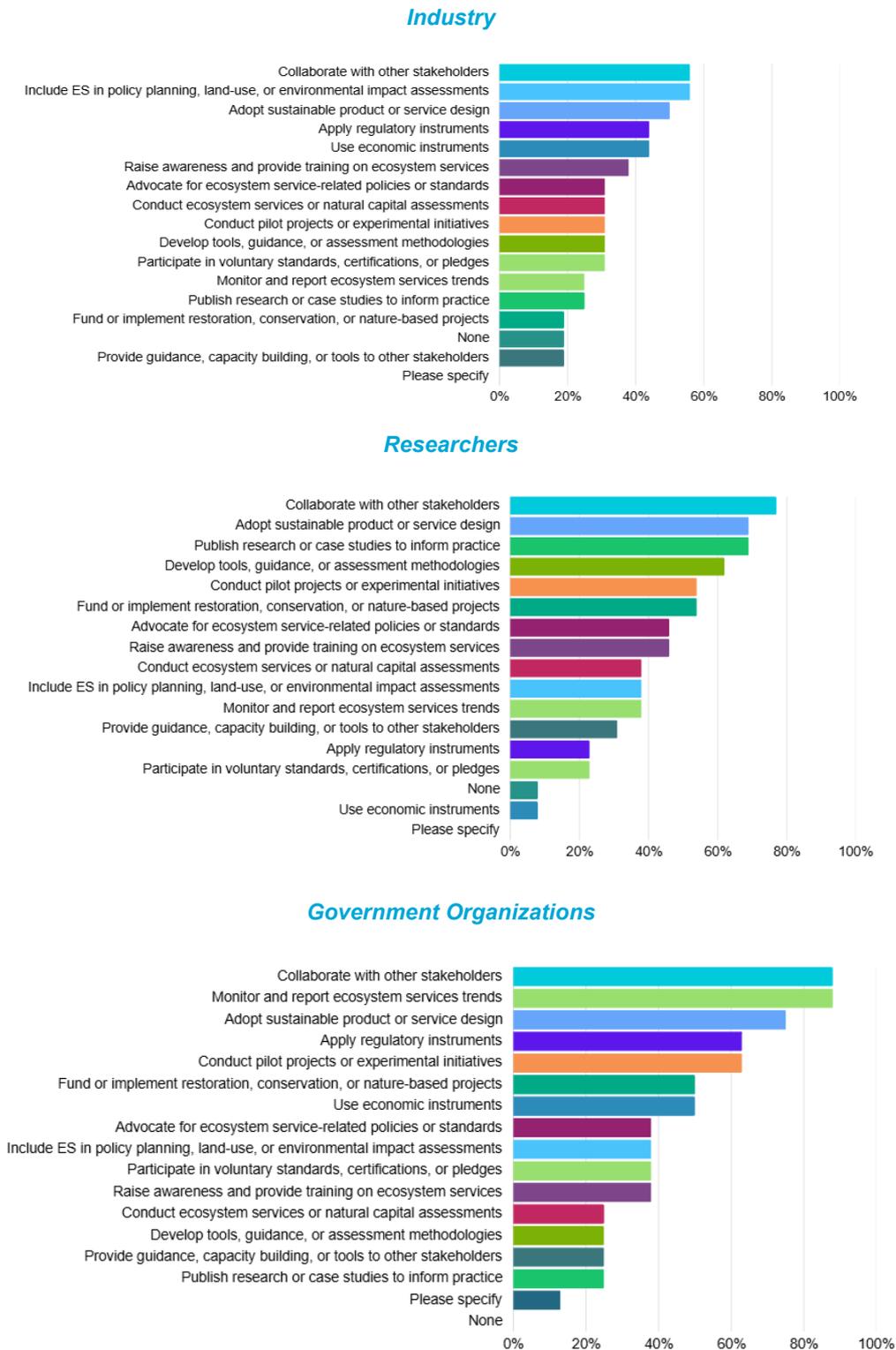
Figure 15: Actions and policy levers considered to Integrate ES in decision-making processes per Organization Type.

Looking at the relationship between ES familiarity and the kind of actions and policy levers considered showed us that those who are familiar (extremely and very combined) rate collaboration with other stakeholders as high, as do *the not familiar* ones, however those that are familiar with ES go on to rate adopting sustainable

product/service design, raising awareness on ES and developing tools, guidance or assessment methodologies as the highest while those that are not familiar rate adopting sustainable product/service design, conduct pilot projects or experimental initiatives, monitor and report ES trends as highest (Fig. 16).
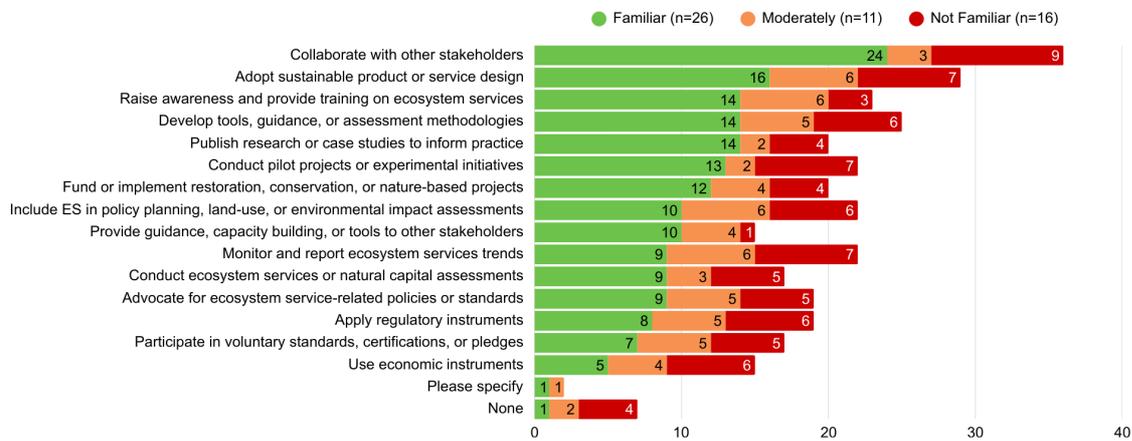

Figure 16: Actions and policy levers considered to Integrate ES in decision-making processes per ES Familiarity Level. (Familiar = Extremely + Very, Not Familiar = Slightly + Not at all). The graph is sorted by Familiar group).

No statistically significant relationships were observed between participants' profile variables, such as age, gender, or organizational role, and their responses to the action lever question. Any potential patterns may have been difficult to detect due to the small sample size within each subgroup, limiting the statistical power of the analysis.

5.5 Enablers and Barriers for ES Integration

The final sub-research question explored which factors stakeholders perceive as barriers or enablers to integrating ES into organizational decision-making. Participants were presented with a set of neutrally formulated statements and asked to rate each on a five-point Likert scale: strong barrier, barrier, neutral, enabler, and strong enabler. This provided a deeper understanding of differing perceptions, showing how the same factor can be interpreted as a barrier or an enabler by different groups, giving us the opportunity to interpret further.

Overall, participants rated stakeholder and client demand as the strongest enabler (when *enabler* and *strong enabler* responses are combined), followed by financial incentives or funding and the availability of tools and models. This suggests that respondents expect external drivers, such as demand, funding, and practical instruments, to play a key role in enabling ES integration.

In contrast, clarity of regulatory or policy frameworks, availability of financial and human resources, and availability and quality of data and metrics were most frequently rated as barriers (when *barrier* and *strong barrier* responses are combined). These responses again point to expectations from external conditions, such as clearer policies and better data provision, to facilitate ES integration. The availability of financial and human resources, however, represents an internal organizational constraint, often shaped by efficiency pressures within a capital-driven economy.

Notably, awareness and understanding of ES received the highest number of *strong enabler* ratings, while also ranking as the second highest *strong barrier*. This highlights the importance of knowledge: when present, it

strongly enables action; when absent, it becomes a significant barrier and in the case of ES, participants indicate it is the first step to start integrating ES into their decision-making processes.

