MERLIN

Deliverable D4.4:

Value Chain Analysis in Key Economic Sectors

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Imprint

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MERLIN Key messages

1. Economic sectors and restoration projects remain disconnected, with businesses often not actively included into restoration projects despite their dependence on natural systems.

2. Value chain analysis provides a structured lens to identify where business interests and restoration efforts converge, helping to align ecological and economic value creation.

3. Sectoral standards and certification schemes play a pivotal role in enabling the recognition, visibility and credibility of restoration efforts within eco-aware markets, helping to mainstream NbS.

4. Multi-actor coordination across different types of actors on the value chain is essential to co-design and operationalise NbS within socio-economic systems.

5. The examples analysed reflect a continuum from mature to emerging integration: organic farming demonstrates a well-established ecological practice embedded in value chains; peat extraction showcases developing restoration-linked certification schemes; and the insurance sector points to future opportunities through innovative risk reduction pathway.

6. Systemic change—supported by empirical evidence, improved standards, and inclusive frameworks—is required to transpose NbS from pilot projects into business practice.

MERLIN Executive Summary

While economic activities are fundamentally dependent on the natural environment, economic sectors are often not actively engaged in ecological restoration efforts. This disconnection stems from multiple barriers, including the fact that **restoration projects are frequently conceived and executed within ecological value-oriented frameworks, which often lack structured mechanisms for private sector participation**. Therefore, opportunities to align ecological and economic objectives remain underexplored.

Deliverable 4.4 of the MERLIN project addresses this gap by exploring whether the **value chain analysis (VCA) can help mainstreaming NbS by identifying where and how freshwater ecosystem restoration can be aligned with business interests**. The process also serves as a stepping stone towards the development of MERLIN Sectoral Strategies.

While a value chain encompasses the full spectrum of activities involved in bringing a product or service from conception through to consumption and eventual disposal, VCA refers to the systematic examination of these processes. **VCA focuses on identifying key activities, actors, and regulatory frameworks, to better understand their interdependencies and the mechanisms of value creation along the chain**. In this report, we also extended the conventional concept of the value measured by price, incorporating ecological and social value.

Using this extended perspective, an explorative, multi-step qualitative analysis is adopted. Our analysis, across different economic sectors, allows to map where and how ecological measures can be integrated into value creation process. It is then illustrated by real-world case studies and complemented by a review of existing sectoral standards. This systematic approach enables us to identify practical entry points for incorporating restoration efforts into business practices.

Three sectors—agriculture, peat extraction and insurance—are selected due to their potential to offer multiple actor-centred analytical focus. In the agriculture sector, the case of organic dairy farming demonstrates a mature and well-acknowledged value chain where environmentally responsible practices are translated into market value via certification schemes. Organic standards, like *EU Organic Farming*, while not strictly defined NbS, still offer a practical model for aligning environmental benefits with commercial outcomes.

In the peat extraction sector, the role of NbS in the value chain for horticultural peat growing media is primarily concentrated in after-use restoration practices. Certification schemes like *Responsibly Produced Peat* (RPP) and *Veriflora* that promote rehabilitation practices and provide labelling tools, though they vary in geographic scope, actor involvement, and the enforcement of restoration measures. We propose ways to engage actors across the value chain to support ambitious after use that restores ecological function.

The insurance sector, though lacking explicit NbS-related standards, demonstrates strong potential for innovation and inclusion of NbS in the service-based value chain. Experimental products such as parametric insurance (e.g. Mesoamerican Reef) and Construction All Risks insurance (e.g. Prince Hendrik Dyke) illustrate how risk reduction through NbS can be embedded in financial services.

The report identifies several common patterns across the three sectors. Apart from the usefulness of using VCA for business-restoration connections, we notice that **sectoral standards play an important role in mainstreaming NbS, as they are enablers for market recognition of restoration efforts**.

Moreover, financial mechanisms beyond the value-added itself, seem to be important for upscaling these solutions, required to initiate the approach as well as maintaining momentum for continuous ecological efforts. Multi-stakeholder coordination is proved essential in successful alignment of ecological and economic value, as **the VCA reveals interdependencies between sectors, therefore the necessity of systematic change for mainstreaming NbS in restoration**.

Acronyms

CAR	Construction All Risks
CSRD	Corporate Sustainability Reporting Directive
ESG	Environmental, Social, and Governance
GRI	Global Reporting Initiative
ISCC	International Sustainability and Carbon Certification
ITC	International Trade Centre
IUCN	International Union for Conservation of Nature
NbS	Nature-based Solutions
RPP	Responsibly Produced Peat
SAC	Sustainable Agriculture Code
SWM	Munich Water Utility (in German: *Stadtwerke München*)
UN PSI	United Nations Principles for Sustainable Insurance
UNEA	United Nations Environmental Assembly
VCA	Value Chain Analysis
WSS	Water Supply and Sanitation

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1 General introduction

This report stems from an observation in the current state of ecological restoration practice in which actors from economic sectors are often not actively involved in restoration projects. This situation appears paradoxical: as on the one hand, businesses depend on ecosystems for raw materials, climate stability and ecosystem services that underpin their operational performance. On the other hand, restoration actions—particularly those grounded in **Nature-based Solutions**—oriented to recover ecosystem functionality, sidelining considerations on the economic feasibility. Yet these objectives are not inherently in conflict; rather, they offer complementary opportunities. By design, NbS aim to generate both ecological gains and address societal challenges, making them well suited to bridge restoration goals with economic needs. **This report explores how value chain analysis can serve as a practical method to identify where restoration efforts and economic interests align, and how restoration projects can better engage with practitioners from economic sectors by recognising their needs in restoration and their contribution in upscaling and mainstreaming NbS**.

1.1 Context and Objective

The connection between business and nature is receiving growing attention under the current circumstances of global environment degradation and climate change. Nature supports businesses through different ecosystem services, including raw materials provision, climate regulation and nutrient cycling, even cultural benefits like recreation and scenic value. Studies show that **85% of world's large companies and more than 50% of the world's economic output are dependent on nature** (World Economic Forum, 2020). Losing access to these services can lead to higher operational costs and lower production, therefore causing great loss of economic value.

Despite of the strong dependency on the environment, freshwater ecosystems across Europe have significantly deteriorated due to intensive human activities, a situation further exacerbated by climate change (Dodds et al., 2013; Khan & Patel, 2021). In response to this situation, **European Union introduced the Nature Restoration Law which mandates comprehensive ecosystem restoration by 2050** (European Commission, 2022).

Nature-based Solutions (NbS) were suggested during the new millennium to address societal challenges related to natural environments (Cohen-Shacham et al, 2016). This type of solution comprises "*actions to protect, conserve, restore, sustainably use, and manage natural or modified terrestrial, freshwater, coastal, and marine ecosystems which address social, economic, and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience, and biodiversity benefits*" (UNEA,2022). In freshwater ecosystem restoration practice, the most recognised NbS interventions include revegetation of peatlands, riparian, channel and floodplain restoration.

To support the design and verification of effective NbS, the **International Union for Conservation of Nature** (IUCN) developed a Global Standard comprising eight criteria (IUCN, 2020)[1]. These NbS criteria serve as a guiding framework to ensure the effectiveness, sustainability and adaptability of NbS interventions. The eight criteria are: (1) addressing societal challenges; (2) designing at appropriate scale; (3) delivering a net gain to biodiversity; (4) ensuring economic feasibility; (5) upholding inclusive and participatory governance; (6) balancing trade-offs and co-benefits; (7) applying adaptive management; and (8) ensuring mainstreaming and integration into broader policy and planning frameworks.

The D3.5 in MERLIN project has highlighted the need to diversify financial instruments to support ecological restoration projects and pointed out that engaging the private sector is a crucial component in ensuring the economic feasibility of NbS interventions (Rouillard, 2025). Nevertheless, **persistent disconnections remain between restoration projects and business engagement.** We notice that on the one hand, many businesses struggle to see how restoration efforts align with their economic goals or can be integrated into their operational models. Barriers to mainstreaming NbS in business include lack of financial evidence (Terranomics, 2022) , technical and knowledge gaps (Bhardwaj et al., 2020), fragmented incentives (Waring, 2024) and competition with other established sustainability investments such as renewable energy (Löfqvist et al., 2023). On the other hand, **restoration projects are often designed and implemented within conservation frameworks, with limited involvement from the private sector** (Waylen et al. 2024).

[1] Further in this report, the criteria set out in the IUCN Global Standard will be referred to as the "*NbS criteria*" for consistency.

In the MERLIN project, complementary tasks are designed to close the gap between restoration and business engagement. Insights on building a financial strategy (D3.5, Rouillard, 2025) discusses the steps taken by restoration actors to identify ways to engage private finance, **while Task 4.4 applies value chain analysis (VCA) to identify entry points for integrating NbS into sector-specific economic activities**. By mapping the flow of values and relationships between sectoral actors within each economic sector, this deliverable provides both sectoral partners and actors in restoration projects with practical guidance for aligning ecological objectives with commercial interests and stakeholder priorities. Note that deliverable 3.5 specifically addressed how the MERLIN case studies could use value chain and other strategies to help with upscaling and mainstreaming their restoration measures. Therefore, **this deliverable provides a complementary sectoral perspective and does not engage with the MERLIN Case studies directly**.

1.2 Methodology

The concept of the 'value chain' was initially introduced for examining the advantages in business competitiveness (Brown, 1997; Porter, 1985). A value chain of an economic sector encompasses the full range of activities required to bring a product or service from conception to final consumption and eventual disposal (Hellin & Meijer, 2006). To better understand the core competitiveness of economic activities, a **value chain analysis (VCA)** is necessary. **VCA is a detailed examination of various elements** such as activities, actors and regulation frameworks to understand the complex dynamics **within a value chain, especially the value-adding (or value creation) mechanism** through various activities along the value chain (Hellin & Meijer, 2006).

In the VCA, **sectoral standards** play the role in shaping how value is produced and delivered as they function as commonly accepted norms or guidelines that specify the quality, safety, or environmental requirements of products and services. By setting clear criteria, sectoral standards help to structure the **value chain coordination** which refers to the organisation of workflow in which multiple actors work towards shared outcomes and in compliance with established standards (Bijman et al., 2012). A better understanding of the value chain coordination allows to identify the **value chain problem** that is issues or challenges occurring within the sequence of activities involved in a value chain (Webber & Labaste, 2007).

Moreover, this broader framework of value chain often implies **supply chain**. However, **a supply chain is different from a value chain**. A supply chain analysis primarily concerns the flow and transformation of goods from raw material through to final delivery (Seuring & Müller, 2008). In contrast, a value chain analysis employs a relational perspective, emphasising how value is created, enhanced, and delivered at each stage till consumption, and even end-of-life disposal. While the supply chain can be considered a component within the broader value chain, the two differ fundamentally in their analytical focus: supply chains examine the mechanics of logistics and material movement, whereas value chains analyse the processes of value generation.

In this report, VCA is chosen as a methodological approach for its **capacity to capture the relational and systemic dimensions of business value creation procedure**. Rather than treating economic processes in isolation, VCA reflects the interdependence among actors—such as producers, consumers, service providers, and regulators—who collectively influence the value creation process (Fearne et al., 2012). By clearly mapping these processes, VCA helps actors in restoration projects better understand business perspectives and identify opportunities to align restoration activities with commercial interests, such as **ensuring a sustainable supply of raw materials or ecosystem services** (for example water, soil and climate stability), **reducing operational costs, or enhancing marketability of products in eco-aware markets with premium prices**. Thus, VCA provides actors in restoration projects with a practical tool to identify the common ground and engage effectively with businesses. This approach helps us to achieve the objective of **bridging the gap between restoration projects and business sectors**.

In our analysis, we incorporate the **socio-ecological dimension** in the conventional definition of value (Folke et al., 2016; Ostrom, 2009). This approach extends the definition of value beyond solely economic aspect that is often measured by changes in market share or final prices for products. This extended perspective enables us to capture intangible and non-market aspects of the value, such as environmental integrity (biodiversity, resource regeneration, carbon footprint, pollution and waste management and so on) and social well-being (livelihood, public health, cultural recognition). This extended value dimension allows us to qualitatively identify and act upon areas where values can be protected or generated rather than focussing on financial flows alone (Moretti et al., 2023; Ros-Tonen et al., 2018).

