



Research Article

Framework for Integrated Ecosystem Assessment (FIEA): A structured approach to support evidence-based decision-making

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Abstract

While numerous ecosystem assessment frameworks have been developed, they often provide valuable insights into and guidelines for assessments from siloed perspectives,

addressing ecosystem assessments primarily through research, public-sector, private-sector or context-specific lenses. They lack the integrated approach necessary to address the multifaceted nature of ecosystem assessments across diverse domains and contexts. Others bring together perspectives from various sectors, but stay at a conceptual level, without specifying detailed steps and processes required for implementation. This fragmentation presents a barrier to achieving holistic and sustainable integrated ecosystem assessment outcomes that account for diverse user needs and relevant interdependencies amongst ecosystem components. The Framework for Integrated Ecosystem Assessment (FIEA) developed by the SELINA project (Science for Evidence-based and Sustainable Decisions about Natural Capital) offers a unified structure that builds upon and refines the existing assessment approaches to facilitate integrated ecosystem assessments and provide information for evidence-based decision-making across multiple sectors. Developed through an interactive co-creation process within the SELINA project, the FIEA engaged a wide range of partners, including scientists, policy-makers and private sector representatives and is designed to be modular and flexible, catering to diverse needs and contexts. The framework encompasses six interconnected phases – Frame, Scope, Design, Assess, Share and Act. It addresses present challenges that limit the uptake of ecosystem information in decision-making by enhancing transparency, stakeholder engagement and adaptability. Within the paper, the FIEA's structure and development process will be addressed, underscoring its potential to bridge the gap between ecosystem science and practical decision-making.

Keywords

integration, ecosystem condition, ecosystem services, science-policy interface, MAES, Capitals Protocol, IPBES

Introduction

Integrated ecosystem assessments have long been recognised as crucial processes for understanding the complex interrelationships between our environment, the services it provides and the human activities that depend on them (Millennium Ecosystem Assessment 2005, IPBES 2019). Central to this effort are assessments of ecosystem condition (including biodiversity) and ecosystem services supply and use. Ecosystem services, ranging from provisioning services (e.g. food and water), to cultural services (e.g. recreation, aesthetic enjoyment), to regulating services (e.g. biological control of pests, global climate regulation), are integral to human well-being and economic productivity (European Commission 2011, Kumar 2012, Czócz et al. 2021).

Globally, the concept of ecosystem services gained major prominence with the Millennium Ecosystem Assessment in 2005, which first categorised and quantified ecosystem services systematically across broad spatial scales (Millennium Ecosystem Assessment 2005). This foundation was subsequently advanced by The Economics of Ecosystems and Biodiversity (TEEB) initiative, which transitioned the discourse towards

economic valuation. By framing biodiversity as a measurable economic asset, TEEB facilitated the integration of natural capital into formal policy and decision-making processes (TEEB 2010). It has been further developed by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), an independent intergovernmental body established in 2012, mandated to strengthen the interface between science and policy related to biodiversity and ecosystem services (Díaz et al. 2015). IPBES has published several assessments, including the Global Assessment on Biodiversity and Ecosystem Services (IPBES 2019), which provided evidence on accelerating biodiversity loss and identified the need of transformative change as essential for sustainability. The IPBES Values Assessment highlighted potential blind spots with regard to legitimacy, credibility, salience, timeliness, process documentation and study cost to explain the lack of uptake of assessments of nature's values in different decision-making contexts (Barton et al. 2022). More recently, the System of Environmental Economic Accounting - Ecosystem Accounting (SEEA-EA) has become a milestone in the standardisation of ecosystem accounting on a global scale. SEEA-EA provides a statistical standard for organising and processing environmental data, linking them to economic and other human activities, thereby enabling accounting for changes in ecosystem extent, condition and services (United Nations et al. 2024).

In the last decade, the European Union has been at the forefront in promoting the incorporation of knowledge on ecosystems and their services in policy- and decision-making. For example, the Mapping and Assessment of Ecosystems and Services (MAES) initiative was launched under the EU Biodiversity Strategy 2020 (European Commission 2011), with Member States required to map and assess ecosystems by 2014. In October 2020, the European Commission released the first EU-wide MAES ecosystem assessment (Maes et al. 2020, European Environment Agency et al. 2021). The upcoming second EU-wide assessment aims to build upon this foundation, leveraging recent methodological advances to enhance policy relevance and facilitate the achievement of targets, such as those outlined in the EU Regulation on Nature Restoration (Vallecillo et al. 2022, European Parliament and European Union 2024). More recently, the EU Regulation 2024/3024 (European Parliament, Council of the European Union 2024) on ecosystem accounting set requirements for EU Member States to report on ecosystem extent, condition and services on a mandatory basis. Despite global and European advances, a persistent implementation gap remains: the uptake of ecosystem (service) assessments in policy and other decision-support contexts (Laurans et al. 2013, Termansen et al. 2022, Barton et al. 2024, Walther et al. 2025). Barriers to uptake include limited availability of decision-relevant, fit-for-purpose evidence, asymmetries in power and influence amongst actors, which shape whose knowledge and values are represented and multiple forms of uncertainty spanning data, models and values (Bertuol-Garcia et al. 2018, Jacobs et al. 2020, Walther et al. 2025).

Parallel to policy initiatives at the global and European scale, a number of ecosystem assessment frameworks have been developed that provide valuable recommendations and guidance on how to conduct ecosystem assessments. Amongst these are: the operational Framework for integrated Mapping and Assessment of Ecosystems and their

Services (here referred to as "operational MAES Framework", Burkhard et al. (2018)); the Natural Capital Protocol (Capitals Coalition 2016); and the IPBES 5-step valuation Framework (Termansen et al. 2023). In addition to that, planning tools, such as the Integrated Approach to Planning (Ministry of Environmental Protection and Regional Development of the Republic of Latvia 2021), have been developed to support the incorporation of ecosystem information into planning processes at the regional and local level.

While all of these contributions provide valuable insights, some critical challenges persist. Existing frameworks and tools often adopt a narrow perspective, addressing ecosystem assessments primarily through siloed lenses. This includes science-based approaches developed to support biodiversity policy implementation (e.g. the operational MAES Framework for the EU Biodiversity Strategy (2020)), approaches tailored to the needs of the public or private sector (e.g. the Natural Capital Protocol) and approaches specific to a particular decision-making context (e.g. the Integrated Approach to Planning). They lack an integrated approach necessary to address the multifaceted nature of ecosystem assessments across diverse domains and contexts (Burkhard et al. 2018, Heink and Jax 2019). Other frameworks bring together perspectives from various sectors, but stay at a conceptual level (e.g. the IPBES 5-step valuation Framework), without specifying detailed steps and processes required for their implementation. The fragmentation of existing frameworks presents a barrier to achieving holistic and sustainable integrated ecosystem assessment outcomes that account for diverse user needs and consider relevant interdependencies amongst ecosystem components.

This paper aims to respond to the above-mentioned gaps, offering a unified approach to ecosystem assessments that: (i) integrates ecosystem condition, services and accounting approaches (building on established frameworks such as SEEA EA (United Nations et al. 2024)); (ii) responds to the needs of all actors potentially involved, from scientists to decision-makers; (iii) accommodates ecological, economic and social dimensions; and, most importantly; (iv) provides the operational guidance required for integrated ecosystem assessments within a single framework. Thereby, this new framework aims to increase the likelihood of uptake of ecosystem information into decision-making by enhancing credibility, salience and legitimacy, hence improving the translation of assessments into decisions (Barton et al. 2022, Barton et al. 2024).

By building upon established frameworks and recent key experiences as presented above, the development of the Framework for Integrated Ecosystem Assessment (FIEA) synthesised insights from various sectors and harmonised the different assessment perspectives to provide a cohesive structure that offers practical and operational guidance for the implementation of integrated ecosystem assessments. Thereby, the FIEA fosters the incorporation of nature's multiple values through ecosystem assessments into decision-making and supports the transformative change necessary to address today's pressing environmental and societal challenges (IPBES 2019).