Finally, availability of tools and models, training, capacity and knowledge sharing, and collaboration among stakeholders were least frequently rated as barriers. This may indicate that respondents have not yet encountered limitations in these areas, or that these factors are generally perceived as supportive rather than obstructive in the ES integration process (Fig. 16). Overall, in our interviews, it was emphasised that the barriers are largely structural rather than motivational which can be interpreted as many stakeholders are willing to act but lack the tools and incentives to do so.
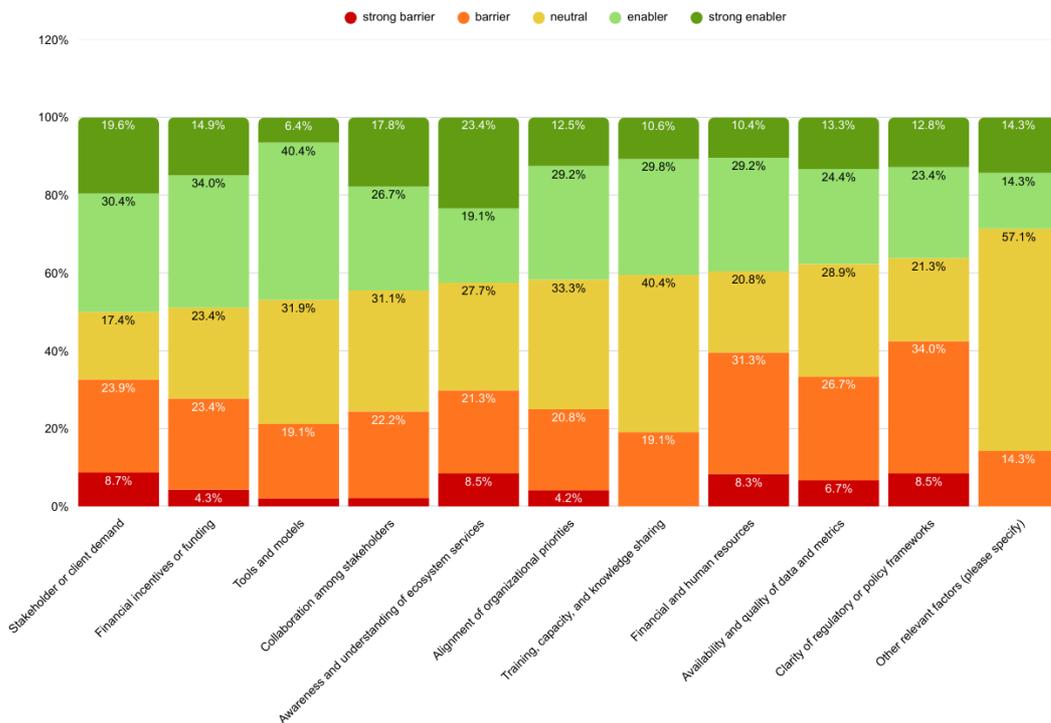
Figure 15: Neutrally formulated statements rated on a five-point Likert scale: strong barrier, barrier, neutral, enabler, and strong enabler. (n=53).

When we examine the data in organization type detail, we see that researchers identified a strong understanding of ES as the most important enabler for integration. At the same time, economic considerations were seen as decisive in determining whether integration takes place. Researchers viewed their organization's internal financial resources as a barrier, while external funding was perceived as an enabler. They also recognized collaboration and demand from other stakeholders as important factors. However, the fact that demand was rated closer to the barrier side suggests that researchers may not yet perceive a strong demand for ES integration from other stakeholder groups (Fig. 17). This point was further emphasized in our interviews, where participants also highlighted the difficulty of quantifying ES. While financial incentives were rated as an enabler in the survey, interpreted as grants for researchers, interviewees noted that in practice, the relevant financial incentives are those aimed at industry, which are the actors who ultimately need to integrate ES into their businesses.

Figure 18: Neutrally formulated statements plotted on a xy-axis graph. If the statement is at the bottom of the diagonal line, it means it is more of an enabler than a barrier, and vice versa. The statements are coloured in terms of their respective group

Industry respondents identified client demand as the strongest enabler. This aligns with the logic of business practice, where responding to market demand is a primary driver of action. In addition, data availability and financial incentives were seen as important supporting factors. Notably, industry respondents rated nearly all factors as enablers rather than barriers. This may indicate that they anticipate ES integration will increasingly become necessary and view most factors as helpful in moving in that direction. At the same time, this pattern may reflect that many industry actors are still at an early stage of their ES integration journey, also implied by their level of familiarity with the concept, and have limited experience with factors that have acted as barriers in the past (Fig 19). Our interview results also highlighted that the industry has less time for regulatory practices when they do not support their bottom line in their P&L which is also reflected on their awareness, motivation, knowledge and internal capacity regarding ES. For ES to become integral, they emphasized that a behaviour change needed to happen on a system level, starting with individuals, to internalize the importance and impact of ES. Additionally, there should be a compelling business case for the main actors.

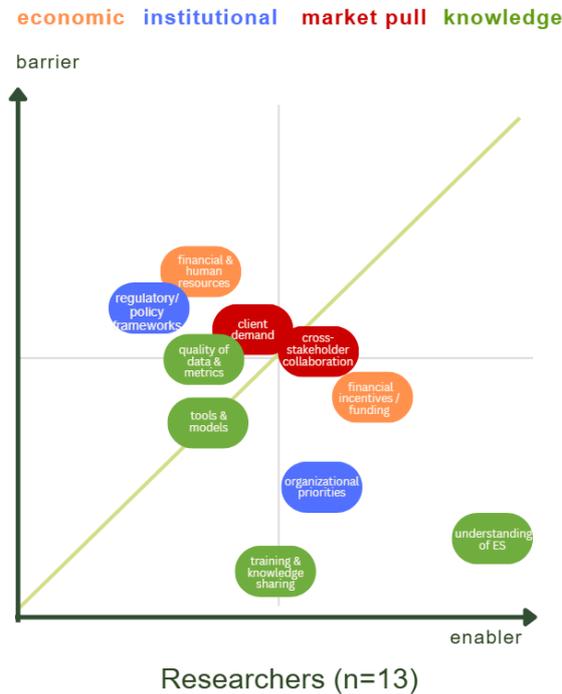economic   institutional   market pull   knowledge

Industry (n=16)

Figure 19: Neutrally formulated statements plotted on a xy-axis graph. If the statement is at the bottom of the diagonal line, it means it is more of an enabler than a barrier, and vice versa. The statements are coloured in terms of their respective group

Government organization respondents, in contrast, identified financial incentives and funding as the most significant barriers, reflecting the reality of constrained public budgets. They emphasized that improved understanding of ES and stronger organizational prioritization would drive action. Clear policies and collaboration were also seen as important enablers. Tools, models, and training were considered supportive, but secondary, factors (Fig. 20). Interviews with governmental organizations participants highlighted an additional challenge: an overabundance of data and departments, which slows progress, combined with higher management's reluctance to embrace significant change and innovation.