More specifically in this report, **our method adopts an explorative, qualitative approach to trace how value is created and exchanged across different value chain steps in selected sectoral value chains**, with the aim of identifying where and how restoration interventions can be integrated into profitable business practices. For achieving this goal, we proceed the analysis through four structured exercises. First, **sector-specific value chain mapping** is conducted to identify key actors, activities, governance structures, and environmental dependencies in target sectors. Second, **illustrative case studies** are presented and analysed to highlight real or potential applications of restoration interventions in addressing value chain problems. Third, a **review of relevant sectoral standards** is performed using the **International Trade Centre (ITC) Standards Map** to assess their role in supporting or hindering NbS, particularly in freshwater ecosystem restoration. Lastly, based on the standard review, **suggestions of standard improvement** were made to synthesise findings for future alignment between ecological interventions and business interests.

Six key economic sectors were identified in MERLIN project for their relevance to freshwater ecosystems: Water Supply and Sanitation (WSS), Agriculture, Insurance, Peat Extraction, Hydropower, and Navigation. Hydropower, Navigation, and WSS were excluded due to their reliance on large-scale infrastructure, relatively monopolistic market operation and heavy regulatory mechanisms, which are less compatible with VCA's multiple actor-centred analytical focus (Kaplinsky & Morris, 2000). **Agriculture**, **Peat Extraction** and **Insurance** are selected as focal sectors based on their potential to demonstrate how to align restoration with business objectives through the VCA (Figure 1). For instance, organic and riparian practices in agriculture reduce input costs and improve market positioning (Tomer et al., 2013); post-extraction peatland restoration building on certification schemes creates consumer acceptance of peat based growing media (Wetlands International, 2019); and wetland-based risk mitigation in insurance can reduce payouts and enable new products (Jongman et al., 2014; Surminski & Thieken, 2017).

Figure 1. Economic sectors selected for value chain analysis

1.3 Structure and audience

The structure of the report reflects our analytical strategies stated above. The agriculture chapter comes first to demonstrate how organic farming — a widely accepted practice while not strictly defined as an NbS[2] — can generate both environmental and economic value. This is followed by a case from the peat extraction sector, illustrating how a restoration-linked certification scheme like the Responsibly Produced Peat (RPP) can drive restoration as an after-use intervention. Lastly, the insurance chapter explores the prospective potential of novel insurance product development through the integration of restoration actions, indicating where future business innovation might emerge.

Building on this sequencing, each sectoral chapter is organised to follow a consistent analytical structure that facilitates comparison and highlights sector-specific insights. Each chapter begins with 1) a **sectoral introduction** that outlines the context and environmental implications of the sector's economic activities. This is followed by 2) a **value chain analysis** that identifies where value-related challenges exist in relation to NbS integration. 3) A **case study** then illustrates either how such challenges are being addressed in practice (as in the agriculture sector), or where potential entry points for NbS integration have been identified (as in the peat extraction and insurance sectors). 4) The subsequent section presents a **review of relevant sectoral standards**, examining their relevance with NbS criteria, their influence on the value chain, and their strengths and limitations in supporting NbS integration. Each chapter concludes with 5) a short **sectoral discussion** reflecting on how the value chain approach has helped bridge the disconnection between business needs and restoration efforts in that particular sector.

[2] Organic farming aligns with many NbS criteria but is not strictly considered an NbS, as it prioritises ecosystem preservation over active ecological restoration, which is central to NbS.

The intended audience—including NbS advocates, environmental policymakers, sectoral partners, and actors in restoration projects—will find in this report a structured explanation of how VCA can be helpful to align ecological restoration with economic value creation and help to be aware of the roles of business practice in financial source diversification and enhance economic feasibility for mainstreaming NbS, although barriers and limitations still need to be acknowledged.

2 Agriculture

Chapter authors: Lea Ilgeroth-Hiadzi, Jianyu Chen

This chapter uses organic farming as a case study to demonstrate how ecological practices can be integrated into sectoral value chains, enhancing economic value creation while aligning with environmental integrity. Although organic farming is not a strictly defined NbS, there is still an established and widely recognised value chain in agriculture sector, along which ecological practices can be converted into market value through certification and labelling schemes.

2.1 Sectoral introduction

The term 'agriculture' is often used as a single category, it encompasses however a vast array of sub-sectors, such as crop production, livestock farming, horticulture, aquaculture, and agroforestry. This diversity results in a wide range of complex activities that make developing a universal value chain map challenging (Scoppola, 2022). Therefore, a case-specific approach to dairy farming is employed in this section. This narrowed-down scope provides a targeted example to illustrate how ecological measure can help to align economic values with ecological benefits within the agricultural value chain.

NbS in agriculture involve using the complex ecosystem to enhance agricultural productivity, resilience, and sustainability. These solutions integrate ecological principles into farming practices to improve soil health, water management, and biodiversity conservation while reducing environmental impacts. In our case study, the dairy farming practice is also related to Water Supply and Sanitation (WSS) sector. The relevance of dairy farming to freshwater ecosystem restoration arises primarily from the farmlands within water catchment areas. **Agricultural land use is extremely important in catchments**, representing about half of the world's habitable land (Viana, 2021). Nutrient-rich runoff containing manure and fertilisers from dairy farms can adversely affect water quality downstream, significantly putting more pressure on the WSS sector (EEA,2018), where increased nutrient loads lead to higher water treatment costs and reduced operational efficiency. Consequently, effective restoration in dairy farming areas, such as buffer strips, riparian planting, and improved nutrient management, can significantly reduce these negative impacts, benefiting both sectors simultaneously (Rizzo et al., 2023).

Organic farming

refers to an agricultural system that relies on natural processes and inputs, emphasising the use of organic fertilisers, crop rotation, and biological pest control to enhance soil fertility and ecological balance, while avoiding synthetic pesticides, fertilisers, and genetically modified organisms (Lampkin et al., 2000).

While the principles of organic farming are closely aligned with NbS criteria, it is not strictly categorised as an NbS, as NbS stress on ecological restoration, while organic farming—by avoiding synthetic inputs and promoting biodiversity conservation—focuses on maintaining existing ecological conditions rather than actively restoring or enhancing degraded ecosystems (Demozzi et al., 2024). Therefore, **this analysis employs organic dairy farming primarily as a practical exemplar to highlight successful sectoral integration of ecological practices into value chains.** This example serves as a reference point for ongoing discussions on how NbS could similarly be embedded into other agricultural subsector value chains to deliver measurable environmental and economic outcomes (Chausson et al., 2024; Miralles-Wilhelm, 2023).

Moreover, the cross-sectoral value chain analysed in this chapter provides evidence-based rationales for business-restoration alignment: **upstream sustainable agricultural practices directly benefit downstream water quality, reducing treatment burdens and associated costs in the WSS sector**. The coordinated management of freshwater ecosystems across these sectors reinforces broader sustainability goals, advancing ecological restoration while simultaneously safeguarding economic feasibility. Therefore, the cross-sectoral value chain between agriculture and WSS is considered as a good example of aligning economic gain with ecological value.

2.2 Agriculture value chain

Based on the strong interdependencies between the agriculture and WSS sectors, a comprehensive cross-sectoral value chain has been developed (Figure 2). This approach enables us to identify potential value chain problem and promote the integration of ecological practice as effective solutions to address these challenges.

The value chain map provides an overview of the flow of economic and environmental value across the agriculture and WSS sector, emphasising how organic farming practice can enhance the value creation by

reducing the impact of pollution from conventional dairy farming on water quality[3]. The focus of the value chain map is placed on the agriculture value chain, in which a detailed network of activities, actors and regulators are represented, with economic and environmental value generated at every step.

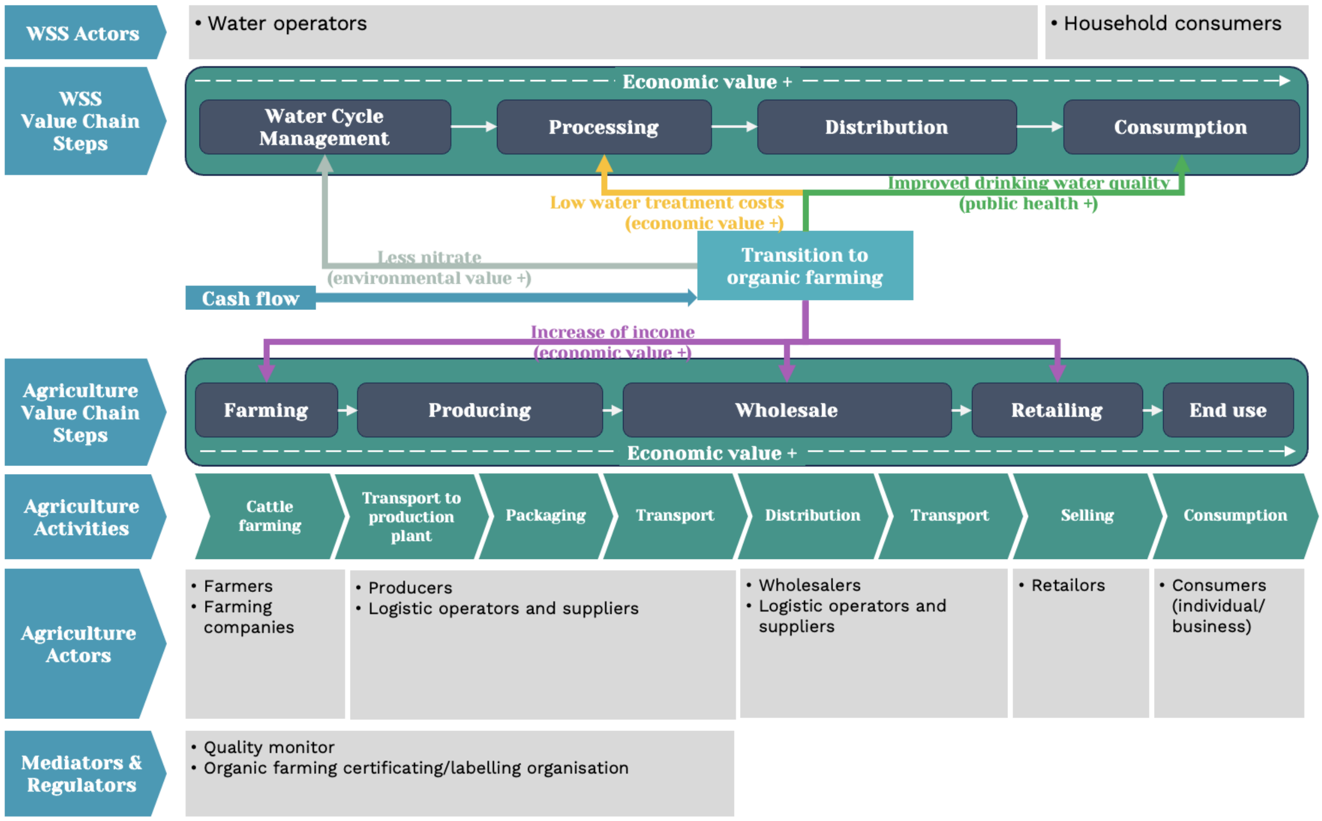


Figure 2. Cross-sectoral value chain between WWS and agriculture highlighting benefits of organic farming

On the cross-sectoral value chain, pollution generated from conventional farming practices stands at the intersection of the agriculture and WSS sector as a significant cross-sectoral challenge. Practices in conventional agriculture, which often involve the heavy use of synthetic fertilisers and intensive livestock farming, lead to substantial nitrate runoff into nearby water bodies and groundwater. This pollution degrades water quality, imposing therefore considerable costs on the WSS sector, which must invest in extensive treatment processes to ensure safe drinking water. The negative impact of pollution from conventional farming practices extends across multiple stages of both the agriculture and WSS value chains, creating a series of interconnected challenges, such as increased water treatment costs, public health risks and biodiversity loss.

To solve this problem, the transition to organic farming—supported by targeted financial compensation, particularly for farms located close to key water sources,—resulted in a significant reduction in nitrate levels. Within the dairy farming value chain, both ecological and economic value are created through this transition. On one hand, the switch to organic farming improves environmental health by reducing synthetic fertiliser use and mitigating nitrate runoff into nearby water bodies. On the other hand, **downstream partners created economic value through selling products in an ecological-aware market**. The collaboration between agriculture and WSS sector also provides farmers with compensation payment and access to new market channels.