To address the complexities and varied perspectives associated with integrated ecosystem assessments, the development of the FIEA has been undertaken as an

interactive collaborative co-creation process. This approach involved diverse partners, including scientists from various research domains, public sector representatives from different levels, as well as private sector decision-makers and civil society organisations, ensuring a holistic integration of ecological, economic and social perspectives. The FIEA development has been undertaken within the SELINA (Science for Evidence-based and Sustainable Decisions about Natural Capital) EU Horizon project*¹, bringing together a consortium of 50 partner organisations from all 27 EU Member States, plus Norway, Switzerland, Israel and the United Kingdom. The SELINA project aims to reshape decision-making processes across public and private sectors by enhancing the uptake of biodiversity, ecosystem condition and ecosystem service information, through the development of integrative methods, tools and co-produced knowledge tailored to decision-making contexts. The consortium's strength lies in its diverse mix of academic, governmental, NGO and private sector partners, fostering a transdisciplinary approach that unites experts from various disciplines, for example, ecology, geography, social sciences, economics, earth observation, spatial planning and science communication. In addition, SELINA offered the unique opportunity of testing the usability of the FIEA within 15 real-world decision-making experiences (called SELINA Demonstration Projects). By engaging with these real-world projects representing various public and private decision-making contexts where information on biodiversity, ecosystem condition and ecosystem services is used to provide information for evidence-based decisions, valuable feedback was collected and lessons learned were drawn. This hands-on approach allowed for the identification and incorporation of practical solutions, ensuring that the Framework remains relevant and effective in addressing actual needs in public and private sector contexts.

Therefore, the focus of this article is on presenting the co-creation process of developing the FIEA and outlining the Framework's key components and individual steps. By showcasing the feedback loops between theoretical development and practical application, the article demonstrates the importance of real-world integration into the developmental process of such an assessment Framework as well as the FIEA's added value with respect to existing frameworks.

Materials and Methods

The FIEA development was designed as a collaborative, interactive co-creation process. This approach has been essential to ensure the integration of diverse needs, perspectives and expertise. Central to the co-creation process was the active engagement of all SELINA consortium partners throughout the whole development process. Thereby, a wide range of potential target users of the Framework were involved, including scientists from various research domains, public sector representatives from different levels, private sector decision-makers, as well as civil society organisations. Over a period of approximately 20 months, they participated in dedicated project workshop sessions, online meetings, diverse feedback rounds, a dedicated task force and through direct testing of the Framework to provide insights and feedback. This

iterative engagement ensured that the Framework meets the diverse needs of different sectors and incorporates transdisciplinary knowledge. More precisely, the FIEA development was divided into seven distinct phases (see Fig. 1).

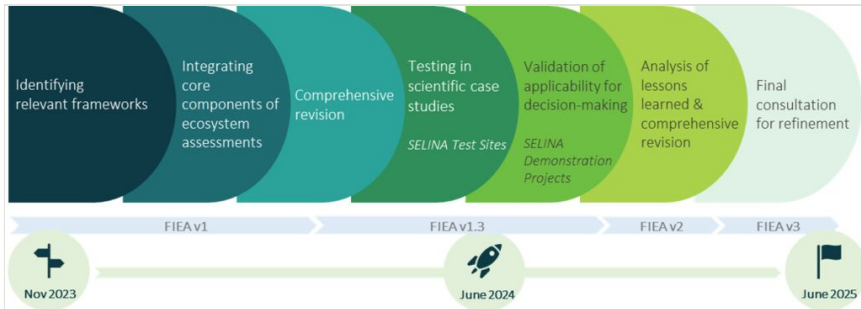


Figure 1.

FIEA development phases, including version numbers and timeline.

Phase I: Identifying relevant frameworks

A comparably large number of relevant assessment frameworks has been launched in the last years (e.g. Mace et al. (2015), Capitals Coalition (2016), La Notte et al. (2017), Burkhard et al. (2018), Leach et al. (2019), de Groot et al. (2022), Termansen et al. (2023), United Nations et al. (2024)). Therefore, the development of the FIEA was grounded in the principle of building upon and integrating existing knowledge and conceptual approaches wherever possible. To this end, the process began with the identification of key frameworks relevant to ecosystem assessments. SELINA consortium members were asked to put forward relevant frameworks that should be considered during the development process. Relevance was attributed to frameworks that: (i) provide approaches

for ecosystem assessments; (ii) have potential for integration into public and/or private decision-making processes; (iii) address diverse values of nature and (iv) promote stakeholder engagement. The collection of frameworks was used to establish a knowledge base that could guide the subsequent development of the FIEA. The selected frameworks were chosen for their functional complementarity across assessment, valuation and decision-support dimensions.

Phase II: Integrating core components

Building upon the collection of frameworks from the first phase, the second phase focused on a detailed decomposition of the selected frameworks into individual phases, steps and/ or components (see Suppl. material 1). The individual phases, steps and/ or components of the proposed frameworks were then compared to one another in order to identify overlaps, complementarities and differences in scope, structure and methodological emphasis. Subsequently, they were clustered and rearranged in order to build the foundation for the FIEA (v1). This process ensured that FIEA integrated key elements from these relevant frameworks, aiming to support more holistic and integrated

ecosystem assessments. In doing so, it moves beyond existing frameworks by providing a unified and adaptable approach applicable across a wide range of scientific and decision-making contexts. Building on this initial foundation, FIEA was further refined and expanded by incorporating insights and findings generated within the SELINA project, as well as relevant knowledge, methodological advances and best practices emerging from recent global and EU-level initiatives (Table 2), many of which have been described in the [#introduction](#). While Table 2 captures the key resources that most directly shaped FIEA, the development process was also informed by a broader body of ecosystem assessment practices. Following the Millennium Ecosystem Assessment (2005), numerous national and regional assessments contributed to advancing concepts, methods and policy interfaces (e.g. the National Ecosystem Assessments from the UK, Spain and Flanders, see U.K.National Ecosystem Assessment (2011), Spanish National Ecosystem Assessment (2013), Stevens et al. (2015), Schröter et al. (2016)). A similar dynamic can be observed for ecosystem accounting, where increasing practical implementation following the publication of the SEEA Ecosystem Accounting guidelines has provided further applied insights and experiences (Hein et al. 2020, Comte et al. 2022, Lange et al. 2022, United Nations et al. 2024). Although the primary focus remains on European and global initiatives, insights from beyond inspired the development process as well. This refinement ensures that FIEA not only reflects a theoretical synthesis of existing frameworks, but is also grounded in contemporary practice and policy developments, thereby enhancing its applicability and robustness across contexts.

Table 1. Overview of the FIEA version numbers and main progress.		
FIEA version	Main progress	Builds upon development phases
v1	• Identification of foundational frameworks and integration of their core components into a unified, hierarchical and circular architecture around six phases and related substeps. • Integration of information from additional key resources to provide information for the development of individual steps.	I, II
v1.3	• Revision following SELINA consortium consultation. • Integration of additional steps into Assess, Share and Act FIEA phases. • Renaming of a phase ("Share" to "Disclose") and of multiple steps to adopt more action-orientated terminology. • Highlighting relevance of stakeholder engagement. • Integration of technical terminology (including crosswalks to synonyms) into a SELINA project-internal glossary. • Introduction of justice considerations^{*2}. • Cross-walk between framework steps and the TNFD LEAP assessment components (Taskforce on Nature-related Financial Disclosures (TNFD) 2024).	III

FIEA version	Main progress	Builds upon development phases
v2	• Integration of feedback and lessons learned from two SELINA Test Sites and SELINA 15 Demonstration Projects. • Refinement of objective, description of target users and guidance material. • Development of three tiers of step descriptions (long/short/simple) with explicit cross-references between steps. • Further development of link to stakeholder participation, including guidance according to the IAP2 Spectrum (IAP2 International Federation 2018). • Highlighting the specific relevance of cultural ecosystem services and qualitative assessment methods.	IV, V, VI
v3	• Final refinements following consortium consultation. • Renaming phase back to "Share" and introduction of a dedicated Level-2 step "Disclose" to distinguish communication from formal disclosure. • Minor clarifications to descriptions. • Advancing justice considerations*². • Integration of recommendations for stakeholder engagement across individual steps.	VII