economic   institutional   **market pull**   knowledge
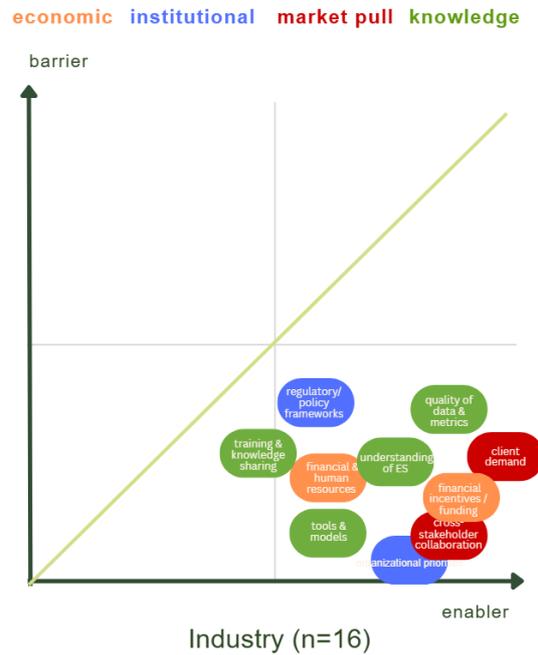
Governmental organisations (n=8)
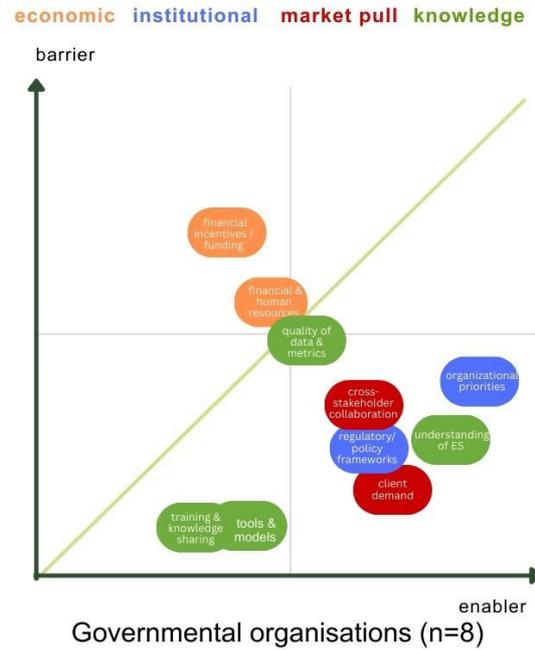
Figure 2016: Neutrally formulated statements plotted on a xy-axis graph. If the statement is at the bottom of the diagonal line, it means it is more of an enabler than a barrier, and vice versa. The statements are coloured in terms of their respective group

When grouping the statements into broader themes, namely economic, institutional, market pull and knowledge, a clear pattern emerges for researchers, knowledge is the primary enabler; for industry, other drivers such as demand and incentives outweigh knowledge; and for government organizations, economic constraints represent the main barrier to ES integration (Figure 21),

	Knowledge	Market Pull	Economic	institutional
Researchers (n=13)	+	±	±	±
Industry (n=16)	+	++	++	++
Policymakers (n=8)	±	+	–	+

Figure 21: The overall rating of statements in their groups per organization type.

6. Discussion

6.1 Ecosystem services as a fragmented concept

This study finds that ES are widely recognised but not consistently defined and framed across stakeholder groups. The results show that reported familiarity with ES does not imply a shared understanding of what the concept entails, or how it should be operationalized and implemented within organizations. Instead, stakeholders interpret ES through different sector-specific lenses.

The insights from interviews strongly support this interpretation. Actors from governmental organizations described ES considerations as included implicitly in existing frameworks, while business-oriented actors highlighted alternative framings that better align with corporate priorities. Within respondents reporting high familiarity, ES are discussed using different vocabularies and problem framings, suggesting that familiarity with the term does not equal conceptual alignment.

Therefore, ES does not function as a shared boundary concept that enables coordination across science, policy, and industry. Instead, it means different things to different actors, depending on the stakeholder context. This fragmentation means that a unique approach for everyone for ES integration is unlikely to be effective, as stakeholders do not start from the same conceptual position.

ES do not need more strict standardization; they need integration efforts to account for existing frameworks and contexts. Translation and reframing strategies are more important than enforcing uniform terminology. For organizations like PBL, this means that analytical and modelling efforts should begin from where stakeholders stand, and not from the assumed "ideal" position where they should be about ES. These translation efforts are important to avoid conceptual fragmentation risks creating coordination issues when ES are introduced in stakeholders' policies and decision-making.

6.2 The dependency-impact gap

A second key finding is the systematic gap between the perceived dependency versus the impact that stakeholders have on ES. While dependency is widely recognized, the impact on ES (or the responsibility over them) is not. Across all groups, respondents reported higher dependence than impact, indicating that organizations acknowledge the benefits they get from nature, but are less willing or able to recognize their own role in affecting ES.

The pattern is most pronounced within industry respondents. These indicate dependence mainly on provisioning services, while perceived impacts (particularly on cultural services) are minimal. This suggests that understanding dependency does not necessarily translate into understanding responsibility. Dependency and impact seem to be separated in stakeholders' perceptions and how they understand their relationship with nature.

This gap is important to look at, because it can weaken the link between awareness and action. Being aware of dependency is not a trigger for impact management and can contribute to ignoring responsibilities, as nature is seen as important but there is no organizational responsibility for its degradation, or it is unclear. For ES to be a driver for decision-making and stop being an abstract concept, stakeholders need explicit mechanisms that connect dependency to impact.

Interview insights also connect to these dynamics. Several interviewees described impacts as indirect or difficult to trace across value chains, resulting in uncertainty about causal responsibility. Others emphasized the lack of tools and metrics that can make impacts visible and relevant for decision-making. As noted by an interviewee from the industry sector, there is a large amount of information out there, but it is not effectively translated into urgency or prioritisation within organizational strategies.

To bridge the dependency-impact gap, tools and approaches should explicitly link dependency, impact, and responsibility. This also helps understand why stakeholders later indicate the need for data, metrics, and policy guidance; because without such instruments, dependency awareness alone seems to be insufficient to motivate action.

6.3 Different stakeholders, different results

The analysis of barriers and enablers shows that the same factors can play very different roles across the studied stakeholder groups. There seems to be no universal pathway for ES integration: Drivers are stakeholder-specific and shaped by distinct decision logics.

For researchers, knowledge-related factors are perceived as the strongest enablers. They generally feel capable of generating ES knowledge. However, economic factors and social or market demand are tipping points that determine if this knowledge is implemented in practice. Institutional factors, such as fragmented policy frameworks and the lack of standardized tools are seen as barriers that constrain translation from research to real decision-making. This shows researchers' abilities to influence action depends less on knowledge production itself and more ion demand, funding, and uptake mechanisms.

For industry actors, client and stakeholder demand emerges as the primary enabler for action, together with financial incentives. Knowledge is a facilitator for implementation but does not seem to be the initiator. Organizational priorities follow external pressures rather than only internal awareness. This is reinforced by interview insights, as an interviewee highlighted how they notice ES quickly drop-down on priority lists during instability periods (e.g., political, economic). ES become decision-relevant when they are demanded or incentivized.

For governmental organizations, institutional mandates and knowledge availability are perceived as enabling factors, while financial incentives and funding constraints are the dominant barriers. This suggests that the challenge for this stakeholder group is not legitimacy or understanding, but lays within resources. They may know what needs to be done and feel ready to act but are lacking financial means to implement ES measures at the organizational scale.

These differences imply that generic approaches to ES integration may not succeed. Instead, there is a need for stakeholder-specific strategies. Translation and uptake mechanisms for researchers, demand signals and incentives for industry, and finding and resource mechanisms for governmental organizations.

6.4 Integration through collaboration

Across the analysed stakeholders, ES are more operationalized through collaboration, implementation within existing practices, and knowledge generations. In contract, new regulatory instruments or market-based mechanisms are mentioned less frequently. This indicates that ES are being integrated in a pragmatic incremented way, and not through redesigning structures.

Collaboration comes up as an important enabler and the most frequent action considered among stakeholders. This suggests that ES integration is a coordination challenge, and that bottom-up or practice-oriented approaches should be favoured over top-down strategies.

Several interpretations of these results are possible. Regulator approaches could be perceived as slow or inflexible, while collaborative approaches invite more for learning and adaptation to different contexts. For PBL, this implies that models and indicators that support coordination, learning, and co-production of knowledge can be valuable. This means supporting platforms that align existing practices could enhance relevance and uptake.

At the same time, the limits of voluntary collaboration should be mentioned. If there is no regulatory base or enforcement mechanisms, pure collaborative approaches alone may struggle to achieve systemic change. Though our results suggest that a pragmatic integration could be effective, it may not be effective on its own.