In the WSS value chain, the primary added value lies in the **improved quality of raw water entering the treatment system, which reduces extra cost**. This translates into operational savings for the utility and ensures compliance with public health standards. Moreover, social value is realised by maintaining affordable and safe drinking water for the population of Munich. Environmental value is enhanced through the long-term protection

[3] While dairy farming is not considered as an intensive water-use sector which pose no significant impact on water quantity. However, this may vary for other agricultural subsectors.

of groundwater resources, aligning with broader ecological objectives, such as biodiversity conservation in freshwater ecosystem.

The value chain analysis **highlights the central role of transitioning from conventional farming practices to more ecological farming practice as a cross-chain level issue**, which affects both the agriculture and WSS sectors. The resulting challenges—ranging from increased treatment costs to environmental degradation and regulatory pressures—underscore the need for more comprehensive and systematic approaches to managing these interconnected value chains. Addressing these issues proactively is crucial for ensuring the long-term ecological and economic sustainability of both sectors.

Given the challenges identified with the conventional farming practice and the potential of various value creation by organic farming, this cross-sectoral analysis exemplifies how ecological methods can be effectively integrated in the value chain of both agriculture and WSS sectors. This case study demonstrates the potential for ecological measure to drive sustainable business practices within both implicated sectors. Therefore, the application of value chain analysis helps us identify critical entry points to leverage collaborative opportunities to align business needs with restoration goals.

More to know:

The nitrate contamination issue had broad implications across EU countries in the farming sector. For example, in Germany, this concern escalated in 2016 when the European Commission filed a complaint against Germany with the European Court of Justice, accusing it of insufficient action against nitrate pollution from agricultural sources. By 2018, the Court condemned Germany for its inadequate measures, demanding more stringent regulations to curb nitrate contamination.

The Court ruling significantly pressured Germany's farming sector, traditionally reliant on fertilisers and manure, which contributed to excessive nitrate leaching into groundwater. This situation not only posed health risks but also contravened the EU Nitrates Directive. In response, Germany introduced stricter fertilisation regulations, including extended no-fertilisation periods and specific restrictions in vulnerable areas, to reduce nitrate levels and comply with EU standards. These regulatory changes required farmers to adopt more sustainable practices, balancing agricultural productivity with environmental protection. (Science Media Center Germany, 2018; Zeit.de, 2018).

2.3 Case study: Mangfall water catchment area

The Mangfalltal case from Germany illustrates a successful cross-sectoral approach to integrate organic farming into value chains, specifically between the agriculture and WSS sector. In the early 1990s, rising nitrate levels in Munich’s drinking water—mainly attributed to intensive cattle farming practices —prompted Stadtwerke München (SWM), the Munich municipal water utility operator, to seek preventive rather than technical treatment solutions.

With effective value chain analysis of both WSS and agriculture sectors, **organic farming was identified as an ecological solution due to its regulated restrictions on synthetic fertiliser use and area-based livestock practices**, which help reduce nitrate runoff. Therefore, SWM launched a support programme in 1992 (SWM, 2023), offering financial incentives to farmers transitioning to organic practices. The financial support was scaled based on the proximity of farms to the city’s water source—Mangfalltal catchment area. Over time, the initiative expanded significantly, with hundreds of farms participating and nitrate levels in drinking water falling to safe levels before treatment.

This collaboration also inspired downstream value creation. For example, dairy products marketed under the "Unser Land" (“Our land”) brand now highlight their origin in the protected Mangfalltal region, linking sustainable agricultural practices to consumer-facing value (Figure 3). The case demonstrates how NbS can address critical value chain problems (here, water pollution), while creating economic and environmental benefits across sectors. Today, this transition to more ecological farming practice helped to build one of Germany’s largest contiguous organic farming regions, bring economic, ecological and social value.

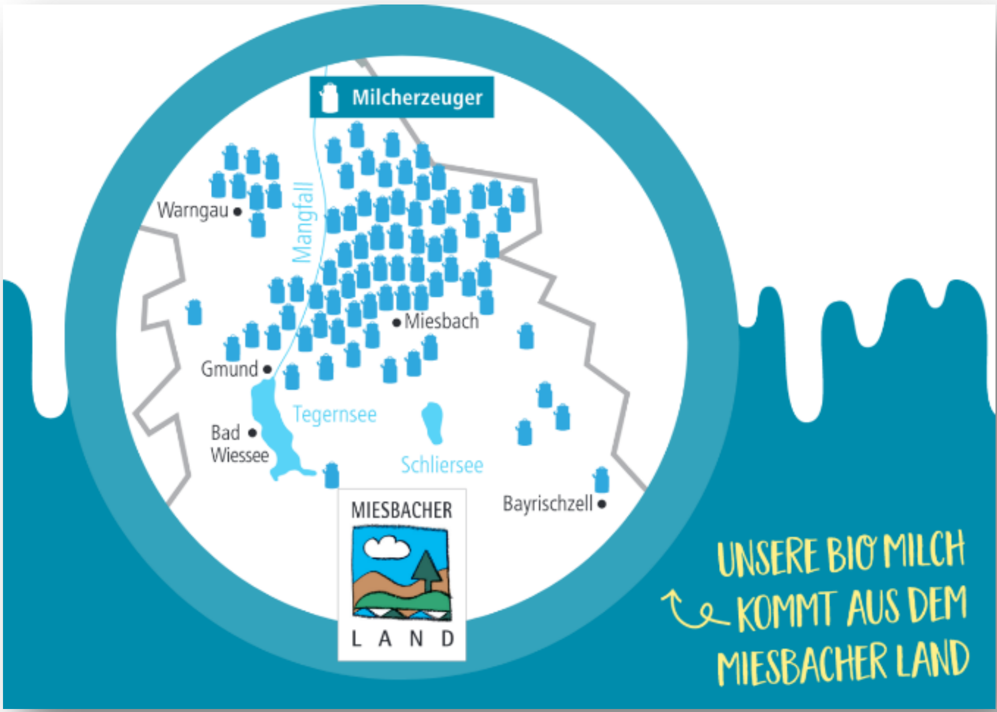


Figure 3. Package of 'Unser Land' diary product showing protected water catchment (Miesbach area)

(Source: [UNSER LAND](#))

By focusing on this specific case study, we can draw valuable insights and develop targeted strategies for aligning business goals and ecological benefits through ecological farming measures. In the Mangfall case, an important part of the value is created in the cross-chain cooperation where organic farming **reduced operational cost at the water treatment step** in WSS sector. Organic farming also benefits downstream business by creating locally recognised dairy product for **both wholesale and retail on the agriculture value chain**. In addition, social value like **reducing public health risk is created for end-users of both value chains**.

2.4 Review of agriculture sectoral standards

As organic farming successfully solved the cross-value-chain problem in our case study, we can move beyond the dairy farming subsector and see whether the integration of ecological farming practice in the general agriculture sector can also contribute simultaneously to offer economic benefits and enhance freshwater ecosystem healthiness. To achieve this goal, a review is conducted on existing sectoral standards and certification frameworks. The objective is to identify standards that facilitate the systematic integration of ecological farming methods (including NbS interventions related for biodiversity conservation or sustainable water management) and how the implementation of ecological measure helps to solve the cross-chain level problem between agriculture and WSS sector on coordinating different steps and actors on the agriculture value chain.

Our research identified 17 relevant standards (Table 4)—15 from the **International Trade Centre (ITC)** Standards Map and two from regional frameworks—that link agriculture to freshwater ecosystem using ecological farming practice. Among these, four standards were found to be particularly aligned with the NbS criteria for delivering biodiversity net-gain, enhance at the same time freshwater ecosystem healthiness (

Table 1).

Table 1. Selected agricultural standards connected NbS criteria and freshwater ecosystem health

Standard	Measures to achieve biodiversity net-gain	Relevance to Agriculture	Relevance to Freshwater Ecosystem
Unilever Sustainable Agriculture Code (SAC)	Includes biodiversity action plans, no deforestation, water stewardship	Applies across agricultural raw material sourcing for food production	Includes specific criteria on freshwater body protection and use
GLOBALG.A.P. Crops Integrated Farm Assurance (IFA)	Includes integrated pest management, biodiversity modules, and soil conservation	Widely used in commercial agriculture and fresh produce chains	Requires water use monitoring and protection of water sources
EU Organic Farming	Embeds biodiversity, soil health, and natural pest control	Applies to crop and livestock systems under EU regulation	Prohibits chemical inputs and promotes water protection
Naturland Standards on Production	Promote sustainable water use, biodiversity conservation, and natural vegetation	Focused on ecological practice like organic farming	Prohibition of synthetic chemical fertilisers, promotion of biodiversity through buffer zones, maintaining natural vegetation along water bodies.

2.4.1 Freshwater ecosystem health and economic value creation through agriculture standards

This section explores how ecological farming standards contribute both to the health of freshwater ecosystem and to economic value creation across the agricultural value chain. Specifically, the analysis reveals how **biodiversity conservation** and **sustainable water management**—two interventions to address societal challenges according to the NbS criteria—are embedded within sectoral standards and operationalised through value chain coordination.

EU Organic Farming

- → **Benefit to freshwater ecosystem:** EU Organic Farming regulations prohibit the use of synthetic fertilisers and pesticides, which not only help on the terrestrial biodiversity conservation, but also significantly **reduces the risk of chemical runoff and nutrient leaching into freshwater ecosystem**. These measures benefit indirectly freshwater ecosystems by minimising pollution and supporting catchment-scale water quality.
- → **Economic value creation: EU Organic Farming mandates full-chain certification and traceability from farm to retailer**. By ensuring all actors comply with organic criteria, it creates a consistent ecological brand identity, displayed by the EU organic label. This enhances consumer visibility, allowing producers, processors and sellers to command price premiums in eco-aware markets, translating ecological benefits into economic value across the whole value chain.

GLOBALG.A.P. Crops IFA

- → **Benefit to freshwater ecosystem:** GLOBALG.A.P. Crops IFA enforces direct measures for water protection, including the implementation of efficient irrigation systems, buffer zones to limit runoff, and water quality monitoring protocols. These practices reduce agricultural pressure on both quality and quantity management of freshwater ecosystems by **minimising erosion, chemical** discharge, and over-abstraction. The environmental emphasis ensures that farms certified under this standard maintain responsible water use and protect aquatic habitats, thus directly benefit the freshwater ecosystem.

- → **Economic value creation:** As a retailer-driven standard, GLOBALG.A.P. is frequently a prerequisite for selling to large EU supermarkets. It assigns a unique GLOBALG.A.P. Number (GGN) to each certified farm, enabling traceability and transparency for buyers. This strengthens consumer trust and visibility, while offering farmers structured market access. Sustainability compliance thus becomes embedded in procurement, linking upstream ecological practices to downstream economic opportunities.

Naturland Standard on Production

- → **Benefit to freshwater ecosystem:** Naturland Standards place a strong emphasis on sustainable water use. The standard includes organic farming, creating buffer zones, and natural vegetation along water bodies. These criteria directly mitigate impacts on freshwater systems by ensuring that farming activities do not degrade surrounding ecosystems.
- → **Economic value creation:** Naturland Standards on Production adopts a chain-of-custody certification model that tracks compliance from farm through processing and packaging. This guarantees that sustainability attributes are maintained along the value chain and can be verified by retailers and consumers. The high level of traceability supports brand differentiation in environmentally conscious markets, particularly in Europe.

Unilever SAC

- → **Benefit to freshwater ecosystem:** The Unilever SAC mandates supplier adherence to strict water stewardship principles, including protection of freshwater bodies, responsible irrigation practices, and measures to avoid water pollution. These requirements help prevent sedimentation, contamination, and depletion of freshwater resources across diverse geographies where Unilever sources raw materials. The code also supports broader watershed health by integrating biodiversity and land-use controls that reduce pressure on aquatic systems.
- → **Economic value creation:** Unlike third-party certifications, SAC functions as an internal governance mechanism embedded within Unilever's internal supply chain. It requires suppliers to undergo sustainability assessments and performance reviews, which are tracked via internal scorecards. This approach aligns environmental performance with corporate procurement goals and ensures consistency across global operations. While not consumer-facing, the SAC adds value by enhancing supply chain resilience and supporting Unilever's broader brand reputation and sustainability commitments.

2.4.2 Strengths and limitations in existing standards

Standards can help at different points of a value chain to embed practices that can help protect the environment and reduce pressures on freshwater ecosystems. However, none of them fully address the range of issues that would make them compliant with the IUCN standard for NbS. Furthermore, often the standards have limitations that reduce their efficacy in adding value, particularly in terms of visibility or desirability of the final product.