Phase III: Comprehensive revision

Extensive engagement with the whole SELINA consortium, thus including partners from various sectors and disciplines, took place in the third phase to solicit in-depth feedback on the preliminary design of the FIEA (v1). This phase included organising thematic project workshop sessions, facilitating online discussions and making the FIEA materials available via a cloud-based platform for revision. All these activities enabled the whole SELINA consortium – including researchers from diverse disciplines such as the natural, social and economic sciences, as well as representatives from the public and private sectors – to critically examine and add (e.g. justice considerations*²) to the Framework. The objective was to gather diverse perspectives and insights that guided substantive refinements. A dedicated FIEA revision task force was also established to address points where feedback from the SELINA consortium was diverging and where differing perspectives could not be reconciled within the formats available to the full consortium. To resolve these open issues, the task force discussed and assessed the alternative viewpoints, aiming to identify balanced compromises. Subsequently, the collected feedback was implemented. This collaborative engagement ensured that the FIEA remained robust and adaptable, addressing the varied needs of different sectors. The revision led to the FIEA v1.3.

Table 2.

Key resources that informed the development of the FIEA.

Resource	Brief description	Primary role during FIEA development
Operational MAES Framework (Burkhard et al. 2018)	Operational framework that builds on the Mapping and Assessment on Ecosystems and their Services common assessment framework and re-organises it in a number of practical steps to be followed to ensure an integrated result.	Defining FIEA's general structure (e.g. adoption of stepwise assessment approach), phases and steps at all levels (Suppl. material 1) (incl. description).
Natural Capital Protocol (Capitals Coalition 2016)	Framework for businesses to identify, measure and value natural capital impacts and dependencies; Aims to integrate nature into financial and business decisions.	Defining FIEA's general structure (e.g. adoption of iterative nature and circular structure), phases and steps at all levels (Suppl. material 1) (incl. description).
IPBES 5-step valuation Framework (Termansen et al. 2023)	Structured process for assessing nature's values in decision-making; Promotes inclusion of diverse value perspectives.	Defining FIEA's general structure, phases and steps at all levels (Suppl. material 1) (incl. description), emphasising, for example, the embedding of diverse values of nature.
Integrated Approach to Planning (Ministry of Environmental Protection and Regional Development of the Republic of Latvia 2021)	Holistic spatial planning approach that bridges traditional boundaries; Ensuring that environmental, economic and social dimensions are considered together.	Defining FIEA's general structure, phases and steps at all levels (incl. description), emphasising, for example, stakeholder involvement, planning and solution development.
Ecological Planning Model (Steiner 2008)	Landscape planning approach linking ecological analysis with design and land-use decisions.	Defining FIEA steps (incl. description), in particular with regard to continuous stakeholder engagement.
SEEA-EA (United Nations et al. 2024)	Statistical framework for organising data about habitats and landscapes ensuring ecosystem service supply and use, tracking changes in ecosystem assets and linking this information to economic and other human activity.	Defining FIEA's structure and steps in particular across the Design and Assess phases (incl. description).
CICES (Haines-Young 2025)	Hierarchical classification for consistent ecosystem service typology.	Formulating FIEA step descriptions across the Design and Assess phases (focus on Ecosystem Services).
A: Mapping and Assessment of Ecosystems and their Services: An EU ecosystem assessment (Maes et al. 2020) and B: EU-wide methodology to map and assess ecosystem condition (Vallecillo et al. 2022)	A: Comprehensive EU-wide assessment of ecosystems and services. B: Harmonised methods for mapping and assessing ecosystem condition.	Defining FIEA's structure and steps in particular across the Design and Assess phases (incl. description).
The Taskforce on Nature-related Financial Disclosures (TNFD) Locate, Evaluate, Assess and Prepare (LEAP) approach (Taskforce on Nature-related Financial Disclosures (TNFD) 2024)	Guidance for organisations to Locate, Evaluate, Assess and Prepare for nature-related risks and opportunities; Supports integration of biodiversity and ecosystem considerations into financial disclosure and strategy.	Operationalised link from FIEA (sub-)steps (Level 2 and 3) to LEAP assessment components.

Phase IV: Testing in scientific case studies

Two SELINA Test Sites (see Table 3) served as practical applications to test the theoretical constructs of the Framework (FIEA v1.3). SELINA Test Sites are scientific case studies where methods and tools are piloted within the SELINA project. Thus, within the project, they serve as experimental grounds supporting the refinement of ecosystem condition, services or accounting indicators, related quantification and assessment approaches and the development of ecosystem-related knowledge. The two Test Sites (Table 3) were an appropriate testing ground for FIEA, as they exemplify practical applications of integrated assessment approaches that link ecosystem condition with ecosystem services. Additionally, both Test Sites emphasise the role of scientific evidence in enabling well-informed and effective decision-making and management. During this phase, the Test Sites’ purposes, workflows and assessment details were mapped according to the FIEA steps and structure, verifying their adaptability and practical fit.

Table 3. Overview of SELINA Test Sites, including location and main objectives (Pais et al. 2023, Hinsch et al. 2024, Pais et al. 2025).		
Test Site	Country	Main objective
Pollination ecosystem services assessment in Hannover Region	Germany	• Method development and increasing the understanding of the spatial distribution of the ES pollination considering ecosystem condition; • Providing a decision-base for an improved biotope management in cultural landscapes and protected areas by deriving recommendations, for example, for priority areas for conservation measures.
Ecosystem accounting of forest fires in northern Portugal	Portugal	• Developing and simulating different management scenarios; • Developing of prescribed burning scenarios and their potential impacts on Biodiversity and Fire regime.

Phase V: Validation of the FIEA's applicability for decision-making

In phase V, we evaluated the usability and applicability of the FIEA (v1.3) through the 15 SELINA Demonstration Projects (Table 4) spanning public and private sectors. This phase transitioned the Framework from primarily scientific settings (see phase IV) into operational and strategic planning and policy contexts including urban and regional development, agriculture, energy, marine spatial planning, forest and nature conservation, green infrastructures and ecosystem restoration.

Demonstration Projects were engaged to assess the alignment of FIEA with practice by: (i) comparing the framework steps with their specific workflows; (ii) assessing the clarity of the FIEA’s purpose, terminology and steps; and (iii) sharing feedback on the usefulness and potential barriers to future use in assessment design and decision support.

Table 4.

Overview of SELINA Demonstration Projects, including location and main objectives.

Demonstration Project		Country	Main objectives
DP01	Spanish National Strategy for Green Infrastructure and Ecosystem Restoration	Spain	To identify green infrastructure elements at a national scale in response to national regulations and political processes, including the development of regional green infrastructure plans for the Autonomous Communities in Spain by 2024.
DP02	Supporting sustainable agricultural practices in the Comprehensive Plan of Lithuania	Lithuania	To contribute to implementing the Comprehensive Plan of the Territory of the Republic of Lithuania for 2030.
DP03	Urban Greening Management Plan for the city of Trento	Italy	To prepare an Urban Greening Management plan for the city of Trento.
DP04	The Bosland Forest Project	Belgium	To ensure long-term preservation and sustainable management of the area of Bosland, which is the largest forest project in Flanders, Belgium.
DP05	Integration of ecosystem services information on marine and terrestrial spatial planning	France (La Réunion)	To improve participation and coordination in ecosystem services-orientated planning strategies, mainly through local assessments of ecosystem services in terrestrial and marine domains.
DP06	Sustainable energy production in mountain regions	Switzerland	To identify suitable areas for constructing new energy infrastructure, including those in mountainous regions, by engaging various stakeholders.
DP07	Maritime spatial planning and thematic planning of coastal public infrastructure	Latvia	To update the Maritime Spatial Plan (MSP) and Coastal Plan of Latvia to support maintenance of resilient marine and coastal ecosystems, sustainable and effective use of marine space and coastal tourism development.
DP08	Integration of Urban Heat Islands and ecosystem services in urban and spatial planning	Bulgaria	To develop an innovative analytic tool for supporting the decision-making processes in urban and spatial planning (to make more informed decisions on urban design and planning to mitigate urban heat islands).