6.5 The central challenge: translation rather than awareness

Bridging our findings together, the central challenge for ES integration is not if stakeholders are aware of ES, but whether perceptions can be translated into decision-relevant responsibility, incentives to act, and resources that facilitate action. The translation gap can be seen in different ways:

- Awareness without shared framing
- Dependency recognition without responsibility
- Stakeholder-specific logics that need different levers for integration
- Willingness to act without sufficient support

Stakeholders generally understand the importance of nature and show willingness to act when pressures and incentives align. However, they struggle to connect dependency, impact and action within their existing organizational structures. As noted during the interviews, what is missing are the mechanisms that translate concepts into accountability, business cases, and concrete decision-making.

Addressing this challenge requires moving beyond awareness-raising to practical tools, clear incentives, institutional support, and decision-support mechanisms that bridge this gap we identified between conceptual understanding and operational integration. If not, ES risk remaining conceptually robust, but weak in real decision-making. Our recommendations in the conclusion are derived from this discussion points.

6.6 Limitations

Because we prioritised a short and accessible survey for higher completion rate, the analysis focused on perceived relations between stakeholders and ES rather than assessing actual dependencies and impacts using objective data. This methodological choice introduces a limitation: the gap between participants perceived familiarity with ES and their actual knowledge remains unknown, even though this gap may influence how respondents evaluate their dependence on and impact on ES. Evidence from previous research shows that although non-specialists often have a good general understanding of ecological issues, they struggle to identify the underlying ecological dynamics (Bennett et al., 2005), suggesting that perceived knowledge may not reliably reflect actual understanding.

While the number of respondents that completed the survey (n=53) could be considered satisfactory overall, it did not allow to identify statistically valid trends. Consequently, the study results are purely descriptive and interpretative, not reaching high levels of generalizability that clearly indicate the positioning of global stakeholders towards ES. This implies that the conclusions drawn should be treated with cautiousness. Nonetheless, the study still offers interesting insights that may be helpful in future studies, especially for PBL in the context of the BAMBOO project.

An additional limitation of this study relates to the composition of the sample. Although the project aimed to include a broad range of international and global stakeholders, 66% of survey respondents were based in the Netherlands. As a result, the findings cannot be readily generalized to the global context, as several regions and national perspectives remain underrepresented. Instead, the overrepresentation of Dutch respondents increases the relevance and generalizability of the findings for the Dutch policy and decision-making context. However, the remaining share of international respondents still provides indicative insights into how ES are perceived and used beyond the Netherlands.

Lastly, due to time constraints, the sampling method was non-probability, purposive sampling strategy supplemented by convenience sampling (Chapter 4). This implies that for the researchers/academia group, the respondents are likely to have a higher familiarity with ES and therefore different perspectives than the general population. Therefore, the perceived familiarity and risk associated with ES degradation might be lower than what was found in our study.

6.7 Future research opportunities

Existing literature suggests that both the proximity of ES and the scales at which they operate heavily influence how stakeholders perceive their dependence on and impact on ES. This suggests that scale and proximity should be explicitly considered when valuing ES in management plans (Hein et al., 2005; Casado-Arzuaga et al., 2013).

In our survey, however, fewer respondents perceived ES degradation as a risk, and because perceived proximity to ES was not measured, it is difficult to assess whether spatial scale or distance influenced their responses. Future research could therefore investigate how factors such as ES scale and proximity shape stakeholders' perceptions of dependence and risk.

Another opportunity to expand this research would be to perform a more in-depth survey, with a larger reach out that allowed for a bigger N to study and a more advanced statistical analysis, to be able to identify statistical correlation and patterns. With such larger database, future studies could also look at other stakeholders that were not included in this comparative study and achieve a more global perspective.

7. Conclusion

In this sustainability challenge, we investigated the case of how stakeholders perceive ES and how perceptions shape integration into decision-making within their organizations. The case for the study was proposed by PBL, as part of the BAMBOO Horizon EU project, which focuses on scoping stakeholder needs for biodiversity and ES indicators, applies and tests ES indicators in case-study context. With our results and conclusions, we aimed to gather evidence on stakeholder perceptions on ES, and how these translate into requirements for models and indicators.

We conducted an online survey, from which we got a total of 53 finished respondents. From these, we observed the groups of governmental institutions, industry, and research. We aimed to conduct a global study, although most of our answers were within EU scope, and especially from the Netherlands. Additionally, we conducted five qualitative interviews.

Our methodology allowed us to answer the proposed research question and the three sub-research questions that allowed us to specifically investigate perception and preference, actions and knowledge, and enablers and barriers. Here, we go back to our research questions, providing explicit answers based on our results, discussion, and recommendations.

Sub RQ-1: How familiar are different stakeholders with ecosystem services, and how do their perceptions of risks, dependencies, and impacts differ across stakeholder groups?

We found that familiarity varies by sector and takes different forms. Researchers show the higher familiarity numbers, while government and industry stakeholders have more answers leaning towards the unfamiliar side, although the lowest was for industry at 50%, which is still not a big number of unfamiliar respondents.

Most importantly, we identified a systematic dependency-impact gap: stakeholders consistently perceive higher dependence on ES than their impact on them. This gap is more pronounced in the industry sector and suggests a diffusion of responsibility that may lead to less mitigation efforts. Risk perception remained moderate across these three stakeholder groups, with only about half of respondents recognizing the degradation of ES as a risk to their organizations. This low-risk perception output is problematic but makes sense with the other results, as it shows this gap between risk perception, dependency and impact.

Recommendations

Stakeholders display varying levels of familiarity with ES and interpret the concept through different sector-specific lenses. Therefore, PBL should prioritise translation and reframing efforts over awareness-raising alone. Analytical and modelling initiatives should start from existing stakeholder perspectives rather than assuming a uniform conceptual baseline. Addressing the dependency-impact gap identified in this study is key. Tools, metrics and policy guidance should explicitly connect ES dependency to impact and responsibility, enabling stakeholders to recognise their role not only as beneficiaries but also as actors influencing ES outcomes.

Sub RQ-2: What actions and policy levers are stakeholders considering implementing in their decision-making process?

Our respondents seem to strongly favour collaborative and pragmatic approaches over other formal regulatory or market-based instruments. Collaboration and stakeholder engagement, implementation within existing

practices, and knowledge generation were the most considered actions in our survey answers. The interviews also revealed that ES-related actions are already being taken, through climate policies, sustainability frameworks, and explicit environmental planning, but they often don't have an "ecosystem services" label on them. This suggests that the most appropriate strategy would be to pursue pragmatic integration within existing structures rather than top-down redesigning.

Recommendations

Stakeholders prefer pragmatic, collaborative and practice-oriented approaches over new regulations or market instruments. Currently, ES integration happens through existing sustainability and environmental frameworks rather than through structural redesign. PBL can strengthen this by supporting models and indicators that foster collaboration and knowledge sharing. Investing in collaborative initiatives that sectors will help accelerate the integration of ES into stakeholders' decision-making.

Sub RQ-3: What factors hinder or support the integration of ES into decision-making processes?

Barriers and enablers are different by stakeholder group. Researchers are enabled by knowledge and constrained by lack of uptake mechanisms and standardized methods. Industry seems to be driven by lack of external pressure and business cases. Governmental stakeholders have institutional mandates but are constrained by funding limitations and coordination challenges. Barriers recognized across all stakeholders include the lack of standardized tools, poor data availability, and the absence of concrete examples linking ES to financial performance

Recommendations

Drivers of ES integration differ across stakeholder types, so strategies must be context-specific, not universal. Translation and uptake mechanisms should help researchers connect ES knowledge to implementation into decision-making. The industry will most benefit from demand-side and incentive-based approaches, such as procurement requirements, client expectations, and financial motivations. Funding and resource allocation mechanisms need strengthening for governmental organisations to move from conceptual alignment to operational outcomes. PBL can play a crucial role here by developing differentiated pathways that consider these distinct stakeholder preferences.