For instance, while the EU Organic Farming standard embeds practices that enhance biodiversity, soil health, and water conservation, its primary focus remains on broad organic principles rather than a targeted NbS strategy. This means that although the entire supply chain—from farm to final product—is covered, NbS is not explicitly distinguished as a criterion on the value chain coordination. The visibility of EU Organic Farming label is very high, and it can be considered as a good example of successful integration of value chain coordination and ecological business practice. Here again, NbS is not clearly displayed as an approach for them to be recognised by end-users.

Similarly, GLOBALG.A.P. Crops IFA includes measures such as integrated water resource protection that align with NbS criteria in terms of addressing challenge on water security. These measures, however, are part of a broader set of environment-friendly or resource-efficient agricultural practices rather than a dedicated NbS approach. While GLOBALG.A.P. achieves strong value chain coordination through traceability and retailer-driven certification, its voluntary adoption on ecological measures often leads to variability in implementation. Consumer visibility is generally low, as the standard is not typically presented as a consumer-facing label; instead, its benefits are realised in the back-end supply chain and quality assurance processes that indirectly influence product trustworthiness.

In the case of **Naturland Standard on Production,** the standard is tailored to employ organic farming methods. Their value chain coordination mechanism is similar to EU Organic Farming standards but lack a comprehensive certification process. Moreover, the **consumer-facing communication is limited** and mostly confined in niche markets.

Unilever's SAC exhibits **strong internal value chain coordination** by embedding directly multifaceted ecological criteria (soil and water management, forestation, water ecosystem conservation) into supplier contracts, ensuring mandatory compliance among suppliers. However, **its systemic influence is confined to Unilever's supply chain as internal standards**, it is not visible to consumers. The benefits of these practices are communicated through Unilever's sustainability reports and marketing messages, but the average consumer is more likely to recognise familiar public labels rather than the details of an internal code.

Overall, while these standards represent significant progress toward incorporating ecological interventions into agricultural practices, they each exhibit limitations in terms of systemic integration or comprehensive supply chain coordination. Moreover, their consumer visibility varies considerably, with some standards being well-known through public certifications while others operate largely behind the scenes. More importantly, although many of the ecological practices align with NbS criteria, in terms of addressing societal challenges and delivering biodiversity net-gain, **none of those standards mentions NbS as a distinguished approach and display NbS to consumers**. In summary, agricultural sector stands out for their established and widely recognised standards, supported by a well-developed system of value chain coordination. **This existing infrastructure presents strong potential to facilitate the further integration of NbS criteria and to support the mainstreaming of NbS as a marketable approach**.

2.5 Sectoral discussion

In this chapter, we used the case of organic dairy farming in Mangfall water catchment area as a practical model for integrating ecological farming practices into agricultural value chains that improve water quality and protect water resources. Although organic farming itself is not strictly defined as an NbS, its mainstream acceptance, established market mechanisms (such as recognised certification and consumer trust), and proven economic benefits offer valuable insights for mainstreaming NbS, which remain less institutionalised within agriculture (Le Clech et al., 2025).

Agriculture occurs within water catchment areas, creating cross-sectoral impacts between farming practices and freshwater quality. Nutrient-rich runoff from conventional farming significantly affects water quality downstream, imposing treatment burdens on the Water Supply and Sanitation sector. Organic dairy farming inherently reduces these pressures through ecological practices like reduced chemical inputs, buffer zones, and improved soil and nutrient management, generating benefits across sectors.

However, our review of agricultural standards highlights clear limitations for broader integration of ecological farming practices including NbS methods. Many existing standards lack systemic frameworks explicitly tailored to NbS, do not adequately ensure continuous environmental monitoring, and vary widely in consumer visibility. Additionally, critical NbS-specific practices such as wetland restoration and natural water retention are underrepresented or absent in mainstream standards.

Therefore, while organic dairy farming effectively illustrates how ecological practices can benefit agriculture and freshwater systems, substantial institutional and market developments are needed to mainstream comprehensive NbS approaches across agricultural value chains.

3 Peat-Extraction

Chapter authors: Alhassan Ibrahim, Jianyu Chen, Kirsty Blackstock, Anna-Helena Purre and Maureen Kuenen

This chapter introduces how rewetting, and where appropriate, revegetation, are being presented as a value proposition for peat extraction businesses supplying horticultural sector through certification processes that link site restoration to the final product and how it is marketed to consumers. This section is a shortened version of a full working paper (Ibrahim, 2024) which is available on request.

3.1 Sectoral introduction

Peat extraction refers to "the removal and drying of wet peat and the collection, transport and storage of the dried product." (Joosten & Clarke, 2002, p. 48).

Peat extraction has evolved from centuries-old domestic use to significant commercial excavation in the twentieth century, for heating (in some countries) and horticultural demands (Bos et al., 2011; Kitir et al., 2018; Wheeler, 1996; Hirschler & Osterburg, 2022; Paoli et al., 2022). **Today, peat constitutes approximately 75% of growing media across Europe due to its favourable properties at low cost** and is projected to remain important (Blok et al., 2019; Kekkilä-BVB, 2022). Thus, the sector is part of the wider value chains associated with ornamental and commercial plant production, providing jobs, income and investment in rural areas. For example, the horticulture industry employs over 550,000 people in Europe provides quality growing media for food productivity (Blok et al., 2019).

Even though peat extraction occurs mostly on degraded peatlands, it still has some environmental impacts (Foundation Responsibly Produced Peat, 2021). The extraction process disrupts the ecosystem services such as biodiversity, geochemical cycling and carbon sequestration associated with functioning peatland habitats (Alexander et al., 2008; Kitir et al., 2018; Mitchell et al., 2004). Most European peatlands have suffered substantial losses from drainage for various commercial uses (European Commission, 2020) and peat extraction has a small footprint compared to forestry, agriculture, and urban development. Rather than focus on environmental impacts of extraction (Paoli et al., 2022; Stichnothe, 2022), the focus of this section is to see how the **value chain can be aligned with restoration of these sites** to functioning ecosystems.

To date, there has been very limited recognition of value chain collaboration using industry standards that aim to address environmental impacts. The section explores the use of two certification processes—**Responsibly Produced Peat (RPP)** and **Veriflora**. By analysing the sectoral value chain, the study identifies opportunities to connect businesses to restoration of peat extraction sites, showing commercial benefits with social responsibility. While acknowledging peat's role in horticulture, the analysis explores how and where mitigation of environmental impacts can occur and the potential for companies to increase the ambition of their after-use plans whilst maintaining or increasing their market share or prices for the final product.

Growing media refers to materials being used to grow plants in containers, generally used within the horticulture sector (Growing Media Europe, nd)

3.2 Peat extraction value chain

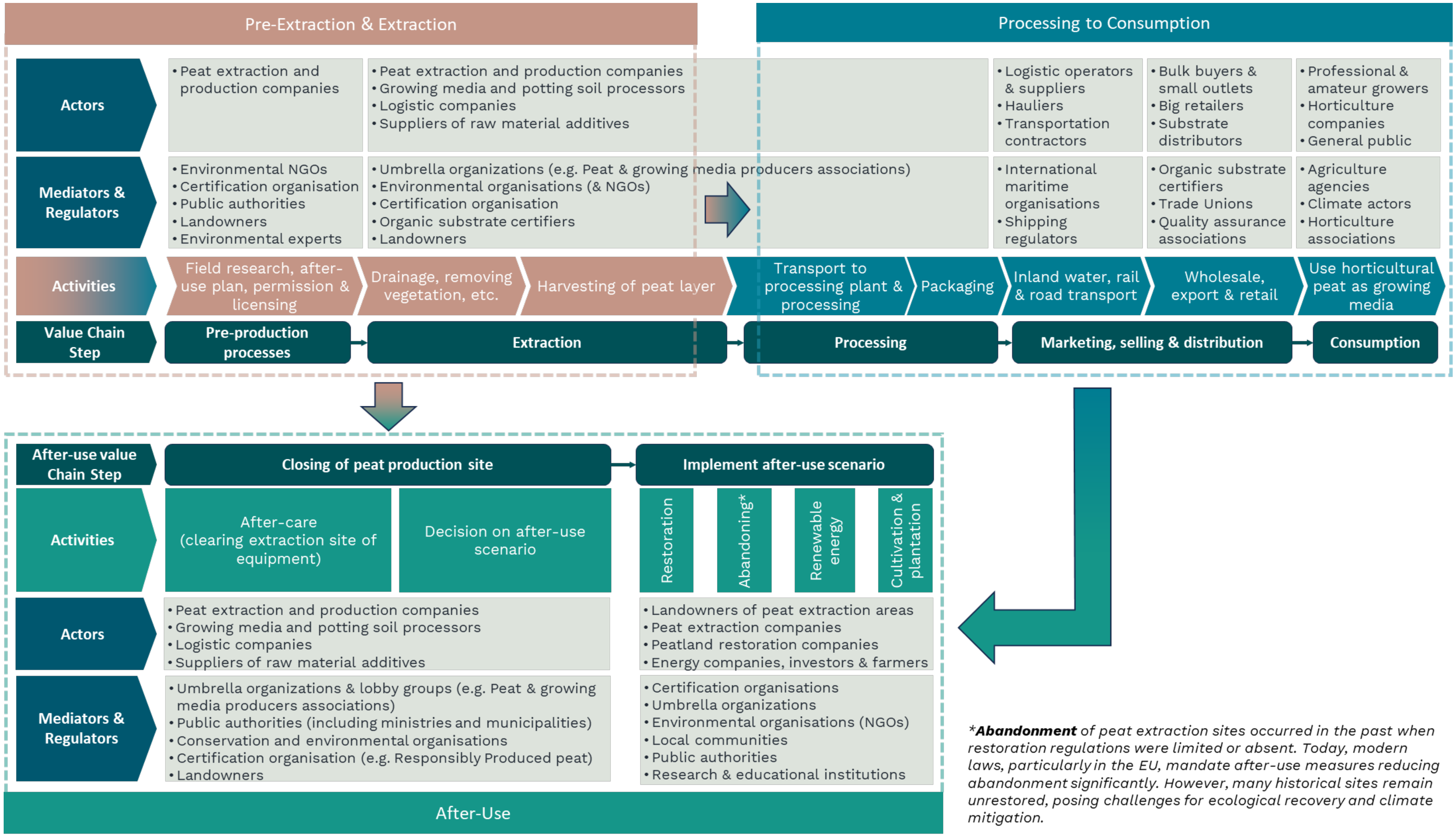
In the peat extraction sector, rewetting and revegetation are implemented in the post-extraction phase. The value chain map (Figure 4) focuses specifically on horticultural peat production. The figure highlights the key steps and activities involved; identifies key actors for each activity, depicting the governance and institutional framework, and explains the socio-economic and environmental values of each activity. The value chain figure does not fully reflect real-world complexity where activities may occur simultaneously rather than sequentially. Our value chain map is built on two bases: (1) Klasmann-Deilmann identifies activities including extraction, transportation, processing, mixing, dosing, packing, loading, and shipping (Gilke, 2018) and (2) Paoli et al. (2022) outline eight steps from field preparation to end-of-life, which can be regrouped into categories: pre-extraction & extraction; processing, marketing/distribution, and use in growing media; and then after use. Note that peat extraction companies are not necessarily involved in all these steps (see actors).

- → **Pre-extraction**: There is a first phase that includes conducting field research, planning the site layout, developing post-extraction land-use plans, and applying for necessary exploitation permits and licenses. The second phase involves on-site activities, including constructing access roads, water treatment structures, draining bogs, and clearing vegetation. These tasks are essential to prepare the site for peat extraction. Key actors include extraction firms, government environmental agencies, certification bodies, and landowners (Bos et al., 2011; Kapetaki et al., 2021; Lukjanova et al., 2020).