Demonstration Project		Country	Main objectives
DP09	Integration of public-private ecosystem services knowledge (MAES) in urban planning and design using 'digital twins'	Norway	- To support more informed decisions on nature-based solutions in urban design and planning; - To calculate the Blue-Green factor efficiently in order to track performance and meet regulatory requirements; - To demonstrate the integration of public-private sources in a "digital twin" for more cost-effective public permitting and private certification.
DP10	Integration of biodiversity and ecosystem services to develop nature-based tourism approaches and a tool that supports these approaches	Malta	To develop a prototype digital platform that integrates near-real-time environmental data with tourism activity to support nature-based tourism (NBT) activities and actions.
DP11	Integration of biodiversity and ecosystem services to develop nature-based tourism approaches	Finland	To advance the Business Finland's (Visit Finland's) Sustainable Travel Finland programme to include criteria and indicators that allow to assess and diminish the impacts of nature-based tourism on marine and island ecosystems and their condition.
DP12	Nature risk screening tools in finance: a review of knowledge gaps in biodiversity metric	Norway	To understand existing biodiversity metrics, measurements, Key Performance Indicators (KPIs) and the knowledge gaps that hinder their transformation into effective nature risk screening tools for financial actors.
DP13	Improved management by increasing synergies between farming activities and ecosystem services provided by agroecosystems to foster biodiversity-based agricultural practices	Italy	To increase the expertise for supporting local farms in the "ecological transition" - through the identification of best approaches to preserve biodiversity and to allow income to increase.
DP14	Guiding future investment in water replenishment and making the business case of biodiversity and ecosystem services strategies to local business	Europe	To use ecosystem services modelling to guide the business case for corporate investment in nature-based solutions that is aligned with company "Environmental, Social, Governance" goals.
DP15	Measuring and valuing biodiversity and ecosystem services within construction projects	Netherlands	To value the impact of biodiversity and nature-inclusive measures implemented in construction projects, with the aim of developing an evidence-based narrative and quantitative ecosystem valuations that showcase the benefits of nature-inclusive building.

To launch the validation process, kick-off meetings were held in October of 2024 to agree on a shared strategy for gathering structured feedback on the framework's effectiveness in supporting both public and private sector decision-making. Following the kick-off meetings, FIEA v1.3 materials were shared with all Demonstration Projects. They were asked to review the materials in advance and to compare the FIEA steps with their existing workflows, noting points of alignment, unclear terminology and anticipated implementation challenges.

Between November 2024 and January 2025, a series of individual interviews were used to systematically collect and discuss the pre-analysis described before, particularly the feasibility of applying FIEA in public decision-making (see Suppl. material 2 for the public sector interview guide). In parallel, interviews were carried out with private-sector actors over the same period (see Suppl. material 3 for private sector interview guide), ensuring that private-sector perspectives also provided information for the ongoing development of the FIEA framework. Further calls with private Demonstration Projects were also required to bridge the conceptual and terminology differences compared to public sector application.

Phase VI: Analysis of lessons learned and comprehensive revision

This analysis involved a detailed assessment of the insights gathered from the real-world review of the FIEA (v1.3, see phase V). This phase examined the challenges encountered, recommendations developed and opportunities identified by the Demonstration Projects. Based on these insights, the FIEA underwent a comprehensive revision to enhance its understandability, functionality, relevance and responsiveness to the needs and relevance for a range of specific decision-making purposes (resulting in FIEA v2). Further, target users were defined according to their functional role in the EU environmental policy cycle and compliance rather than by job title alone. The target user categories primarily encompass actors within EU institutions and Member State ministries and agencies, as well as corporate and industry organisations, along with relevant technical stakeholders engaged in environmental management and evidence provision.

Phase VII: Final consultation for refinement

In the final phase, the whole SELINA consortium was re-engaged to review the revised FIEA version (v2) and to provide input. The focus was on the revision of the newest features and adaptations. However, if necessary, partners were also invited to provide final overarching feedback on the Framework as a whole. All materials related to the FIEA v2 were made accessible to the entire SELINA consortium via a cloud-based platform. Input and suggestions could be provided directly within the shared documents using embedded comment functionalities and designated sections for feedback. In addition, consortium members were encouraged to share their perspectives via email, with the option to arrange dedicated virtual meetings for clarification or in-depth discussion when required. This focused consultation ensured that the latest adjustments were critically assessed and refined as needed.

In addition to that, building on relevant justice literature (Schlosberg 2013, Loos et al. 2023, Locatelli et al. 2025), an analytical screening of the FIEA steps to identify where and how justice considerations may arise was carried out. Using three core dimensions (recognitional, procedural and distributive justice) as the analytical basis, each substep was examined to assess whether decisions taken at that point could influence: (i) who is recognised in the assessment process; (ii) who participates or has influence; (iii) how data and assessment-design choices shape what is produced as evidence and whose values are made visible and (iv) how benefits and burdens may be distributed once a decision is implemented. Where such influences were identified, the relevant justice dimension(s) was(were) recorded. Contextual justice was treated as a complementary lens for interpreting these linkages, highlighting how socio-historical, institutional and power-related factors shape how recognition, participation and distribution play out in specific decision-making contexts. All of these contributions supported the fine-tuning of the FIEA, resulting in the final FIEA version (FIEA v3).

Results

The Results Section is structured into three subsections: The first subsection presents relevant intermediate outputs of the co-creation process underpinning FIEA's development; the second describes the final Framework, detailing its structure and steps; and the final subsection explores FIEA's added value.

Framework development

This Section presents the key results of the co-creation process, structured along the different phases of the framework development (Table 1), with emphasis on the integration of feedback and its influence on subsequent revisions.

Phases I and II: Foundational frameworks and the integration of their core components

Partners initially identified three main frameworks (Table 2) as essential for a comprehensive understanding of ecosystem assessments: The operational MAES Framework developed in the ESMERALDA project (Burkhard et al. 2018), the IPBES 5-step valuation Framework (Termansen et al. 2023) and the Natural Capital Protocol (Capitals Coalition 2016):

- The operational **MAES Framework** provides a structured approach for ecosystem assessments, central to the European Union's Biodiversity Strategy 2020. It is a nine-step operational framework aimed at guiding the mapping and assessment of ecosystems and their services across EU Member States. The steps are designed to address various activities: from defining questions to mapping ecosystems, assessing their condition, quantifying services and integrating results for dissemination. This process links ecosystem condition and services with socio-

economic factors, emphasising their spatial dimension and stakeholder integration (Burkhard et al. 2018).

- The **Natural Capital Protocol** (Capitals Coalition 2016) offers an approach to integrate natural capital into business decision-making processes. It provides a four-stage framework – Frame, Scope, Measure and Value and Apply – aimed at identifying, measuring and valuing natural capital impacts and dependencies. This structured methodology guides organisations through key steps, from defining objectives to evaluating impacts and dependencies, quantifying and valuing natural capital and applying the results to provide information for strategic decisions. The Protocol emphasises the integration of natural capital considerations into existing business practices, promoting sustainable decision-making that aligns economic activities with environmental stewardship. Through this process, it links business operations with natural resource management, highlighting the critical interdependencies essential for maintaining long-term sustainability (Capitals Coalition 2016).
- The **IPBES 5-step valuation Framework** provides a cascade-like structured approach to embedding the diverse values of nature into decision-making processes. This approach, rooted in the IPBES' Values Assessment, aims to enhance the integration of nature's values into policy and project evaluations. The Framework's steps include establishing a legitimate valuation process, defining the purpose of valuation, determining the scope, choosing and applying relevant valuation methods and effectively communicating valuation outcomes to provide information for decisions. This approach emphasises transparency, inclusiveness and adaptability by considering the trade-offs in valuation regarding relevance, robustness and resource efficiency. By focusing on a variety of stakeholders and ensuring that diverse values influence decision-making, the IPBES Framework fosters transformative change towards a sustainable and equitable future (Termansen et al. 2023).