Synthesis:

These three questions were helpful to get specific insights to answer our main research question, where we asked, "**How do stakeholders perceive ecosystem services, and how do these perceptions shape the integration of ES into their decision-making processes?**"

After the extensive study and specific analysis of different aspects, we conclude that the central challenge is translation, not awareness. Stakeholders seem to generally understand that nature is important, and that they depend on it to keep the business running. However, there is a general struggle to translate this awareness into concrete action within the structures that they have. We identified five key patterns:

(1) ES are recognized but not shared as a common framework.
(2) There is a dependency-responsibility gap where stakeholders perceive benefits but underestimate their own impacts.
(3) Different logics are driving stakeholders, there is not universal lever for integration, so action should consider context-specific strategies.

(4) Integration should be based on a bottom-up approach that focuses on collaboration.
(5) Operational mechanisms are missing, as stakeholders report the lack of tools, resources, incentives, and standardized methods to act on their understanding.

The perception of stakeholders is very important mainly because it shapes the integration of ES into the policy of any organization. They do so by shaping external pressures and enabling conditions, so it means more than just awareness.

Through our research, we found that industry acts when clients demand and their incentives align, governmental stakeholders act when funding and coordination exists, and researchers consider they are producing knowledge, but its uptake depends on others. The gap seems to be structural and operational, not conceptual, as we observe stakeholders wanting to act but lacking the means to do so effectively.

To conclude, our findings show that the main obstacle for ES integration is not convincing stakeholders that nature matters but enabling them to act on what they already know in ways that fit their realities and needs. Rather than for calling for more abstract awareness-raising, we point to the need for better translation infrastructures: tools, incentives and collaboration that connect dependency to impact to responsibility and resources. By making these connections explicit and relevant, ES can evolve from a fragmented concept to a practical language for coordinating actions across industry, governmental organisations and researchers.

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Appendix A: Survey

Section 1: Background/ Respondent Profile

1. Which of the below best describes your organization?
   - o Industry/ Business
   - o Policy/ Government
   - o Research / Academia
   - o Consultancy / Advisory
   - o NGO / Civil Society
   - o Other (please specify)
2. In which country are you based in?
3. What is your age bracket?
   - o Under 25
   - o 25-34
   - o 35-44
   - o 45-54
   - o 55-64
   - o 65 or older
   - o Prefer not to say
4. What is your gender?
   - o Female
   - o Male
   - o Non-binary / gender diverse
   - o Prefer not to say
   - o Prefer to self-describe:
5. At which level is your organization most active (select all that apply)
   - o Local (e.g. province, city or smaller)
   - o National (single country)
   - o Regional / Continental (e.g. EU, ASEAN)
   - o Global / International

Section 2: Understanding Ecosystem Services

6. How familiar are you with the term "Ecosystem Services"?
   - o Not at all familiar
   - o Slightly familiar
   - o Moderately familiar
   - o Very familiar
   - o Extremely familiar

Section 3: Relevance and Impact (Double Materiality)

7. Which of the following ecosystem services does your organization **depend on** and/or **impact** through its activities? (Please rate each that apply in both categories, leave empty if you do not know.)

	Your organization depends on			Your organization impacts		
	Not at all	Slightly	Highly	Not at all	Slightly	Highly
Renewable & non-renewable energy *(solar, wind, biomass, hydropower)*	○	○	○	○	○	○
Clean air & climate regulation *(air quality, carbon storage, climate control)*	○	○	○	○	○	○
Food, water & raw materials *(food, water, timber, fiber, fuel)*	○	○	○	○	○	○
Waste treatment & purification *(water purification, waste assimilation)*	○	○	○	○	○	○
Biodiversity & pollination *(pollination, wildlife space, pest control)*	○	○	○	○	○	○
Healthy soils & nutrient cycles *(soil formation, fertility)*	○	○	○	○	○	○
Water systems & hazard protection *(flood protection, erosion control)*	○	○	○	○	○	○
Health & wellbeing contributions *(medicine, psychological benefits)*	○	○	○	○	○	○
Cultural & recreational values *(recreation, tourism, sense of place)*	○	○	○	○	○	○

8. In relation to your organization's main activites, does the degradation of ecosystem services present a direct or indirect **risk** to your organization?
    - o   Yes
    - o   No
    - o   Unsure

9. If yes, which ecosystem services present the greatest risks to your organization?
    - o   Renewable & non-renewable energy (solar, wind, biomass, hydropower)
    - o   Clean air and climate regulation ((air quality, carbon storage, climate control)
    - o   Food, water & raw materials (food, water, timber, fiber, fuel)
    - o   Waste treatment & purification (water purification, waste assimilation)
    - o   Biodiversity & pollination (pollination, wildlife space, pest control)
    - o   Healthy soils & nutrient cycle (soil formation, fertility)
    - o   Water systems & hazard protection (flood protection, erosion control)
    - o   Health & well-being contribution (medicine, psychological benefits)
    - o   Culture & recreational values ((recreation, tourism, sense of place)
    - o   Others *(please specify):

Section 4: Integration, Barriers & Support

10. To what extent are ecosystem services currently considered in your organization's strategies or policies?
    - o   Not considered
    - o   Occasionally mentioned but not integrated
    - o   Partly integrated
    - o   Strongly integrated
    - o   I do not know

11. Which of the following actions or policy levers does your organization currently use or consider for integrating or promoting ecosystem services (ES) in decision-making? (Select all that apply)

Policy & Planning

☐ Include ES in policy planning, land-use, or environmental impact assessments

☐ Apply regulatory instruments *(mandatory reporting, offsets, compliance requirements)*

☐ Use economic instruments *(subsidies, taxes, tradable credits)*

Implementation & Projects

☐ Fund or implement restoration, conservation, or nature-based projects

☐ Conduct pilot projects or experimental initiatives

☐ Adopt sustainable product or service design *(e.g., circularity, resource efficiency)*

Research, Monitoring & Tools

☐ Monitor and report ecosystem services trends *(databases, indicators)*

☐ Conduct ecosystem services or natural capital assessments

☐ Develop tools, guidance, or assessment methodologies

Collaboration & Advocacy

☐ Collaborate with other stakeholders *(businesses, policymakers, NGOs, research institutions)*

☐ Advocate for ecosystem service-related policies or standards

☐ Participate in voluntary standards, certifications, or pledges

Capacity & Knowledge sharing

☐ Raise awareness and provide training on ecosystem services

☐ Provide guidance, capacity building, or tools to other stakeholders

☐ Publish research or case studies to inform practice

Others

☐ ⭐ Please specify

[_____]

12. Rate how the following factors acts as a **barrier** or **enabler** for *integrating ecosystem services* in decision-making within your organization. (Rate how each factor acts in your organization. For example, if tools and models are lacking, "Availability of tools and models" is a barrier; if they are available, it's an enabler. Leave empty if you do not know.)

	strong barrier	barrier	neutral	enabler	strong enabler
Availability of tools and models	○	○	○	○	○
Clarity of regulatory or policy frameworks	○	○	○	○	○
Alignment of organizational priorities	○	○	○	○	○
Availability of financial and human resources	○	○	○	○	○
Level of awareness and understanding of ecosystem services	○	○	○	○	○
Availability and quality of data and metrics	○	○	○	○	○
Degree of stakeholder or client demand	○	○	○	○	○
Level of collaboration among stakeholders	○	○	○	○	○
Level of training, capacity, and knowledge sharing	○	○	○	○	○
Availability of financial incentives or funding	○	○	○	○	○
⭐ Other relevant factors (please specify) [____]	○	○	○	○	○

13. Which of the following best describes your organization's primary sector of activity?
   o Agriculture, forestry, fisheries, or food production
   o Energy, utilities, or extractive industries
   o Manufacturing and industrial production
   o Construction, real estate, or infrastructure
   o Transport and mobility
   o Finance, investment, or insurance

o   Information & communication technology (ICT), media, or telecommunications
o   Public sector, education, or research
o   Consultancy
o   Others *(please specify):

If "Which of the following best describes your organization's primary sector of activity?" Manufacturing and industrial production is selected

13a. Which of the following industries best describes your organization's manufacturing activities?