- **Peat Extraction**: This phase involves the harvesting of peat using specialised machinery. This step is implemented by peat extraction companies.
- **Processing**: Harvested peat is transported to processing plants, conditioned, mixed with other ingredients, and packaged. Transport can be by train, truck, or ship, with processing possibly occurring in a different country (Gilke, 2018b; Paoli et al., 2022).
- **Marketing, Selling, and Distribution**: Peat is distributed to wholesalers and retailers via inland water, rail, or road transport. Actors include logistic operators, haulers, supermarkets, international suppliers, and distributors (Koseoglu et al., 2023; IndexBox, 2021).
- **Use of Peat as Growing Media**: Peat is used for indoor or open-field horticulture by farmers, professional growers, amateur gardeners, and the general public. The largest consumers in the EU are Finland, Germany, and Sweden (Growing Media Europe, 2021; Koseoglu et al., 2023; IndexBox, 2021).
- **Closing the Peat Extraction Site**: Before extraction ceases, a decision is made on closing the site and its after-use. This involves aftercare of the site, including removing infrastructure and clearing the area (Peronius, 2023). The approach varies between Member States, but once regulatory conditions are met, any rented land (e.g. in Finland) is then handed over to the landowner, who decides on its after-use (Ibrahim & Nyírő, 2023; Neova Group, 2022b)
- **Implementing After-Use Scenario**: Depending on various factors, the site may be restored to a wet or revegetated ecosystem, cultivated for food, or other plantation such as forestry and grassland, or used for renewable energy. Restoration is prioritised in many European countries (Klasmann-Deilmann Group, 2021; Neova Group, 2022a, 2022b; Priede & Gancone, 2019). After-use scenarios like rewetting and revegetation offer ecosystem benefits, including biodiversity recovery and carbon sequestration.

In terms of aligning restoration and value chain opportunities, the ‘before’ (pre-extraction) phase is important, as these after-use plans that enable these different after-use scenarios (see Figure 2) are created, and the environmental conditions that must be met during the site’s operation are set out and agreed. Furthermore, the analysis includes the after-use stage which is not a standard in value chain analysis of the sector. The implementation of after-use practices that benefit the environment and climate presents a valuable opportunity for restoring degraded peatlands. Whilst there are other opportunities for environmental interventions (e.g. in reducing GHG emissions from transport and processing), the focus here is on restoration of freshwater, particularly peatland, ecosystems.

- The **pre-production** stage provides knowledge about peatland ecosystems (King, 2022).
- **Extraction** can cause pollution to water courses through nutrient runoff and other contaminants (Baird et al., 2011; Hoffman et al., 2018; Waddington et al., 2015); which is why water treatment infrastructure is generally part of the permitting process, to avoid contamination of neighbouring areas.
- Environmental impacts of **after use** depend on chosen scenarios (Räsänen et al., 2023).
    - Restoration using rewetting enhances biodiversity and carbon sequestration (Priede & Gancone, 2019). The best techniques for restoration or rewetting vary, depending on the specific conditions of each site. Factors such as methane emissions, the hydrological situation, soil conditions, and the surrounding ecosystem must all be carefully considered to determine the most effective approach.
    - Cultivation provides provisioning services from agriculture, paludiculture or afforestation. However, this tends not to restore the peatland to a functioning freshwater ecosystem with strong biodiversity benefits.
    - Renewable energy using solar and wind panels can offset the greenhouse gas emissions from the extraction process, helping to reduce the carbon footprint over time. Some suggest there are minimal environmental impacts (Bord and Móna, 2015) but there are concerns on the impact of such infrastructure on the peatland hydrology (Chico et al., 2023). It is important to carefully assess whether solar or wind power can co-exist with the restoration of natural habitats. The sustainability of this approach depends on the specific context and requires thorough consideration since it is a relatively new approach.



Abandonment of peat extraction sites occurred in the past when restoration regulations were limited or absent. Today, modern laws, particularly in the EU, mandate after-use measures reducing abandonment significantly. However, many historical sites remain unrestored, posing challenges for ecological recovery and climate mitigation.

Figure 4. Value chain map for horticultural peat: This value chain map provides a simplified overview for clarity, though it acknowledges alternative after-use scenarios across different countries.

3.3 Case study: Responsibly Produced Peat Certification

This section presents a case study showing how peatland restoration can be developed as part of the peat-based growing media value chain. **The focus is on the Foundation Responsibly Produced Peat (RPP), which runs a voluntary certification scheme in Europe to ensure responsible peat extraction and after-use practices**. Operating across Germany, Sweden, Finland, Poland, Latvia, Estonia, and Lithuania, RPP will not certify peat from harvesting in high-value peatlands and promotes rewetting and revegetation after extraction to enhance biodiversity and carbon sequestration.

RPP is a collaboration between scientists, NGOs, and peat companies, to help protect pristine peatlands while ensuring responsible use of extraction sites (Klasmann-Deilmann Group, 2021)[4]. The certification scheme is governed by multiple actors through the Board, the Committee of Experts, executive team and independent experts.

- The Board with representatives from the Growing Media Producers Association, Environmental NGOs (e.g. Wetlands International), and National Peat Associations (e.g. Latvia Peat Association) makes the final decision on granting RPP certificate and supervises the Executive team.
- Committee of Experts comprises membership from peat production companies, scientific research institutions, certification experts and peatland and ecological restoration experts. They manage the certification scheme (development and assessment) and advise the Board.
- Executive team runs the daily aspects of the foundation, including certification and supports the Board with strategic planning and development of the scheme.
- Independent inspectors, who are qualified peatland experts assess peat extraction sites, to ensure they comply with the RPP Principles and criteria. These criteria cover aspects of legality, site selection, production, management and after-use implementation.

To strengthen the certification, a coalition of the Dutch Government Agencies, the horticulture sector (including growing media businesses) and NGOs signed an agreement (known as the Dutch Covenant) in 2022 with the aim to reduce the environmental impacts of growing media.[5] One key attribute of the agreement is that all entrepreneurs use only RPP-certified peat or equivalent by 2025 (Foundation Responsibly Produced Peat, 2022).[6] RPP discourages extraction from High Conservation Value peatlands and prioritizes extraction from degraded sites followed by restoration. The RPP certification aligns business and restoration objectives by raising awareness of peatlands' biodiversity and climate mitigation potential, whilst countering negative perceptions of peat-based products through their commitment to reducing environmental impact. Leading horticulture companies in Europe adopt RPP's approach to ensure responsible practices throughout their value chains (Peters & von Unger, 2017).

The RPP case confirms that the alignment primarily occurs in the pre-extraction, closing peat extraction sites, and after-use steps. The value added for peat extraction companies who receive RPP-certification is:

- Involvement of environmental NGOs: several peat extraction companies and authorities help increase credibility and trust in the certification process
- Certification promotes societal acceptance of peat extraction and use of peat in growing media, where no viable alternatives are available (Foundation Responsibly Produced Peat, n.d.).
- If the certification can guarantee responsible production, it can ensure peat remains available to meet the essential need for growing media for crop and forestry provision.
- The certification process increases awareness of responsible production of peat, showing how to minimise the environmental impact and selecting the best after-use option, prioritizing peatland restoration

Overall, the RPP-certification can help build the reputation of the peat extraction companies. It is a useful case study to show how certification can support NbS through value chain governance due to increased stakeholder partnership and cooperation, particularly communication between peat extraction companies and buyers of peat to raise awareness of the environmental challenges and the roles of all stakeholders in the chain.

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[4] https://www.responsiblyproducedpeat.org/en/who-we-are

[5] https://www.devpn.nl/in-de-media/brede-maatschappelijke-coalitie/

[6] https://www.responsiblyproducedpeat.org/en/what-we-do

Many peat extraction companies have received the RPP certification (equating to about half the area of peat production for growing media), and growing media producers have joined the Chain of Custody (Foundation Responsibly Produced Peat, 2018), the system that verifies the volumes of certified peat brought into the market. These companies are listed on the RPP website under 'peat producers' and 'peat users', which allows potential buyers of RPP-certified peat to easily find the companies.[7] These growing media producing companies can apply the RPP label to their products.

The RPP certification aims to protect peatland biodiversity, safeguard the environment and support restoration efforts to improve peatland conditions. For instance, the certification promotes peat extraction only in highly degraded peatland areas and ensures that extraction does not occur on pristine peatlands or negatively impact surrounding areas with significant natural values. Moreover, the certification requires restoration/rewetting where technical possible and otherwise the best option with maximum benefits for the environment and climate is the preferred 'after-use' option when peat extraction on the site ceases (see Figure 5). The first RPP-Certified area to enter the after-use phase was Budwity from AGARIS. For this location, the licensing required a reclamation, leading to renaturation of the peat extraction site.[8] The reclamation was then undertaken and approved by responsible authorities.

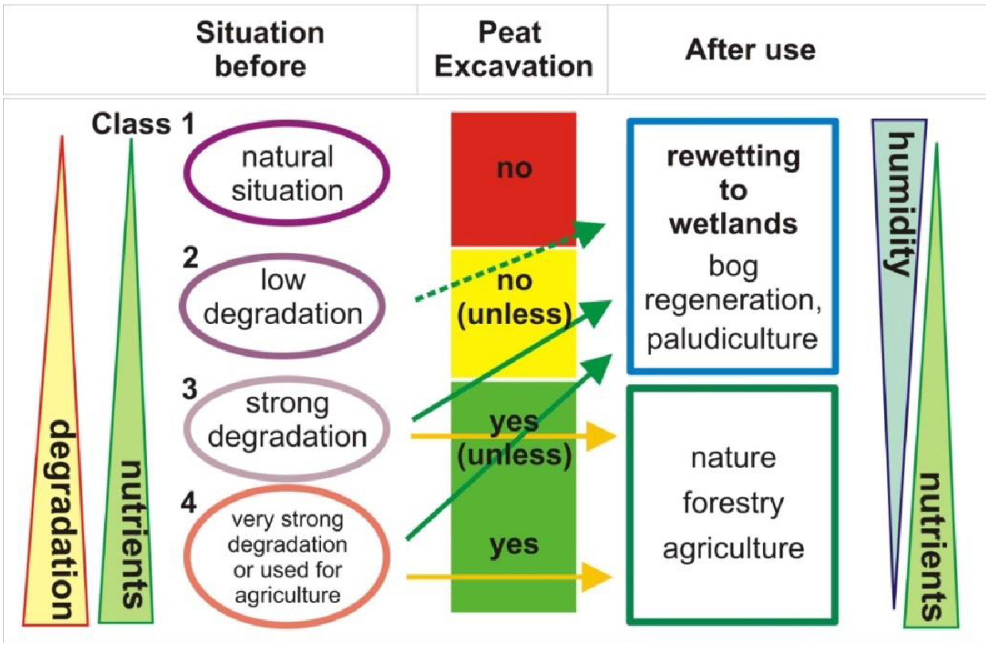

Figure 5. RPP's definition after-use destination

3.4 Review of peat extraction sectoral standards

This section reviews standards associated with peat production and aims to clarify how current standards support mainstreaming freshwater ecosystem restoration, explore how to improve existing standards to enhance their effectiveness of implementing NbS in the sectoral value chains. To achieve these goals, we compare RPP with other standards to assess how they help align an NbS approach with the value chain steps, and their potential to promote sustainable practices in peat production. The full list of standards is provided in section 7.2.3. Apart from RPP and Veriflora certification, none of the reviewed standards have a direct link with production and use of peat or restoration of peat extraction sites. For instance, Horticert is about developing alternatives, while Naturland standards on Production focuses on organic farming and restriction on the amount of peat that can be used. **Therefore, further analysis in this section will focus on RPP and Veriflora**. Their similarities and differences are highlighted in section 7.2.3. Here we focus on how these two standards support NbS and ecosystem restoration. Table 2 summarises water, biodiversity and climate sustainability issues across both Standards. The criteria are extracted from the reviewed standards and may not match the

[7] https://www.responsiblyproducedpeat.org/en/rpp-registered-companies

[8] https://www.responsiblyproducedpeat.org/en/budwity-is-the-first-rpp-certified-location-that-entered-the-after-use-phase

original description. For instance, in RPP, tackled aspects are distributed in different value chain steps instead of a thematic section addressing on the criteria.