Within the first round of feedback collection, concerns emerged regarding the under-representation of public sector perspectives. In response to these concerns, the Integrated Approach to Planning Framework (Ministry of Environmental Protection and Regional Development of the Republic of Latvia 2021) was incorporated (Table 2):

- The Latvian Guidelines for Coastal Area Development Planners (Ministry of Environmental Protection and Regional Development of the Republic of Latvia 2021) promote the **Integrated Approach to Planning** that treats coastal land and adjacent marine areas as a single, interconnected space. The Framework emphasises the need for holistic spatial planning that bridges traditional boundaries between terrestrial and marine governance. It calls for coordinated decision-making across administrative levels and sectors, ensuring that environmental, economic and social dimensions are considered together. Central to this approach is the application of ecosystem-based principles. The guidelines stress the importance of involving a wide range of stakeholders. Additionally, the

integration of spatial data and compatible indicators across land and sea domains is encouraged to support evidence-based planning.

Together, these four frameworks formed the principal foundation for developing the FIEA and defining its overall structure (Table 2). Specifically, they provided the conceptual basis for the main FIEA phases (Level 1), whereas the design of the other levels and their specifics also drew on additional sources of information and methodological inputs (Table 2). Those relate to, for example, the Ecological Planning Model (Steiner 2008), the SEEA-EA (United Nations et al. 2024) and ecosystem services classification schemes (e.g. Common International Classification of Ecosystem Services (CICES), Haines-Young (2025)), to enhance the relevance and applicability of the FIEA in different scientific as well as decision-making contexts where such sources are known and commonly adopted.

Next to the consideration of available key resources, the initial development of the FIEA was guided by several core requirements identified by the SELINA consortium: adopting a nested, hierarchical approach; implementing a circular design that facilitates iterative cycles and potentially allows for multiple entry points; and creating an overarching Framework that encompasses multiple perspectives and is adaptable to various decision-making contexts to ensure flexibility, while, at the same time, recognising that not all steps or sub-steps may be relevant for every purpose and every user. All of this led to the FIEA v1 (see Suppl. material 6 for visualisation), a hierarchically nested framework structured around six phases: Frame, Scope, Design, Assess, Share and Act.

Phase III: Comprehensive revision

Following the initial development of the FIEA (FIEA v1), extensive feedback was collected through multiple formats, providing the basis for the adaptation and enhancement of the Framework. Feedback indicated, for example, the need for additional steps between the "Assess" and "Act" phases, focused on, for example, the development of solutions. Accordingly, a "Develop solutions or recommendations" step was inserted to identify options or pathways, informed by the preceding steps and assessment results (see Suppl. material 6). This step involves proposing and designing possible solutions or recommendations that align with the initial purpose of the assessment, potentially addressing the identified impacts and dependencies and aiming at mitigating the risks or capitalising on the opportunities uncovered. Further feedback indicated the need for a clear process of monitoring and evaluation before revisiting the "Frame" phase. To address this, a "Monitor and evaluate" step was incorporated, in which progress is tracked and the effectiveness of actions, based on the ecosystem assessment, is examined. This evaluation determines whether objectives have been achieved and assesses the adequacy of measures in addressing impacts, dependencies, risks and opportunities. Additionally, the "Share" phase was renamed to "Disclose" to increase the relevance of formal disclosure obligations.

Additional suggestions emphasised the importance of continuous stakeholder engagement and utilising a more action-orientated language throughout the Framework.

Although preferences for terminology varied depending on participants' backgrounds, a single formulation was adopted at this stage. To acknowledge the diversity of perspectives and support a common understanding, all relevant terms were subsequently compiled into a project-internal glossary, providing clarity and ensuring transparency in language use (e.g. "actor" *versus* "stakeholder"). To emphasise that stakeholder engagement is a continuous and context-sensitive process, the FIEA substep "Engage stakeholders" was renamed to "Start engaging stakeholders" and moved to the beginning of the "Scope" phase. Furthermore, in the visual representation of the FIEA, a cog wheel labelled "Stakeholder engagement" rotating around the circular framework to signal its continuous, cross-phase role, was introduced (see Suppl. material 6 for visualisation). Feedback stressing the importance of integrating justice dimensions was also taken up. Links were identified between specific FIEA substeps and processes related to topics of justice. Those links focused on raising awareness about diverse justice dimensions and identifying entry points within the FIEA for addressing the different dimensions. It was also highlighted that the FIEA should be linked to the Taskforce on Nature-related Financial Disclosures (TNFD) (2024) Locate, Evaluate, Assess and Prepare (LEAP) approach. Accordingly, a step-wise link was implemented. Building on these and the other revisions, the FIEA v1.3 was developed (see Suppl. material 6 for visualisation).

Phases IV and V: Insights from testing the FIEA in scientific case studies and from validating its applicability for decision-making

The combined activities of phases IV and V demonstrated the applicability and robustness of the Framework (FIEA v1.3) across more complex settings, while also revealing areas needing further attention and guidance. In phase IV, the piloting of the FIEA in scientific Test Sites validated the internal consistency and applicability of the Framework from the perspective of designing integrated scientific methods and the successful testing offered initial insights and orientation that supported the subsequent phases.

Phase V focused on real-world contexts through the 15 SELINA Demonstration Projects, spanning public and private decision-making processes. The comparison of the projects' recent, ongoing and upcoming workflows to the FIEA steps confirmed the Framework's capacity to align with real-world decision-making processes and its adaptability across different domains. The diversity of projects provided evidence that the Framework was not limited to academic or experimental conditions, but that it can also function under practical constraints and dynamics. The feedback and lessons learned gathered throughout the process laid the foundation for the comprehensive revision in phase VI.

Phase VI: Lessons learned and comprehensive revision

The feedback received from the Demonstration Projects (Table 4) comprised both general comments – covering, inter alia, overall impression, clarity and understandability, usability, presentation and format and comprehensiveness – and comments that were specific to individual phases and steps (see Suppl. material 4).

The importance of making the Framework accessible and comprehensible for different target user groups emerged as a key finding. In response, the objectives of the FIEA and accompanying supporting materials were refined to provide clearer guidance and target user groups and exemplary use cases were defined to ensure the Framework's relevance across sectors (Fig. 2). Public-sector decision-makers include individuals within EU Member State governments or institutions responsible for shaping, negotiating and implementing environmental policies and regulatory frameworks. Private-sector stakeholders develop business strategies, implementation plans, risk management approaches and compliance and reporting processes and include, for example, farmers applying the framework to provide information for land management decisions and assess ecosystem dependencies and impacts. Researchers focus on knowledge generation, method development and the application of indicators and models for ecosystem assessments. Civil society organisations represent societal interests, contribute local knowledge and engage in advocacy and participatory assessment processes, using the framework to support collaborative assessments and provide information for community-based decisions.

Public Sector Decision-Makers and Planners (e.g. municipal environmental planners, regional authorities, ministries)
Use FIEA to support land-use planning, conservation strategies, restoration programs, or reporting on biodiversity and ecosystem services, potentially including alignment with national and EU-level policy.
Private Sector and Corporate Teams (e.g. farmers, corporate businesses with environmental dependencies or impacts)
Apply FIEA to assess ecosystem-related risks and opportunities, support sustainability reporting, or guide nature-positive strategies.
Scientific/ Research Communities (e.g. universities, environmental researchers, scientific advisory bodies)
Use FIEA as a structured and integrative guide to design ecosystem assessments that generate knowledge, reveal system dynamics, and test methodologies (even without immediate decision-making context).
Civil Society, NGOs, Stakeholder Initiatives (e.g. environmental NGOs, landscape partnerships)
Use FIEA to structure collaborative assessments that balance ecosystem condition, human well-being, and long-term sustainability across jurisdictions and stakeholder interests.