Materials & Basic Processing
○ Textile, textile products and clothing
○ Wood and wood products
○ Pulp and paper, paper products
○ Chemicals, chemical products and fibers
○ Rubber and plastic products
○ Glass, ceramics, and non-metallic minerals
○ Basic metals and fabricated metal products
○ Petroleum refining and nuclear fuel
○ Food, beverages, and tobacco

Machinery & Equipment
○ Telecommunications equipment
○ Machinery and industrial equipment
○ Electrical and electronic equipment
○ Computers and office machines
○ Medical, precision, and optical instruments

Transport & Other Manufacturing
○ Automotive manufacturing
○ Other transport equipment (e.g., aerospace, shipbuilding, rail)
○ Furniture, jewelry, and musical instruments
○ Recycling and waste processing
○ ★ Other (please specify)

14. What is the size of your organization
o   1-9 employees
o   10-50
o   51-100
o   101-500
o   500+

15. What is your role or level of responsibility?
o   Researcher / Analyst
o   Specialist / Advisor
o   Middle management
o   Policymaker / Regulator
o   Top management (Executive / Board level)
o   Others *(please specify):

Appendix B: Interview Questions

Before we start, I would like to explain the purpose of this interview. As mentioned in our survey, we are conducting this research as part of a university project on how stakeholders understand and use ecosystem services in decision-making.

Your participation is voluntary, and you can choose not to answer any question or stop the interview at any time. We will treat your responses confidentially and will not attribute any statements to you personally.

With your permission, we would like to use the information you share for research purposes only.

Do you consent to participate in this interview?

<u>**Warm up**</u>

1. Could you briefly describe your role and your organisation's main activities?
    a. Probing questions
        i. What kinds of decisions are you typically involved in?
        ii. Does your organisation use concepts like ecosystem services, nature-based solutions, biodiversity, or sustainability frameworks?

<u>**Dependencies (Q2a) and impacts (Q2b)**</u>

2. In the survey, you indicated certain ecosystem services that your organisation depends on. Could you explain why you selected those? (show options as a reminder)
    a. Probing questions
        i. What does "dependency" mean in your organisation's context?
        ii. Are there guidelines by your organisation on how to implement such dependencies in your daily work, or is it more of an implicit relation of dependency between your organisation and ES?
        iii. In the survey, we asked if you see such dependencies as a risk for your organisation. You answered yes/no/not sure, why did you choose that option? Do you see any risks in such dependencies?
3. In the survey you also indicated that your organisation's activities impact on certain ecosystem services. Could you explain why you selected those?
    a. Probing questions
        i. Do you think your organisation impacts on these ES directly or indirectly?
        ii. Why do you think your organisation impacts on these ES?
4. Can you think of a specific decision, project, or situation where ES considerations (dependency or impact) played a role, even indirectly?
    a. Probing questions
        i. Were ES explicitly part of the discussion?
        ii. Who pushed to take ES into account, or who hesitated?
        iii. What made it easy or difficult to concretely integrate ES in the decision-making process?

Barriers & Enablers

5. In the survey, you identified several barriers/enablers for integrating ES in decision-making processes (e.g., awareness, collaboration, funding, data availability). Which of these are most relevant/influential to your organisation, and why?
    a. Probing questions
        i.   Why did you indicate those factors?
        ii. Can you give an example where a barrier slowed, blocked, or complicated ES integration in the decision-making process?
        iii. What would it take to turn that barrier into an enabler?
        iv. Are these barriers organisational (internal), sectoral, regulatory, or cultural?
        v.   How much value do you think investors of your organisation give to ES in terms of dependency and impacts to your organisation's activities/business model?

General formulation:

"How much attention do the key decision-makers or external stakeholders that influence your organisation place on ecosystem service dependencies and impacts regarding its activities?"

For corporate stakeholders:

"How much importance do investors, clients, and corporate leadership place on ecosystem service dependencies and impacts within your organisation's strategy or business model?" Does ES influence investor relations, disclosure frameworks (e.g., TNFD), or risk management?

For municipal workers:

"How much attention do city administrators, political leadership, or funding authorities give to ecosystem services when evaluating projects or plans?"

Do ES considerations appear in budgeting, urban planning, or public tenders?

For Water & Land-use Advisor (Gebiedsadviseur Water en Ruimte):

"How much priority do your clients, regional authorities, or project partners give to ecosystem service considerations in water and land-use decisions?"

For Academic Researcher:

"How much priority do funders, academic institutions, or policymakers give to ecosystem services in the research agendas you work with?"

Are ES explicitly required or implicitly expected?

For Agricultural Research Scholar (Indian Agricultural Research Institute):

"How much importance do research sponsors, agricultural ministries, or local communities place on ecosystem service impacts and dependencies?"

6. Do you see differences in how various teams, departments, or partner organisations perceive or act on ecosystem services?
   a. Probing questions
      i. Are there conflicting priorities between different departments (partially covered by probing question of Q3, so depends on how the interview goes)
      ii. Do you think there are any gaps between technical and management levels? (e.g. priorities, best practice, short vs long term planning, maybe local vs global approach for big companies, company's reputation)
      iii. Differences between public/private actors?

Actions & Knowledge

7. Your survey answers indicated that your organisation uses or considers certain actions or policy tools related to ES. Could you describe a concrete example?
   a. Probing questions
      i. Why that action/tool and not another?
      ii. Were you able to stick to the initial idea/plan to implement ES in the decision-making process or did you have to give up or change plans due to barriers?
      iii. How successful was it?
      iv. Was it resource-intensive? Would you/your organisation do it again?
      v. Do you think your organisation ultimately benefited from this strategy, or do you expect the effects of it to have an impact in a longer time horizon?
8. What knowledge, data, tools, or support do you feel are currently missing, either for you personally or for your organisation, to integrate ES more effectively into decisions?
   a. Probing questions
      i. Is it data availability or also data accessibility? (technically available but very time/effort consuming)
      ii. Do you think you are lacking practical guidelines on how to account for ES in your work?
      iii. Do you get any training to do so?
      iv. Is there any uncertainty about regulation or future risks?
9. What would your organisation need from the research community to help it better integrate ES in their strategies? More specifically:
   a. What data do you want?
   b. What uncertainty do you want to be explored?
   c. What type of research output would be helpful for you (scenario analysis, dashboards, checklists, etc.).

Closing

10. If you could change one thing, within your organisation or externally, to make integrating ecosystem services easier, what would it be?
11. Is there anything else you would like to add that we haven't covered?

Appendix C: Ethics

This survey is part of the research project **BAMBOO – "Biodiversity and trade: mitigating the impacts of non-food biomass global supply chains"**, funded by the European Union's Horizon Europe Programme (Grant Agreement No. 101059379).

Purpose of the project

You are invited to participate in a research project funded by Horizon Europe where the main purpose is to identify trade-offs between biodiversity impacts along global supply chains of non-food biomass and to determine leverage points for transformative change to halt and reverse biodiversity loss, both now and in the future. For this purpose, we develop new biodiversity impact assessment models, create a new, hybrid multiregional input-output (MRIO) model based on the well-known EXIOBASE and the biomass-specific FABIO models, and link the combined models to the integrated assessment model IMAGE for scenario generation. Apart from global assessments and recommendations, we showcase the applicability of our models in two local case studies of global relevance, fishmeal and fish oil production in Peru and cotton production in Tanzania, as well as two case studies with retailers.

Which institution is responsible for the research project?