Table 2. Assessment of core NbS-related criteria covered in RPP and Veriflora

Focus	RPP	Veriflora
Water	Development of water quality management plans and address impacts on surrounding waterbodies: conducted through Environmental Impact Assessment (EIA) and compliance with relevant EU directives. EIA must assess minimise negative off-site impacts on hydrology of adjacent areas and take measures to minimise negative off-site impacts on water quality and floods. Priority to peatlands already drained. Most companies are required to monitor water quality during extraction. Rewetting preferred after-use when feasible.	Requires water quality management plans which consider the surrounding wetland environment: buffer zone and contamination source tracking. Requires concrete measures including buffer zones to address impacts on water quality during operation. Requires creation of buffer zones around waterbodies and must be effective in protecting water quality. Requires regular monitoring of measures to protect water bodies and quality. Companies need to track source of contamination and minimise impacts on water.
Biodiversity	EIA must map biotope types and assess fauna and other species Only certifies areas without high biodiversity value Prioritise restoration when returning to natural peat-accumulating situation is possible Requires EIA or quick scan to minimise impacts on special protected species Prohibit selecting sites adjacent to areas of high biodiversity value if the impact on these sites cannot be mitigated Clearly prohibits extraction on areas of HCV Doesn't mention assessment of net-gain in biodiversity but requires after-use conditions to be better than before.	Require companies baseline description of flora and fauna prior to peatland opening. Requires companies to develop rehabilitation and restoration plans. Requires restoration or sphagnum farming after extraction ceases with targets for vegetation species. Requires producers to maintain areas of high-ecological values (HCV) within the extraction sites. Clearly prohibits extraction on areas of HCV
Climate	Requires EIA to state expected GHG emissions from extraction. Requires reduction of emissions during extraction on-site and off-site. Requires prevention of uncontrolled emissions Doesn't mention restoration leading to carbon sequestration. Promotes implementing climate mitigation measures when full restoration is not possible.	Companies to conduct baseline inventory and set targets for reducing emissions during operation Require procedures to monitor air quality during operation. Companies to adopt an approach to increase carbon sequestration during production processes, including maintaining wetlands and buffer zones.

3.4.1 Working with value chain actors to promote ecosystem restoration as NbS.

Generally, both standards are explicit on their preference for restoration or rehabilitation to return peat extraction sites to a condition better than before extraction took place.

RPP's role in coordinating actions across the Value chain:

The RPP certification process separates the value chain in two, comprising Business Cycle and Supply Chain. Business Cycle covers value chain steps Pre-production process (site selection, After-use plans and Permit acquisition), Peat extraction, Closing of sites and After-use. Supply Chain covers value chain steps Peat extraction, Processing to produce growing media, Marketing, Selling & Distribution and End-use. In the RPP, the coordination for restoration mainly occurs in the Business Cycle. The RPP is clear that they "cannot prescribe the behaviour of other than individual companies such as the industry as a whole or government" (Foundation Responsibly Produced Peat, 2021, p. 4). This has the following implication:

- → Certified peat extraction companies are main actors responsible for undertaking responsible production and restoration of the peat extraction sites once extraction ceases.
- → The only role of other actors in the supply chain, such as growing media companies, retailers and traders, concerns documentation and labelling of certified peats. Hence, such actors do not have direct role to play in terms of restoration of peat extraction sites following restoration. However, growing media producers can ensure that responsibly sourced peat is available on the market and support the costs of certification.
- → While the certification requires companies to undertake stakeholder consultation in selecting sites and undertaking after-use, it does not specify the role of mediating actors such as public authorities, landowners and conservation agencies in facilitating restoration.
- → Since the focus is only on the business cycle, the environmental impacts (e.g. emissions) from the use of peat and role of actors in reducing that aspect are not covered by the standard.

Veriflora's role in coordinating actions across the Value chain:

Veriflora applies to the peat extraction companies (Producers), covering site selection, extraction and restoration or rehabilitation. The companies' role also covers processing and trading of the peat products, up to the point that the company does not own the peat. Therefore, the following coordination responsibilities can be made:

- → The standard does not specifically mention who the specific actors within the supply chain are apart from the companies who produce peat.
- → Hence, mediating actors such as local governments, landowners and traders do not have any obligation whether for restoration or ensuring appropriate trading of certified peat on the market.
- → Companies are required to engage with stakeholders such as local communities, regional authorities and other experts.
- → Similar to the RPP, the environmental impacts (e.g. emissions) from the use of peat and role of actors in reducing that are not covered by the standard.

RPP and Veriflora exhibit limitations in value chain coordination for peatland restoration **as they do not adopt a whole of value chain approach in supporting restoration**. Within the existing framework of both standards, they consider peat extraction companies as opposed to other actors within the value chain, which is a limited way of thinking and may hinders mainstreaming NbS in business practice. Therefore, some proposals to improve the standards are presented.

3.4.2 Proposition for sectoral standards improvement

Based on the review and analysis of the focused standards in peat-extraction sector, the following propositions are made:

- → **RPP should ensure full certification across all extraction sites.** Although RPP encourages certification of all sites, companies may still extract from non-certified locations under certain conditions. To meet its goal of 100% certified peat, extraction should be limited to certified sources only.

→ **Both standards should expand coverage to all peat producers.** Being voluntary, the standards allow non-certified companies to operate without clear restoration obligations. Wider adoption would require policy support, as demonstrated by the Dutch Covenant.

→ **Peat quality and usage impacts should be included in certification.** While aiming to reduce emissions, neither standard addresses the properties of peat itself. Other standards (e.g. RHP, Naturland, EU Organic, ISCC) could complement RPP and Veriflora by including the environmental impacts of peat use and tracing the quality of the final product.

→ RPP and Veriflora could engage these other standards to also **require other value chain actors** to support restoration in peat-extraction after-use if they benefit from marketing products using responsible production certification.

→ **Encouraging peat extraction companies to support large-scale restoration** beyond the peat extraction sites to address on-site and off-site environmental impacts during the period

→ of peat extraction, rather than waiting until after-use that can only occur once extraction ceases.

→ **A supportive policy framework is essential for implementation.** To realise these goals, standards like RPP need to be backed by EU-wide regulatory mechanisms. This could include mandatory restoration requirements, and a shared European policy framework, potentially modelled on the Dutch Covenant and supported by the EU Restoration Law.

These propositions can help existing standards to identify the windows of opportunities for integrating NbS in the value chain to address environmental challenges while maximising the value provided to businesses.

3.5 Sectoral discussion

This chapter assessed how NbS can be integrated into the peat extraction sector through value chain analysis. While the full chain—from pre-extraction planning through use and after-use—offers multiple intervention points, NbS are primarily integrated in the pre-extraction and after-use phase, where restoration activities such as rewetting and revegetation generate ecological benefits like carbon sequestration and biodiversity recovery.

However, the current conceptual framework guiding more ambitious restoration — largely mediated through sectoral standards — shows limitations. Existing standards tend to treat ecological value as separate from economic goals. To effectively mainstream NbS, the sector should move beyond this dichotomy and adopt a more inclusive and creative approach that recognises ecological restoration as compatible and beneficial to long-term economic value creation.

Strengthening certification schemes like RPP and extending their scope beyond after-use phases could help anchor restoration in more places along the value chain. Value chain analysis therefore proved valuable in highlighting potential opportunities in multiple links of the chain, rather than solely a permitting obligation.

Restoration of past extraction sites rely on wider ecological processes – rewetted sites require surrounding ‘donor’ sites from which vegetation can recolonise the extraction sites and to have an impact on climate mitigation, larger areas than individual extraction sites may be required to be restored. Thus, this case also implies cross-sectoral interactions with surrounding land users (farmers, foresters, biomass producers or conservation managers) which is more fully described in the Peat Extraction Sectoral Strategy (Ibrahim et al. 2025).

4 Insurance

Chapter authors: Audrey Vion-Loisel, Jianyu Chen

This chapter explores how insurance products can integrate NbS into the insurance value chain for risk reduction, therefore enhancing financial reliance for restoration projects and creating business value for insurance companies. It examines how innovative insurance products, such as the parametric insurance, can support restoration activities by lowering long-term operational costs and incentivising investment in freshwater ecosystem restoration, even in the absence of formal NbS-related sectoral standards. Through experimental case studies, this section highlights how insurance can act as an enabler across other sectoral value chains, demonstrating its potential role in mainstreaming NbS within financial systems.

4.1 Sectoral introduction

Risk management is in the central place of the insurance value chain (Harrington & Niehaus, 2003). While conventional insurance models primarily address risk through engineered infrastructure, **NbS in the insurance sector involve using ecosystem services to mitigate risks and enhance environment resilience against undesired events and environmental hazards**. As understanding grows regarding the capacity of using NbS to mitigate environmental hazards, the insurance sector is adapting their products to support environment restoration. (Re)insurance instruments can financially protect ecosystem restoration projects, as they further de-risk restoration projects and make them more attractive to investors and public funders.

Reinsurance

Reinsurance is a practice where one insurance company (called the reinsurer) agrees to cover some of the risks taken on by another insurance company (called ceding company). Reinsurance helps the ceding company to manage large amounts of risk, maintain stable financial performance, and protect itself from major losses (Adiel, 1996).

In addition to financial protection, the insurance sector has the potential to incentivise NbS adoption more broadly, such as premium discounts for implementing ecological risk reduction measures, support for monitoring and data sharing, and the development of sector-specific standards. All these measures offer mechanisms to mainstream NbS in the insurance sector.

However, existing examples of NbS-related insurance products remain limited. Beyond technical barriers—such as the lack of sufficient data and modelling to support the mainstreaming of NbS in the insurance sector (UNEP FI, 2023)—structural conflicts within the existing value chain have also been identified, including the sector's reliance on nature-negative insurance models[9] (UNEP FI, 2024) and its dependency on short-term financial returns (Terranomics, 2022). A VCA of the sector can help recognise the potential of NbS on the insurance value chain in reducing the frequency and severity of claims, lowering premiums, and promoting sustainable risk management (Ternell et al., 2020).

This chapter takes a forward-looking perspective to provide insights into how the insurance sector could evolve to support and mainstream NbS. Case studies from outside MERLIN highlight that integrating NbS criteria into insurance is not merely a technical adjustment but a systemic innovation—one that can align financial benefits with ecological restoration goals. Through cross-sectoral cooperation, the insurance sector can become a key enabler in monetising the value of ecological resilience.

4.2 Insurance value chain

For a better understanding of how the NbS criteria can be integrated in the insurance sector, a sectoral value chain mapping is performed (Figure 6). In the general value chain mapping process, the intention is to produce a value chain map suitable for the EU insurance sector, since it is designed for application across the EU rather than a specific country. However, the difficulty arises because the insurance sector is heavily regulated and functions differently in various countries (GFIA, 2024). Therefore, this map will differ not only between companies but also from one country to another. Consequently, a more adaptive perspective is recommended when considering applying the value chain map in specific geographical areas or sectoral context.

[9] According to UNEP FI (2024), *nature-negative insurance* refers to insurance activities or products that contribute to nature loss or have negative impacts on biodiversity and ecosystem services. Currently, 58% of the world insurance instruments support the nature-negative insurance that drives deforestation, pollution, habitat destruction, or other harmful environmental externalities.

For example, in Spain, the public entity Consorcio de *Compensación de Seguros* ('Consortium for Insurance Compensation') is the sole organisation in Spain responsible for covering flood losses, whereas, in some other EU countries, multiple companies compete for this coverage (OCU, 2023). Therefore, a general value chain map is created as follows, based on the several previously established frameworks of the sector (KPMG, 2020; van Rossum et al., 2002, Rodrigues, 2020, Deloitte, nd).

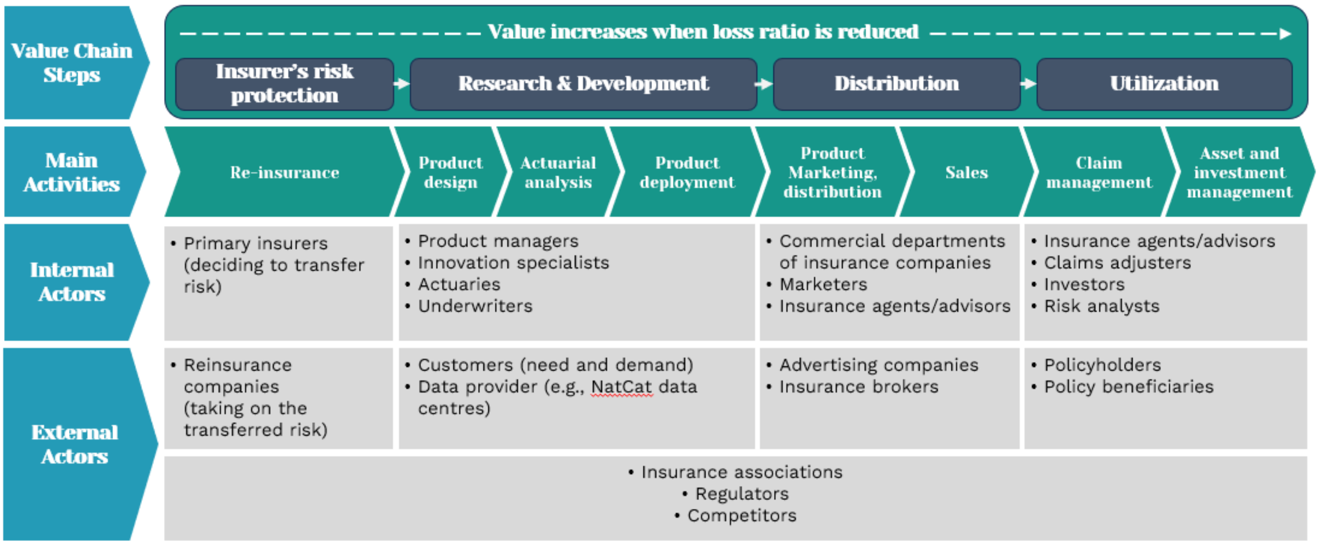

Figure 6. General value chain map of insurance sector

Figure 6 presents a generalised value chain of the insurance sector, showing how internal and external actors contribute to the value creation at different stages—from risk protection through reinsurance to final service delivery through claims and investment management. The value chain is read horizontally, with columns representing sequential steps and rows identifying who is responsible, supportive, or influential at each point.