Figure 2.
Potential FIEA target user groups and exemplary use cases.

Additionally, requests for more granular guidance within each Framework step led to the addition of more detailed descriptions. In fact, three different versions of the descriptions for individual steps and sub-steps were created to cater to various needs: a long version providing very detailed descriptions, a short version distilling only the most crucial elements and a simple version devoid of technical terminology for better accessibility. The long version of the descriptions, with detailed explanations and explicit cross-references between steps, is particularly suited for experts, researchers and other more technical practitioners who require detailed guidance for conducting or designing assessments. The short version, which condenses the most crucial elements, might be more appropriate for, for example, project developers and policy advisors who need to grasp the framework quickly and apply it in practice without going too far into methodological depth. The simple version, written without technical terminology, is tailored to policy-makers, managers and non-technical stakeholders (e.g. community representatives and NGOs) who are primarily interested in understanding the process, relevance and implications rather than methodological detail. In response to feedback, within the long version of the description, cross-references were added linking between the FIEA steps to make input–output relationships and dependencies more explicit.

A suggestion was made to incorporate a decision tree to facilitate the implementation of the Framework according to varying user needs. However, a separate decision tree was considered unnecessary, as the FIEA is already structured as a stepwise Framework. Its built-in cross-referencing and modularity allow users to navigate and apply the Framework according to their specific context and purpose. Throughout the development process, the importance of refining stakeholder engagement strategies was repeatedly emphasised. Therefore, general information on potential stakeholder roles was added, based on the IAP2 Spectrum of Public Participation (IAP2 International Federation 2018). Feedback highlighted the importance of placing greater emphasis on the assessment of cultural ecosystem services and on opportunities for qualitative analysis, which led to their strengthened consideration within the Framework. On the basis of these revisions, the FIEA v2 was established.

Through the testing of the FIEA in the Demonstration Projects and in parallel with the specific feedback and revision recommendations, also broader insights were collected. Since these insights did not result in further revisions of the Framework itself, but have instead highlighted its strengths and challenges, they are presented in the Section [#the_practical_value_of_the_fiea](#).

Phase VII: Final consultation for refinement

During the final revision, feedback from the entire SELINA consortium was incorporated to develop the final framework version. Slight modifications were made to the descriptions of individual FIEA substeps during this phase. Particular emphasis was placed on broadening private-sector perspectives. Therefore, clarity around the term "disclose" was improved by transitioning to a broader "Share" title for the Level 1 phase, with the addition of a dedicated Level 2 step, "Disclose". This distinction separates general communication and dissemination activities from actual disclosure obligations.

Recommendations for stakeholder engagement, including suggested formats, were added to the FIEA steps. Further, the linkage between FIEA and the justice dimensions was also updated. The focus was placed on those steps in the process where recognitional, participatory, distributive and contextual justice are most visible and actionable in ecosystem assessments. For each selected step, a structured description was developed that: (i) explicitly links the step to justice, clarifying why it matters; (ii) unpacks the four justice dimensions in relation to the specific step; and (iii) explains the practical relevance of these linkages, ensuring that the FIEA is not only normative, but also operational. On the basis of these revisions, the final FIEA (FIEA v3) was established.

Framework for Integrated Ecosystem Assessment (FIEA v3)

This Section presents the final version of the FIEA, outlining its overall structure, key components and (sub-)steps. Following the iterative development process and incorporation of feedback, the final structure of the circular Framework consists of six interconnected phases: Frame, Scope, Design, Assess, Share and Act (see Fig. 3). Each phase has multiple steps that guide the user through the process of defining the purpose of the ecosystem assessment, selecting the methods, indicators and data, implementing the ecosystem assessment, communicating and applying the results and integrating the results in decision-making (see Suppl. material 5 for table-based structure of the FIEA v3, including description on the level of individual Framework steps). Depending on the user group and the specific purpose of the assessment, the phases may vary in their level of detail. By engaging stakeholders throughout the assessment cycle, the FIEA emphasises the continuous and context-sensitive involvement of stakeholders across all phases for achieving an integrated, impactful, broadly accepted and applicable assessment. It acknowledges the importance of different levels of participation, for example, along the IAP2 Spectrum of Public Participation (IAP2 International Federation 2018) – from informing to co-creating and empowering – based on purpose, context and available capacities.

The **Frame** phase establishes the foundation for the assessment by defining its overall purpose, expected outcomes, and intended users, while ensuring legitimacy through inclusive and transparent approaches. It also includes analysing relevant stakeholders and their roles, as well as identifying key risks and opportunities that link the assessment to real-world consequences. Building on this, the **Scope** phase initiates stakeholder engagement and defines assessment questions and objectives. It further prioritises the most relevant impacts and dependencies and clarifies the spatial, temporal, social and ecological boundaries of the work. In the **Design** phase, the objectives are translated into concrete targets and strategies for assessing ecosystem types and extent, condition and services. This includes entry points for the selection of suitable methods, indicators and data, alongside consideration of communication needs, policy alignment, scenario and uncertainty assessments. The **Assess** phase represents the core of the framework, where the previously defined objectives and designs are put into practice. In this phase, the agreed methods, indicators and data are systematically applied to assess, map and

potentially account for ecosystem types and their extent, the condition of ecosystems and ecosystem services. Beyond producing technical analyses, the Assess phase integrates different knowledge sources and perspectives, combines qualitative and quantitative approaches and ensures that assessments are context-specific and scientifically robust. By transforming the design into tangible results, the Assess phase forms the foundation for the subsequent synthesis, communication and uptake of findings, making it the pivotal element of the overall process. The **Share** phase synthesises results, revisits impacts and dependencies and develops solutions or recommendations in co-creation with stakeholders. Results are then tailored to specific audiences, communicated through appropriate channels and – where relevant – formally disclosed. Finally, the **Act** phase focuses on the uptake of results into public and private decision-making, their implementation through concrete actions and policies and the monitoring and evaluation of progress and effectiveness. A principle of continuous iteration and improvement underpins all phases, ensuring adaptation and refinement in light of new insights and changing contexts.

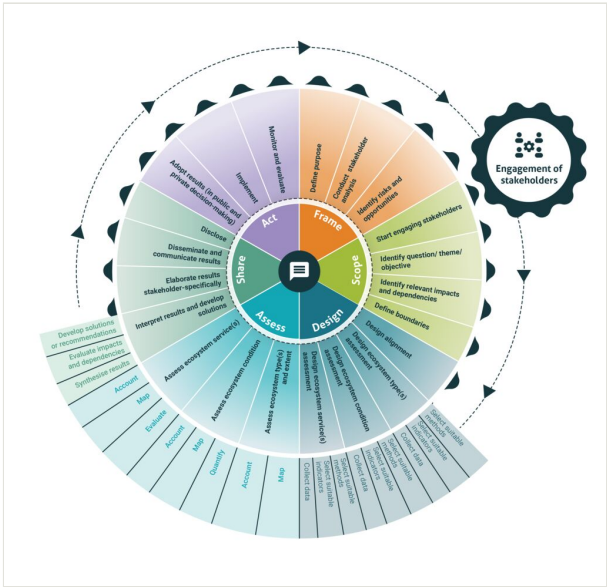


Figure 3.
Final version of the FIEA (v3, see Suppl. material 6 for illustration of early iterations of the FIEA).