The Norwegian University of Science and Technology is responsible for the project (project coordinator). This project is a collaboration among nine institutions across eight countries in- and outside of Europe:

- Norwegian University of Science and Technology, Norway
- Leiden University, the Netherlands
- Vienna University of Economics and Business, Austria
- Federal Institute of Technology Zurich, Switzerland
- Netherlands Environmental Assessment Agency (PBL), the Netherlands
- Africa Policy Research Institute, Germany
- Pontifical Catholic University of Peru, Peru
- Sokoine University of Agriculture, Tanzania
- SGS (General Society of Surveillance), Portugal

Why are you being asked to participate?

We aim at reaching at least 300 survey participants across multiple stakeholder groups, with a focus on 1) policymakers, (non-) governmental and international organisations, and 2) retailers, other business and industry actors, and consultants. You are a representative of the targeted stakeholder groups with relation to ecosystem protection and/or non-food biomass supply chains.

What does participation involve for you?

If you choose to take part in the project, this will involve you filling out an online survey. It will take approx. 10 minutes. The survey includes questions about preferences regarding ecosystem services. Your answers will be recorded electronically.

Participation is voluntary

Participation in the project is voluntary. If you choose to participate, you can withdraw your consent at any time without giving a reason. All information about you will then be made anonymous. There will be no negative consequences for you if you choose not to participate or later decide to withdraw.

Your personal privacy – how we will store and use your personal data

We will only use your personal data for the purpose(s) specified here, and we will process your personal data in accordance with data protection legislation (the GDPR).

PBL will facilitate the survey. Personal data will be used for communication related to the participation. The project group can access a list of participants and their affiliations, as the group will discuss the representativeness and relevance of the pool of participants in view of the project goals. Such data will be shared within the project through a password-protected OneDrive folder hosted at the Norwegian University of Science and Technology, with the OneDrive server based in Ireland.

When processing and summarising the information collected, individual participants will not be linked to specific survey responses. Your name and/or affiliation will only be listed in the acknowledgements of potential deliverables and publications if you give specific consent to it.

What will happen to your personal data at the end of the research project?

The planned end date of the project is 31 August 2026. The final deliverable, in which we report on the stakeholder engagement, is due at the end of the project and will not be public.

After all deliverables have been submitted in their final version, any participant lists with contact information will be deleted. Related scientific publications may still be published after that date. De-identified survey responses will only be deleted after related papers have been accepted for publication to allow for verification. Until then, data will continue to be stored on the project-internal OneDrive folder and on the infrastructure of the project partner leading the respective related publication.

Your rights

So long as you can be identified in the collected data, you have the right to:

- access the personal data that is being processed about you
- request that your personal data be deleted
- request that incorrect personal data about you is corrected/rectified
- receive a copy of your personal data (data portability), and
- send a complaint to the Norwegian Data Protection Authority regarding the processing of your personal data

What gives us the right to process your personal data?

We will process your personal data based on your consent.

Based on an agreement with the Norwegian University of Science and Technology, the Data Protection Services of Sikt – Norwegian Agency for Shared Services in Education and Research has assessed that the processing of personal data in this project meets requirements in data protection legislation.

Where can I find out more?

If you have questions about the project or want to exercise your rights, contact:

- The Norwegian University of Science and Technology via the BAMBOO project leader Francesca Verones (**francesca.verones@ntnu.no**)
- PBL via the survey facilitator Alexandra Marques (**alexandra.marques@pbl.nl**)

Yours sincerely,

BAMBOO Project Leader

Do you consent to participate?

I have received and understood information about the project BAMBOO and have been given the opportunity to ask questions. I give my consent for the following:

- ☐ to participate in the online survey
- ☐ to be acknowledged as a representative of the institution with which I am affiliated
- ☐ to be acknowledged by name
- ☐ for my personal data to be stored after the end of the project for verification until a planned, related scientific article has been published
- ☐ for my personal data to be processed until the end of the project
- ☐ No, I do not wish to participate

Appendix D: Interview Results

- **ES familiarity**

Interviewee 1 - governmental organisation	Interviewee 2 - industry	Interviewee 3 - governmental organisation	Interviewee 4 - industry	Interviewee 5 - researcher
They are familiar with concepts related to ES, although the term "ecosystem services" is not always used explicitly. Instead, the municipality commonly refers to climate adaptation, heat stress, biodiversity, water management, quality of life, and sustainability frameworks. ES are often embedded implicitly in policies, design guidelines, and project requirements rather than being labelled as such.	They are very familiar with ES and biodiversity. However, she explained that these terms often did not resonate well with companies. "Natural capital" and "biodiversity" were introduced, but they sometimes caused confusion. What resonates more strongly with companies is the concept of "net zero nature". Language and framing are therefore very important.	They are familiar with ecosystem services through their studies. In daily work, the term "ecosystem services" is not used very often. Instead, the focus is mainly on water systems, water quality, health, and energy. ES-related ideas are present, but they are not always explicitly named as ecosystem services.	The interviewee is not very familiar with the concept of ecosystem services as a formal framework. However, he has a good practical understanding of how his business depends on nature. Ecosystem services are not used explicitly in company strategy or decision-making.	They are extremely familiar with ES as she does research on integrating them into decision-making of Indian Ministry of Agriculture for a sustainable and secure food supply in India

- **Dependencies on ES**

Interviewee 1 - governmental organisation	Interviewee 2 - industry	Interviewee 3 - governmental organisation	Interviewee 4 - industry	Interviewee 5 - researcher
The municipality depends on ecosystem services to keep the city	As a service-oriented organisation, their organisation does	Their organisation depends on:	The company depends on nature mainly through raw	Its organisation depends and impacts highly on all mentioned ES but

| liveable, safe, and future proof. Important dependencies are climate regulation, cooling through green spaces, water storage, and water infiltration. These dependencies are addressed through many policies, guidelines, and legal frameworks at the municipal and national level. | not have a direct operational dependency on ecosystem services. However, it is indirectly dependent on ecosystem services because its employees depend on clean air, food, water, and materials.

More importantly, their organisation works closely with large companies, especially in energy and industrial sectors, to help them understand how their businesses depend on ecosystem services. | Healthy water systems

Clean drinking water

Flora and fauna within water systems, which require daily maintenance

Renewable energy, for example from wastewater treatment

Water availability for agriculture, especially during dry periods

The organization also depends on technical elements, such as batteries for waste processing, but water remains the most critical dependency. | materials and energy:

Hemp is a key input material for growing mycelium.

Energy is needed to grow the mycelium.

The interviewee expects energy-related impacts to decrease in the future because a new factory will have solar panels. He is not very interested in how hemp is produced or its sustainability, but mainly in its price. | "Waste treatment & purification", on which it depends and impacts slightly because research institute where the interviewee works at focuses on agriculture (department of agronomy), horticulture, crop improvement. |

- **Impact on ES**

Interviewee 1 - governmental organisation	Interviewee 2 - industry	Interviewee 3 - governmental organisation	Interviewee 4 - industry	Interviewee 5 - researcher
The municipality project has direct and indirect impacts on ES. Activities such as tree removal, soil disturbance, construction (…) can negatively affect habitants, water flows and ecological connectivity. The municipality is increasingly having a positive impact by adding green spaces, improving ecological connections, enhancing water permeability, and applying nature-based solutions in public scape and area development projects	The organizations' direct impact on ecosystem services is limited, as it does not produce goods or extract resources. Its influence is indirect, through the guidance, tools, and support it provides to member companies. By shaping how companies understand and act on nature-related issues, they can influence how those companies impact ecosystem services.	The organisation has a direct impact on ecosystem services. It has full control over water systems and wastewater treatment processes. Wastewater treatment produces bacteria and methane, which is used to generate biogas. These activities influence water quality and have effects on air quality. The organization therefore both manages and alters ecosystem services through its daily operations.	The interviewee does not clearly see an impact of improved environmental conditions around the company on business performance. However, the company aims to reduce its environmental impact through sustainable production choices, mainly for economic reasons and for consistency with the company's mission and reputation, not explicitly because of ecosystem services.	Its organisation depends and impacts highly on all mentioned ES but "Waste treatment & purification", on which it depends and impacts slightly because Indian Agricultural Research Institute focuses on agriculture (department of agronomy), horticulture, crop improvement.