The chain begins with reinsurance, where insurers transfer high-risk exposure to reinsurers to protect themselves from large financial losses. It then moves through research and development, where customer demand drives product design, actuarial modelling, and innovative offerings like parametric insurance. Distribution follows, involving marketing, brokers, and advisors to connect products with users. The final stage is utilisation, covering claims processing and asset management to ensure efficient payouts and capital allocation.

Importantly, end users appear at different stages under various roles: as customers during product development, as policyholders once a contract is signed, and sometimes as beneficiaries when third parties are insured. Meanwhile, cross-cutting actors such as regulators, industry associations, and competitors shape the entire chain, influencing standards, compliance, innovation, and market positioning. This comprehensive mapping helps identify where value can be enhanced and where strategic interventions, including the integration of NbS, may offer future potential.

Potential of NbS in parametric and insurance value chain problem

This section analyses how NbS criteria can be integrated into insurance value chains to enhance value creation. A key mechanism in the sector is improving the "loss ratio," which compares the amount paid out in claims to premium income (Corporate Finance Institute, 2024). Insurers improve this ratio through better underwriting, risk assessment, and claims management. Innovation plays a central role (Sandquist, 2022)—for example, in Romania, insurers co-developed crop-specific products with the agricultural sector, offering weather alerts and interactive claim platforms to retain customer loyalty.

> **Parametric insurance**
> or *index-based insurance*, is a type of indemnity insurance that pays a predefined amount when a specific event occurs (e.g., a natural disaster), based on measurable parameters (such as wind speed or earthquake magnitude). The payout is triggered automatically when these parameters exceed a predetermined threshold, streamlining the claims process and enabling faster payouts, with

For achieving this, tools such as **parametric insurance**, which provides rapid payouts based on environmental triggers, enable quicker post-disaster compensation and secure project continuity. Insurance can also provide financial coverage for long-term maintenance, helping restored ecosystems remain functional and resilient over time (Kousky & Light, 2019). By safeguarding these projects against external shocks, insurance increases their durability and enhances their credibility as green infrastructure investments.

Integrating NbS into insurance activities represents a frontier for innovation. In this value chain, product development—particularly of parametric insurance—occurs during the R&D phase, supported by actuarial modelling and third-party data. Commercialisation follows in the distribution step, while the utilisation phase sees automatic payouts triggered by event indices. The R&D and utilisation steps constitute the main bottlenecks: innovation here depends on long-term monitoring and data analysis, as well as eco-focused product development (Mitisek, 2021). **The value chain problem identified in the insurance sector is a multi-step value chain problem, primarily centred on the research and development (R&D) and utilization steps.**

On the one hand, to remain competitive, R&D teams need adopting innovative methods to develop new products and improve existing ones, focusing on adapting to changing risks, leveraging technology, and enhancing customer experiences by offering more tailored insurance products. This includes reallocating resources to support breakthrough initiatives and investing in advanced technologies for long-term monitoring, data collection and analysis. R&D efforts also extend to eco-friendly products or environment-related insurance policies (Mitisek, 2021).

4.3 Case study: parametric and Construction All Risks insurance

Exploring the role of innovative insurance policies in environmental restoration, two case studies illustrate how these solutions can support and enhance restoration projects. The integration of NbS and innovative insurance products addresses value chain challenges, making previously uninsurable objects insurable and offering financial security while promoting sustainability.

> **Construction All Risk (CAR)**
> also known as Contractor's All Risk insurance is a comprehensive insurance policy that covers a wide range of risks associated with construction projects. It typically provides protection against physical damage to the works in progress, materials, and equipment on site, as well as third-party liability for property damage or bodily injury arising from the construction activities (Harrington & Niehaus, 2003).

The case of Quintana Roo in Mexico highlights the application of parametric insurance to protect the Mesoamerican Barrier Reef System from hurricane damage. This approach mitigates the associated risks under which the local population and economy would be under in the absence of recovery due to the damage suffered by the reef (Scotti, 2021). Therefore, this case study demonstrates the potential of NbS to enhance product development and risk management in the insurance sector. It underscores the synergy between ecological preservation and economic stability, benefiting both the insurance industry and local stakeholders in high-risk areas.

Similarly, the Prince Hendrik Sand Dyke Project in the Netherlands showcases the use of Construction All Risks (CAR) insurance policies combined with NbS to safeguard protective infrastructure from erosion and enhance local natural habitats (Gray, 2024). This project exemplifies the dual benefits of integrating traditional insurance with NbS to protect both infrastructure and the environment, showing that innovative insurance products can be applied beyond parametric solutions.

Both case studies specifically address the value chain problem in the research and product development step and also the risk analysis step. For example, by reducing the risk of hurricane-induced damages on inland tourism activities within the geographical area, the insurers introduce a new product line for the insuree, using localised data to develop tailored parametric insurance policies.

Moreover, this approach in the case study indirectly impacts on the sales stage, which, if unresolved, could lead to the uninsurability of certain activities or policies due to prohibitively high premiums. For instance, when flooding risks are extremely high, insurance companies must cover potentially significant costs by raising premiums, making insurance unaffordable for policyholders. The incorporation of NbS provides added value by transforming otherwise uninsurable objects into insurable ones, benefiting the insurance sector through new business opportunities and aiding stakeholders, particularly those in high-risk zones.

These case studies collectively underscore the critical role of innovative insurance policies in environmental restoration. By integrating NbS with both parametric and CAR insurance products, these projects reduce risks, promote sustainable development, and support economic resilience, highlighting the importance of innovative insurance solutions in advancing the broader adoption of NbS.

4.3.1 Parametric insurance in environment restoration: State of Quintana Roo, Mexico

The Mesoamerican Barrier Reef System, particularly along Mexico's Yucatan Peninsula, exemplifies innovative practices within the insurance value chain. This reef, spanning nearly 1,000 kilometres across the Caribbean coasts of Mexico, Belize, Guatemala, and Honduras, is the largest in the Americas. The reef's significance is multifaceted, contributing an estimated $6.2 billion annually through tourism, commercial fishing, and coastal development, while also playing a critical role in storm protection, coastal erosion prevention, and supporting diverse marine life (World Economic Forum, 2021).

Faced with threats from climate change, storm damage, and human activities leading to its declining health, the Quintana Roo government took a proactive stance by insuring the reef. This initiative was validated when Hurricane Delta in 2020 triggered an insurance payout of $800,000 for the reef's repair and restoration. A key element of this strategy was the establishment of the "**Coastal Zone Management Trust**" by **The Nature Conservancy** and the State Government of Quintana Roo, showcasing the integration of NbS into both economic and environmental spheres (World Economic Forum, 2021).

This initiative aims to preserve a vital section of the reef, an ecosystem integral to the region's economic fabric, particularly through its tourism industry, which generates around USD 9 billion annually (PreventionWeb, 2018). Central to this conservation effort is the world's first parametric insurance policy for a coral reef, marking a pioneering venture in utilizing insurance for environmental protection.

Parametric insurance pays out when a specified, verifiable event occurs (Kousky and Light, 2019). In this case, when wind speeds exceed certain thresholds, policy payouts are triggered. This type of insurance obviates the need for assessors to evaluate the damage, eliminates the need for economic valuation of the damage, and resolves potential disputes over the extent of the damage. The aim is to provide funds to restore the reef quickly, ensuring swift financial recovery following natural disasters and safeguarding the reef's structure and the local economy's stability.

The benefits of this initiative are manifold. It supports biodiversity and the tourism industry and offers several advantages to the insurance companies who initiate such products, including the development and sale of an innovative product already replicated in other areas such as Hawaii (The Nature Conservancy, 2024), reduction in losses on insured assets (assuming some assets protected by the coral reef are insured by the company financing the parametric insurance), and potential marketing and reputational gains through innovation and good practice dissemination.

The broader benefits of this NbS initiative aim to bolster economic resilience, encourage conservation, and establish a new market niche within the insurance industry. **Like other projects for mainstreaming NbS as the method for environmental restoration, the collaborative nature of this project involves a wide range of stakeholders**, from government bodies to hotel associations and academic institutions, blending **The Nature Conservancy**'s scientific knowledge with **Swiss Re**'s risk management expertise, initially supported by **The Rockefeller Foundation**, and the Mexico-based insurer, **Afirme Seguros Grupo Financiero SA de CV (Afirme Insurance Financial Group, Inc.) (**Kousky and Light, 2019; PreventionWeb, 2018**)**. Specifically, in this case, the cost of the insurance policy that secures the maintenance and restoration of the coral reef in the event of a hurricane is funded by the tourism industry through taxes (Kousky & Light, 2019).

This case study not only highlights the role of insurance in environmental conservation but also underscores the importance of NbS in coastal defence and climate resilience. Notably, a healthy coral reef can reduce 97% of a wave's energy (PreventionWeb, 2018), significantly decreasing land damage. It illustrates the insurance sector's capacity to devise innovative solutions for protecting crucial natural assets and supporting local economies, thereby emphasizing the synergy between ecological preservation and economic sustainability.

While parametric insurance itself is not new, the innovation in this case lies in the collective action of beneficiaries (the tourism sector) of a public good (the coral reef) to insure an ecosystem that they do not own.

4.3.2 CAR insurance in environment restoration: Prince Hendrik Sand Dyke, Netherlands

The Prince Hendrik Sand Dyke Project in the Netherlands stands as a notable example of how insurance solutions can support large-scale infrastructure projects while simultaneously promoting ecological health. This case study underscores the project's successful use of a Construction All Risks (CAR, or Contractor's All Risk) insurance policy, which played a crucial role in mitigating financial risks and ensuring timely project delivery. Additionally, the project exemplifies how NbS can be integrated into infrastructural developments to yield both infrastructural and environmental benefits.

Initiated to address the pressing issue of dyke erosion along the Dutch island of Texel, the Prince Hendrik Sand Dyke Project aimed to reinforce the dyke, preventing further erosion and securing the coastline against the rising sea levels exacerbated by climate change. The project's primary focus was to enhance the dyke's integrity, which is critical for protecting the low-lying areas from flooding.

The project involved the NbS by constructing a sand dyke, which not only reinforced the existing dyke but also created new natural habitats for local wildlife (Fordeyn and Lemey, 2019). By depositing sand along the coastline, the project fostered the development of dunes and wetlands, which serve as vital habitats for various plant and animal species (Temmerman et al., 2013). These newly formed natural habitats have enhanced local biodiversity and contributed to the region's ecological health.

The project's design also incorporated measures to ensure that the sand dyke would continue to evolve naturally, adapting to changing environmental conditions and providing long-term ecological benefits (van Slobbe et al., 2013). This integration of NbS into the project's framework highlights the potential for infrastructure projects to deliver both environmental and protective benefits, aligning with sustainable development goals.

Given the scale and complexity of the project, a comprehensive risk management strategy was essential. The project team opted for a CAR insurance policy to cover potential risks associated with the construction phase. This type of insurance protects against a wide range of perils, including physical damage to the works, third-party liability (Musundire & Aigbavboa, 2015), and project delays (Gray, 2024). Similar to parametric insurance, which offers swift payouts based on predefined triggers, the CAR insurance policy ensured that any unforeseen issues could be swiftly addressed without derailing the project timeline, providing the project stakeholders with the confidence to proceed, knowing that potential disruptions can be managed efficiently, allowing for the continuation of innovative construction methods.