Justice considerations

Justice considerations are highlighted at multiple points throughout the FIEA, with individual substeps relating to more than one justice dimension (see Suppl. material 5 for table-based structure of the FIEA v3, including justice considerations). This is especially obvious in early framing stages (e.g. when defining purpose, identifying stakeholders and recognising risks and opportunities), where decisions simultaneously influence

procedural justice (who is included and has influence) and recognitional justice (which knowledge and values are considered legitimate), thereby shaping which impacts are regarded as relevant. A second, less obvious connection appears in the “technical” stages of assessment design (methods, indicators and data choices), where decisions about what is measured and how it is assessed can favour certain value types (for example, biophysical or monetary indicators), while making others less apparent. In later stages, particularly when synthesising evidence, developing solutions and translating results into key decisions, distributive implications become more prominent as trade-offs amongst decisions need to be negotiated and benefits and burdens allocated. Overall, these results show that mapping justice across FIEA is highly relevant to enable users and decision-makers to anticipate where justice-related risks are likely to arise, from framing and evidence collection to outcomes and where transparent reasoning, inclusive interpretation and equity-focused monitoring are most vital.

The practical value of the FIEA

This Section examines the practical relevance and added value of the Framework as they emerged during the testing and refinement process, illustrating how it advances beyond existing approaches in supporting real-world applications and decision-making processes.

The practical value of the FIEA has become most apparent when reflecting on the experiences of Demonstration Project partners who tested its usability during the co-creation process. Demonstration Project partners raised a number of practical challenges and critical implementation points. These inputs were the basis for the step-wise adaptation of the framework and are discussed in detail in the Section [#framework_development](#). In this Section, the focus lies on the added value that Demonstration Project partners identified during implementation, highlighting how the FIEA can support their work in practice.

Integrative nature: As a first source of value, its integrative nature as a design tool for ecosystem assessments was noted. Demonstration Project partners stressed that the FIEA helps bring together ecological, economic and social dimensions within a single process. This was seen as particularly important for projects that had previously focused mostly on one dimension only or where activities were fragmented across different actors. A policy partner from Belgium reported that “it covers the whole process”, highlighting how the FIEA connects aspects that were often treated separately. In Norway, it was described as a “good exercise to help structure reporting”. Demonstration Projects highlighted how the Framework supports integration across knowledge domains. Several partners reflected that this integrative quality makes it easier to situate technical assessment work within broader decision-making contexts and to link scientific outputs with social and economic considerations.

Transparency: Second, the FIEA was perceived as clear and logically organised. Its stepwise design provides transparency and makes it easier for users to follow complex processes. A partner from Bulgaria stressed that “each stage is clearly defined”, while in

Malta, it was highlighted that “it follows a logical flow and reflects the process we actually went through”. This clarity supports both understanding and communication of results and was particularly valued by Demonstration Projects already familiar with similar frameworks or protocols.

Knowledge co-creation: Third, its value was found to lie in facilitating communication and collaboration. The FIEA was said to act as a bridge between scientific work and stakeholder engagement, offering a common reference point for dialogue and helping to structure engagement. Diverse actors can easily see how their contributions relate to one another, supporting co-creation and collective ownership of the process.

Flexibility: Fourth, the FIEA’s flexibility was noted as a practical advantage. It was seen as adaptable to different contexts and scales, enabling Demonstration Projects to tailor their application to their own needs. As an interviewee from Italy explained, the “flexibility of the framework enhances usability”. Partners also valued its modular approach, which allows selecting and applying those elements most relevant to the process stage and context, rather than feeling bound to follow the entire process step by step.

Alignment: Finally, its alignment with broader policy and methodological debates was emphasised. The FIEA’s alignment of structure and terminology with established standards, such as the Natural Capital Protocol, Capitals Protocol and SEEA-EA, was viewed as strengthening its credibility and relevance. As several partners reflected, “its consistency with [the language of] international standards makes it easier to link to EU and global debates”.

Alongside these benefits, some Demonstration Project partners (Table 4) highlighted that translating theoretical aspects into practical applications was not always straightforward, particularly for Projects with limited resources or for those less familiar with ecosystem terminology. While these issues were acknowledged and subsequently addressed through adaptations to the FIEA (see Section [#framework_development](#)) – including the development of different levels of description – they may continue to pose challenges, especially for small and medium-sized enterprises, as well as for local authorities or municipalities that often face similar capacity constraints.

These reflections underline that the FIEA’s practical value does not lie in rigid adherence to every step, but in its role as an integrative, clear, flexible, modular and communicable structure. It brings together complementary strengths from established frameworks, while addressing their respective limitations. In contrast to sector-specific (e.g. the operational MAES Framework, the Natural Capital Protocol), context-bound (e.g. the Integrated Approach to Planning) or conceptual frameworks (e.g. the IPBES 5-step valuation Framework), the FIEA offers an integrated approach necessary to address the multifaceted nature of integrated ecosystem assessments across diverse domains and contexts, specifying detailed steps and processes required for implementation. It offers ways to implement integrated ecosystem assessments, accounting for relevant interdependencies amongst ecosystem components, engaging with stakeholders and situating efforts within wider policy and methodological contexts.

Discussion

The FIEA's main features and innovations

Addressing the key challenge of limited uptake of ecosystem assessments in decision-making highlighted in recent literature (Longato et al. 2021, Walther et al. 2025), FIEA offers a practical pathway to improve adoption. Despite global and regional efforts – for example, the Kunming-Montreal Global Biodiversity Framework and the EU Biodiversity Strategies 2020 and 2030 – as well as national instruments, such as the Bulgaria's Forestry Act (Zakon za gorite (Forest Act of the Republic of Bulgaria) 2011), actual uptake of ecosystem evidence by decision-makers remains low (Laurans et al. 2013, Termansen et al. 2022, Walther et al. 2025). The FIEA's development through co-creation directly addresses these issues by enhancing the Framework's credibility, salience and legitimacy, which are crucial for increasing ecosystem services uptake (Barton et al. 2022).

More precisely, the co-creation approach employed in developing the FIEA was pivotal to strengthening its relevance, its inclusiveness and applicability. Inclusiveness is vital for decision-making because it ensures diverse perspectives are heard, which builds foundational trust amongst stakeholders and proactively identifies potential flashpoints, significantly reducing the risk of costly conflicts in complex areas like investment. By engaging scientists, public and private sector representatives, as well as civil society organisations, the FIEA ensures a robust integration of knowledge and expertise from the ecological, economic and social dimensions. This process enriched the Framework with diverse insights and practical applications. However, during the development and revision of the FIEA, at times, compromises amongst diverse perspectives were necessary, as some decisions did not achieve unanimous agreement. While these decisions helped ensure the Framework's functionality, they also underscore the complexity and challenges inherent in developing a Framework intended to address various needs and objectives (see Section [#challenges_of_the_fieas_cocreation_and_general_limitations](#)).

By incorporating the potential for iterative feedback loops and offering a flexible, modular design, the FIEA seeks to allow for pragmatic approaches to be undertaken in its implementation, reduce information costs and improve the translation of assessment findings into actionable insights. This adaptability is designed to accommodate various contexts and needs. The capacity to iterate ecosystem assessments over time across policy or project cycles contributes towards the likelihood of uptake in policy and project design (Barton et al. 2022).

Feedback during the usability testing of the FIEA v1.3 with Demonstration Projects emphasised the value of having clearly defined and well-structured phases. The logical flow was described as facilitating comprehension and implementation and as supporting integration into existing processes. Representatives from both the public and private sectors noted that the FIEA's structure aligns with relevant approaches and recent developments at the EU and global scale. The FIEA offers a practical way to connect

research with decision-making, helping to support more efficient and sustainable practices in ecosystem management. In addition, the FIEA recognises ecosystem condition as an analysis component equivalent in importance to other elements – a feature that, apart from its conceptual inclusion in MAES, is not yet a common standard. Furthermore, by incorporating ecosystem accounting in line with the SEEA-EA (United Nations et al. 2024), the FIEA extends its applicability to areas with limited coverage in other frameworks. During the FIEA development, the ongoing progress by the Capitals Coalition – namely the evolution from the Natural Capital Protocol to the more comprehensive Capitals Protocol (Capitals Coalition 2025) and the Beta Framework for Integrated Decision-making (Capitals Coalition 2024) – was actively monitored and considered. This transition reflects a broader shift towards integrated, multi-capital approaches to decision-making, encompassing not only natural, but also social, human and produced capitals (Capitals Coalition 2025). Besides, the implemented link from the FIEA steps to the TNFD's LEAP framework assessment components (Taskforce on Nature-related Financial Disclosures (TNFD) 2024) increases FIEA's relevance by improving comparability and alignment and enabling more interoperable, efficient workflows across private-sector processes.