- **Perceived risk**

Interviewee 1 - governmental organisation	Interviewee 2 - industry	Interviewee 3 - governmental organisation	Interviewee 4 - industry	Interviewee 5 - researcher
The interviewee sees ecosystem service dependencies as a risk. First, the large number of rules and requirements can make projects very complex. Contractors may hesitate to submit tenders because the requirements are difficult to meet in real public spaces. Second, environmental regulations can lead to high costs and delays. For example, if a protected species is found during an area development project, this can strongly affect planning and budgets. Because of this, ecosystem services are both necessary and a source of risk in projects.	The interviewee emphasized that many companies focus mainly on their impacts on nature, but much less on their dependencies on ecosystem services. This is a risk because dependencies can translate into real financial and operational risks. Currently, many companies are slowing down or stopping their work on nature due to geopolitical tensions and cost-cutting. Because there is often no strong legal driver, nature-related work is seen as optional and is one of the first areas to be reduced.	The interviewee recognizes risks related to these dependencies. Water scarcity is a risk, especially during dry periods when decisions must be made about which agricultural areas receive water. Another risk is that progress is slowed down because knowledge and data are not always shared. When data and models are kept within organizations, innovation and better decision-making are limited.	They mention that degradation risks mainly in relation to raw material supply. Healthy soils and pollinators are important because they affect the availability of raw materials.	ES are occasionally mentioned but not integrated in the organization's strategies, because there is no common definition of ES and sometimes, they are considered but do not receive the label of ES (this leads to lower risk perception). Also, Farmers are not aware of ES benefits other than yield 80% are small farmers so they only focus on yield. Soil fertility and pollination have not monetary value, so farmers don't care about those

- **Barriers for ES implementation**

Interviewee 1 - governmental organisation	Interviewee 2 - industry	Interviewee 3 - governmental organisation	Interviewee 4 - industry	Interviewee 5 - researcher
Public spaces are often already fully developed, or plans are outdated. Many departments and stakeholders are involved, which can slow down decision-making. Management is often unwilling or unable to support innovative or green ideas. Budgets are often too limited to fully implement green ambitions. Data is available, but not always up to date or accurate.	Barriers depend on the maturity of individuals and companies: At lower levels in organizations, people often lack awareness and do not know how to address ecosystem services. At higher levels, the main barriers relate to data needs and decision-making processes. Internal education is needed before ecosystem services can be scaled up into formal policies. Many stakeholders and clients still do not fully understand ecosystem services. A lack of clear business cases makes it difficult to justify action. Awareness, motivation, knowledge, and internal capacity are	A lot of knowledge and data exist, but they are not always shared. Progress is limited when organizations do not exchange models or insights. Many aspects are quantified, especially related to water, but this does not automatically lead to better integration of ES. Different departments focus on different parts of the system, which can slow down cooperation.	Limited time and capacity as a small company. Strong dependence on external funding and grants. Lack of client demand for ecosystem services-related actions. If clients do not ask for it, the interviewee has little time to focus on it.	Main ones are lack of awareness and data availability. Example: respect of ES --> Quantification of cultural ES (non-monetary inputs, aesthetic, sense of comfort, tourism, birdwatching) they attempted to quantify it through travel cost-meter, but it does not really A further barrier is that farmers are not open to new ways of farming that incorporate ES in decision-making

	all required, but they do not always develop at the same pace.			

- **Enablers for ES implementation**

Interviewee 1 - governmental organisation	Interviewee 2 - industry	Interviewee 3 - governmental organisation	Interviewee 4 - industry	Interviewee 5 - researcher
Strong municipal policies on climate adaptation, water, and biodiversity. Shared data tools to monitor the city are used across departments. Early involvement of management in projects. Better cost–benefit explanations of green solutions, which can justify higher budgets.	Strong stakeholder and client demand, which can trigger interest. Clear awareness of the issue and a compelling business case. Internal capability, including resources and skills. The interviewee referred to a change model that links individual understanding to collective organizational action, showing that behavioural change is as important as technical solutions.	Existing ES models that the Water Authority has available. Sharing these models with companies and partners. Strong expertise within certain departments, especially those working directly on water systems. Some departments are frontrunners when it comes to ecosystem services.	Clear regulatory or policy frameworks, if they exist. Strong demand from clients or stakeholders. Availability of financial incentives or funding. Without funding or client demand, ecosystem services are not a priority.	Enablers are financial incentives: E.g. rice consumes water, but they have high yield and economic return, so farmers have economic incentive to grow rice. --> Focus is money, rice gives them good margins. Therefore, economic incentives would encourage them to plant crops with lower impact

- **Actions and policy levers for ES implementations**

Interviewee 1 - governmental organisation	Interviewee 2 - industry	Interviewee 3 - governmental organisation	Interviewee 4 - industry	Interviewee 5 - researcher
A specific map monitoring tools for the city, which provides data on heat stress, soil	The organization the interviewee works at itself does not implement ecosystem service	The organization uses models related to ecosystem services and water	The company already takes several actions that relate to ecosystem	There is need for awareness campaign (for example in the form of workshops)

quality, and climate risks. Mandatory ecological studies, such as Tree Effect Analyses (BEA) and nature scans. Climate adaptation and water safety policies, which make green measures a basic requirement in design. Nature-based solutions, such as green banks, trees, and water infiltration measures, which are integrated into planning and maintenance.	actions directly. Instead, it assesses and supports companies. A major challenge observed is that many companies lack concrete examples of ecosystem service dependencies and how these affect financial performance. Companies need real case studies that show how ecosystem service dependencies translate into costs, risks, and impacts on the bottom line, especially for financial teams.	systems. These models are shared with external parties, such as companies. However, the main challenge is not the lack of data, but the lack of shared tools and standard methods for calculation and valuation.	services, although not under the ES label: Sustainable product design focused on circularity and resource efficiency. Participation in pilot projects or experimental initiatives. Use of subsidies and financial instruments. Consideration of environmental impacts in planning and decision-making. These actions are mainly driven by economic logic and business coherence, not by ecosystem services as a concept.	on ES to understand implications of ES for policy and farmers.

Other relevant remarks from interviews

- Interviewee 1:

There are clear differences in how ecosystem services are viewed. Ecologists and designers focus more on long-term benefits, while project managers and clients often focus on costs and feasibility. Developers usually only include ecosystem services when the municipality requires it. The interviewee would like ecosystem services to become stricter requirements, supported by more funding, better data, and stronger involvement of management from the start of projects.

- Interviewee 2:

The interviewee stressed the importance of psychology and communication. Technical information alone is not enough. Ecosystem services need to be communicated in a way that "hooks" businesses and helps them build

strong business cases. They suggested that more attention should be given to marketing, framing, and behavioural aspects, for example through focus groups.

Knowledge, data, and tool gaps:

- There is already a large amount of information available.

- The main gap is not data, but communication.

What is missing includes:

- Clear stories that explain ecosystem service dependencies and risks

- Better communication of urgency, resilience, and long-term business value

- More focus on dependencies rather than only impacts

- Interviewee 3:

They note differences between departments. Their own department, which focuses on water systems, is relatively advanced in working with ecosystem services. Other departments, such as those dealing with wastewater, are less involved.

The interviewee also asked to remain anonymous and expressed interest in seeing how their answers will be used before publication.

Knowledge, data, and tools gaps:

They explain that data is available, but tools are not. Specific gaps include:

- A lack of recognized quantification tools for ecosystem services.

- No standard calculation method that everyone uses.

- The risk that organizations adjust calculation methods to achieve favourable outcomes ("calculating yourself rich")

- Standardization and agreed values are seen as essential

- Interviewee 4:

The interviewee believes that if people had more knowledge about ecosystem services, it could benefit their business.

If they could change one thing, it would be that legislators financially support lower-impact products and favour them through policy and funding mechanisms.