The Framework not only emphasises the importance of stakeholder engagement, but also explicitly mentions aspects, such as uncertainty analysis in the assessment cycle, a critical factor identified as affecting ecosystem services uptake (Rounsevell et al. 2021, Walther et al. 2025). Furthermore, by promoting transparency and inclusivity through stakeholder engagement and active disclosure, the Framework facilitates navigating the complexities of diverse values and worldviews (Dou et al. 2023). General guidance as well as step-specific recommendations for stakeholder participation are provided. Additionally, the framework identifies, at selected steps, where recognitional, participatory, distributive and contextual justice are most relevant and provides operational guidance for addressing them. Together, the stakeholder engagement and justice considerations strengthen trust in results, improve the durability of decisions and broaden the framework's relevance across governance contexts. They increase the value of FIEA by producing outputs that are not only scientifically, but also socially robust and easier to integrate into policy, planning and private-sector processes.

Consistent with the IPBES Values Assessment (Pascual et al. 2023), the FIEA has the potential to support ecosystem assessments undertaken for all three valuation purposes: informing (e.g. for knowledge generation, awareness raising and impact evaluation), deciding (e.g. for evaluating options in projects, policies or corporate management) and designing (e.g. standard setting, damage estimation). Its modular architecture allows users to apply only those steps relevant to their purpose and capacity, with assessment depth that may vary from research-orientated applications to decision-orientated assessments. Overall, the FIEA facilitates the internalisation of nature's values by focusing on ecosystem assessments and allowing for embedding plural valuation, uncertainty analysis and documentation within decision cycles. However, any actual internalisation through statutory reporting, certification or binding instruments requires

adherence to the respective external standards, which the FIEA is designed to inform and complement rather than replace.

Challenges of the FIEA's co-creation and general limitations

Through the co-creation process, a few limitations were encountered that are worth discussing. A primary challenge was balancing the diverse interests and expectations of a broad range of involved partners, including scientists, policy-makers, private sector representatives, as well as civil society organisations. Each group brought distinct priorities and constraints, which necessitated compromises that did not always fully satisfy all parties involved. Further, communication barriers arose, for example, concerning terms such as “stakeholder” and “actor” or “material” and “relevant”, stemming from differences in terminology, conceptual approaches and levels of expertise across disciplines and sectors. These disparities occasionally led to misunderstandings and necessitated additional clarification efforts, for example, the development of a glossary. Furthermore, crafting a framework that is both integrative, flexible and adaptable, yet simple enough for practical application, has presented its own difficulties, as there is a constant risk of overly complex design potentially overwhelming users. Additionally, the process highlighted the need for robust implementation support which one can encounter by providing appropriate guidance material and exemplary cases.

Conclusions and Outlook

The FIEA development has set out two primary objectives: (i) To develop a unified Framework for integrated ecosystem assessments that ensures applicability for scientific assessments as well as decision-making in both public and private sectors, integrates ecological, economic and social dimensions, incorporates considerations of ecosystem condition, services and accounting approaches and provides the level of detail required to implement integrated ecosystem assessments; and (ii) to achieve this development through a collaborative interactive co-creation process involving diverse potential target users, thereby enhancing the Framework's relevance, adaptability and practical applicability. The FIEA fulfils these objectives as a flexible Framework that combines, integrates and streamlines insights from multiple sources across different sectors. It assembles ecological, economic and social aspects, making it applicable in various contexts to support scientific assessments, as well as decision-making in both public and private sectors. The Framework's modular design allows it to be customised to diverse needs and requirements. Thus, it has proven its suitability for practical use in real-world applications. As the FIEA includes sub-steps for assessing ecosystem condition and also includes ecosystem accounting, it naturally takes into account recent scientific developments in this area. The step-wise co-creation approach was vital in shaping the FIEA. By working closely with scientists, public and private sector representatives, as well as civil society organisations, the Framework was refined to ensure it is applicable while meeting real-world needs. In conclusion, the FIEA stands as an integrated and flexible framework, including step-wise guidance required for implementation, that supports

ecosystem assessments and decision-making relevant for, for example, the creation of scientific evidence, environmental planning, restoration measures, business management and policy development. It bridges the gap between theory and practice, helping to incorporate ecosystem services into decision-making and fostering sustainable management practices.

Outlook

The FIEA will serve as the foundational structure for the SELINA Compendium of Guidance. The tailor-made Compendium is a highly anticipated SELINA outcome, designed to effectively communicate project results to potential users and transform these outcomes into actionable knowledge. By doing so, it aims to support scientific progress and to facilitate the uptake of ecosystem assessments in both public and private decision-making contexts. The interactive tool will incorporate clickable elements and links to additional materials, thus transforming the complex structure into a more accessible and engaging format. Explanation boxes and pop-up descriptions will provide users with immediate guidance on technical terms and complex concepts. Through the Compendium of Guidance, scientific guidance from the SELINA project and beyond will be made available, aligned with the FIEA's steps. The guidance is anticipated to be tailored to diverse target users across different sectors and levels of technical expertise offering customised pathways through the Framework to address varying objectives and information needs. It will integrate a filter system enabling users to customise its application, enhancing its modular nature, for example, allowing context-specific applications as well as simpler "one-off/ad hoc" modular use of specific steps.

Considering the co-created, reality-checked and very comprehensive new framework, the FIEA has the potential to complement already existing frameworks and to become a major tool to guide integrated ecosystem assessments.

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Author contributions

SL, JS, BB, LB, MvW, DG, DNB, IL, GR, CB developed the idea of the integrated ecosystem assessment framework, defining the aims and scope (Conceptualisation). SL, JS, BB, JKH, JW designed the co-creation process and approach to developing and iterating the framework (Methodology). SL, JS, BB, MvW, LH, GN, DG, JKH, SN, VvH, JW were responsible for the development of the initial framework draft, analysing stakeholder input and feedback on draft versions, as well as synthesising results (Development & Analysis). EB, MvW, LH, GN, PR, FSM, DG, JKH, CC, DNB, GR, IL, NG, SN, VvH were responsible for the review of the framework draft versions as well as overseeing the testing the applicability of draft versions of the framework (Validation and Review). SL, JS, BB, LB, SP prepared framework figures and other illustrations (Visualisation). SL prepared the initial version of the manuscript (Writing – Original Draft). All authors contributed to Writing – review and editing and have read and approved the final version of the manuscript.

Conflicts of interest

The authors have declared that no competing interests exist.

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Supplementary materials

Suppl. material 1: Foundational framework components

Authors: Lange et al.

Data type: table

Brief description: This supplementary material consists of table sheets presenting the main underlying frameworks and their respective (procedural) steps.

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Suppl. material 2: Interview template - public DPs

Authors: Kato Huerta et al.

Data type: pdf

Brief description: Interview template - public sector Demonstration Projects

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Suppl. material 3: Interview template - private DPs

Authors: Heine et al.

Data type: pdf

Brief description: Interview template - private sector Demonstration Projects

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Suppl. material 4: DP Feedback Log - FIEA v1.3

Authors: Lange et al.

Data type: table

Brief description: Log on Feedback from Demonstration Projects on FIEA v1.3

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Suppl. material 5: FIEA v3 - table version

Authors: Lange et al.

Data type: table

Brief description: Table version of FIEA v3

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Suppl. material 6: FIEA development

Authors: Lange et al.

Data type: figure

Brief description: Chronological development of FIEA - visualisation.

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Endnotes

*1 <https://project-selina.eu/>

*2 This refers to assessing the implications of ecosystem assessment steps for recognitional, procedural and distributive dimensions of justice, including whose knowledge and values are represented, who participates in and influences decisions and how outcomes are distributed.