The Prince Hendrik Sand Dyke Project exemplifies how integrating comprehensive insurance strategies and NbS into infrastructure projects can yield multiple benefits. The use of a CAR insurance policy effectively mitigated financial risks, ensuring timely project completion and protecting against potential delays and failures. Simultaneously, the project's innovative approach to dyke construction safeguarded the coastline and enhanced local natural habitats, demonstrating the potential for NbS to contribute to ecosystems.
This case study underscores the importance of adopting comprehensive risk management strategies and integrating NbS in large-scale infrastructure projects. The Prince Hendrik Sand Dyke Project serves as a model for future endeavours, illustrating how insurance and NbS can play pivotal roles in achieving sustainable development goals and enhancing resilience against environmental challenges.

In summary, the integration of NbS into the insurance sector presents a significant opportunity to innovate and enhance value creation across the insurance value chain. By incorporating NbS into products like parametric and CAR insurance, insurers can offer more responsive and tailored financial solutions in environment restoration projects, mitigate risks associated with natural catastrophes, reduce claims, and improve loss ratios. Case studies such as the Mesoamerican Barrier Reef and the Prince Hendrik Sand Dyke demonstrate how NbS can be effectively combined with innovative insurance products to support environmental restoration, protect critical infrastructure, and foster both environmental and economic resilience. These examples highlight the importance of advancing efforts in the research and development step, leveraging technologies, and fostering collaboration across sectors to drive sustainable development and address emerging challenges.

4.4 Review of insurance sectoral standards

This section reviews existing standards and principles to explore how insurance can more broadly support freshwater NbS as part of disaster risk reduction strategies. Since the insurance sector is not explicitly included in the ITC standards platform, our analysis draws from adjacent sectors—primarily agriculture, tourism, and finance—as well as external sources directly related to insurance. Agricultural standards such as EU Organic Farming and DEMETER (2023) promote biodiversity and climate resilience, indirectly reducing risk for insurers. Similarly, GLOBALG.A.P. fosters on-farm habitat protection, potentially benefiting insurance through reduced exposure, even though no standard explicitly mentions insurance (Table 3).

In the tourism sector, the UNCTAD BioTrade Principles promote measures that strengthen resilience and adaptive capacity (UNCTAD, 2020), offering conceptual alignment with cases like the Mexican coral reef insurance. These examples suggest insurance could both benefit from and incentivise compliance with sustainability standards. From outside the ITC database, regulatory frameworks such as the EU Taxonomy classifies some insurance activities as contributing to climate adaptation and align with sustainability objectives. The Principles for Sustainable Insurance (UN PSI) encourage in developing solutions, offering an entry point for NbS integration. Additionally, the Global Reporting Initiative (GRI), is developing insurance-specific standards expected in late 2024 (Global Reporting Initiative, nd).

Table 3. Summary of insurance sector standards review

Standard	Related sector	Relation to			What is the link?
		Freshwater ecosystem	Insurance	NbS	
Organic Agriculture	Agriculture	Yes	No	Weak	If these farming practices can be proven to make crops more resilient to climatic disasters like floods, they can reduce the payouts required by the insurance sector.
DEMETER					
GLOBAL GAP					
UNCTAD BioTrade Principles & Criteria	Tourism	Yes	No	Weak	Principle 2 emphasizes the "adaptive capacity of species and ecosystems to climate-related hazards and natural disasters." This theme is crucial for MERLIN's ongoing development efforts in relation to the insurance sector.
European Taxonomy on Sustainable Activities	Financial	Yes, in general but not in the part relating to insurance	Yes	Medium	Two insurance activities are listed as sustainable activities: "reinsurance" and "underwriting of climate-related perils," the latter specifying the offer of "rewards for preventive actions taken by policyholders."
UN PSI	Insurance	No	Yes	Weak	Discussions arising from Principle 2, which calls for raising awareness of environmental, social, and governance issues, managing risk, and developing solutions, can lead to the consideration of such solutions being NbS.

Few existing standards currently link freshwater ecosystem restoration with the insurance sector, largely because integrating restoration efforts into insurance practices is still a novel concept. However, insights from MERLIN's participatory activities in May 2024 (Vion-Loisel, 2024) indicate growing interest among sector actors in understanding how NbS could inform underwriting and investment strategies, with calls for clearer guidance from governments or public authorities. As outlined in the Sectoral Strategy (Vion-Loisel et al., 2025), developing tools or standards to enable an understanding of the risk-reduction potential of NbS could support insurers in integrating these solutions into their value-creation processes. While full standardisation is challenging due to local ecological and project-specific variability, general recommendations for enhancing sectoral standards—particularly those establishing clear criteria for effective NbS—could provide a useful basis for broader integration.

Proposition for sectoral standards improvement

One of the primary improvements needed is the explicit inclusion of NbS as recognised risk mitigation strategies within insurance policies. Based on the existing requirements given in the EU taxonomy for insurance to offer incentives to policyholders who implement NbS interventions, standards could help guide insurers' analysis of the effective risk reduction observed by implementing these measures based on local conditions. This approach would align with the EU Taxonomy's emphasis on sustainable activities and the UN PSI, which encourage solutions for environmental, social, and governance (ESG) issues (UNEP FI, 2021). Several detailed improvements are proposed:

- **Leverage existing standards for broader adoption**: Existing standards like the EU Organic Farming and GLOBAL GAP can serve as models for incorporating NbS criteria. These standards already include practices that enhance resilience, such as crop rotation and biodiversity protection. By adapting these standards to align with principles in the insurance sector, insurers can better adapt their products with restoration activities that reduce risk and support ecosystem services.
- **Regulatory and Reporting Frameworks**: Incorporating NbS criteria into regulatory and reporting frameworks, such as the EU Taxonomy and the GSI is crucial. The EU Taxonomy includes insurance activities like reinsurance and underwriting of climate-related perils, which include the need to reward preventive NbS actions taken by policyholders. Additionally, forthcoming insurance-specific standards from the GRI should explicitly address sustainability aspects, ensuring comprehensive reporting on the environmental impact of insured activities.
- **Promoting Collaborative Efforts and Awareness**: Finally, promoting collaborative efforts between insurers, regulators, and other stakeholders is essential. Principle 2 of the UN PSI encourages raising awareness and developing solutions for ESG issues (UNEP FI, 2021). Discussions under this principle should explicitly include NbS as viable solutions for managing risks and enhancing resilience. By fostering partnerships and increasing awareness, the insurance sector can play a pivotal role in mainstreaming NbS.

There is considerable potential for the sector to further incorporate NbS into their value chains, moving beyond regulatory compliance to leverage the EU Taxonomy in addressing both environmental and societal challenges. However, several preconditions must be met to mainstream these solutions effectively. For NbS to be fully integrated into the insurance sector, standards need to evolve to explicitly recognise and incentivise such approaches. By building on successful case studies, adapting existing standards, and strengthening regulatory frameworks, the insurance industry can play a key role in enhancing environmental resilience and sustainability. These advancements would not only reduce risks but also unlock new business opportunities while supporting the long-term health of ecosystems and communities.

4.5 Sectoral discussion

In this chapter, we explored the emerging potential of integrating NbS-driven restoration activities into the insurance sector through the VCA. Potential solution of the value chain problems is illustrated through examples of parametric insurance in the Quintana Roo coral reef and the CAR insurance in Prince Hendrik Sand Dyke project in the Netherlands. These cases demonstrate how innovative insurance products can integrate an NbS approach effectively. Although NbS integration remains at an early stage within insurance business models, these pioneering examples demonstrate clear mutual benefits: insurers reduce long-term loss ratios and improve risk portfolios, while restoration projects gain stable funding and broader resilience.
business interests and restoration goals are therefore aligned.

In conclusion, integrating restoration efforts into the insurance sector requires the development of innovative insurance products and improvement of sectoral standards that explicitly recognise and incentivize NbS interventions in restoration projects. Insurance operates not as a self-contained value chain but rather as a cross-sectoral enabler, supporting other sectors such as agriculture and tourism. Therefore, embedding NbS criteria into insurance products has the potential to mainstream the NbS across multiple sectors.

However, our review of sectoral standards reveals that the insurance sector currently lacks robust frameworks specifically encouraging or certifying NbS-aligned restoration activities. While external initiatives like the EU Taxonomy and the UN PSI offer useful entry points, there remains a gap in dedicated sectoral standards, neither in the insurance sector nor in other sectors, explicitly recognising ecosystem restoration as a financially feasible solution. Evolving these existing standards can not only mitigate risks but also open new markets, aligning business and conservation interests.

5 General discussion and conclusion

In this report, sectoral VCA is conducted through examples of organic dairy farming, peat for horticultural growing media and non-life parametric insurance. Our objective is to explore the potential of using VCA to identify where and how restoration objectives can be aligned with business needs in the three selected economic sectors: agriculture, peat extraction, and insurance.

5.1.1 Sectoral findings

The agriculture section represents the most mature and well-structured case of ecological practice with commercial relevance. Organic farming, while not meeting a strict definition of NbS, serves as a widely accepted and commercially successful proxy. It exemplifies how ecological practices can align with market mechanisms, particularly through the use of consumer-facing labelling schemes (for instance the EU Organic Farming) or the internal value chain coordination (such as the Unilever SAC). These schemes translate complex certification standards into simple consumer signals – whether they are consumer-visible labels or long-term reputational effort—that foster demand and differentiate products in an eco-aware market.

Furthermore, agriculture sector also exhibits the most comprehensive and numerous sectoral standards relevant to restoration, covering multiple dimensions, such as biodiversity conservation, sustainable water management and soil health. These standards are not only well-developed in ecological content but also in their capacity to coordinate actors across different steps of the sectoral value chain. Examples include holistic certification system for each step of the agriculture value chain (e.g. EU Organic Farming) and internal supply chain frameworks (e.g. Unilever SAC). However, **limitations persist as no current certification standard, or label scheme are explicitly designed to identify and certify NbS as a distinct approach or demonstrate systematic alignment with NbS criteria. Apart from EU Organic Farming, most standards lack consumer visibility or remain confined to niche markets**.

Peat extraction, by contrast, offers a sectoral example where there are emerging institutions to align restoration of past extraction sites with final product certification. Here, the focus is on the restoration of ecosystems after the extractive activities, so the VCA has been adapted to stress the importance of pre- and post-extraction phases, where restoration activities are planned and implemented respectively (e.g., wetland rewetting and biological habitat rehabilitation). Two sectoral standards—Responsibly Produced Peat (RPP) and Veriflora—were reviewed in detail. While both are voluntary standards, they demonstrate potential to link peat production with peatland restoration of past sites. However, neither of these two standards posits restoration as a condition during the active extraction phase but a one-time action in the post-extraction phase. Moreover, restoration responsibilities are conditional upon specific certification schemes, land ownership and national regulations, which limit the replicability of their certification system. These limitations point to a need for more binding, multi-actor standards that integrate restoration more firmly across all phases of the peat value chain.

Insurance represents the frontier sector of aligning service-based businesses with ecological restoration, where few standards exist. However, the sector holds substantial transformative potential according to our analysis. Through case studies such as the parametric reef insurance in Quintana Roo, Mexico, and the CAR-insured dyke restoration project in the Netherlands, the sectoral VCA demonstrates evidence on how NbS can be tied directly to risk reduction of policyholders and thus generate business value for insurers.

Although empirical examples remain limited, these cases illustrate that the integration of restoration measures into insurance products not only improves financial resilience of restoration projects but also creates space for cross-sectoral collaboration. For instance, parametric insurance schemes—where payouts are triggered by predefined environmental indicators such as rainfall or river levels—could be deployed in agricultural regions where restored floodplains reduce flood disaster risks. In such settings, farmers could benefit from reduced premiums, as the restoration lowers the probability and severity of insured events, thereby decreasing the long-term financial exposure of both farmers and insurers. Currently, there are no standards within the insurance sector that explicitly address the integration of restoration efforts or alignment of NbS criteria. This highlights however the opportunity where other sectors could benefit from incorporating NbS criteria into their existing standards and work with insurers to co-create sector-specific standards.

Another limitation relates to the current lack of empirical data across the broader landscape, as documentation remains sparse in terms of integrating restoration measures into sectoral VCA. Addressing these gaps—conceptual, regulatory, financial, and empirical—is critical for enabling NbS to become part of mainstream business practice. As Sectoral Strategies (Bérczi-Siket et al., 2025) are developed in MERLIN project, relevant findings will provide a foundation for designing interventions that align ecological goals with commercial realities.

5.1.2 Cross-sectoral synergy through value chain analysis

Beyond sector-specific insights, several cross-sectoral synergies and structural issues have emerged.

First, value chains provide a useful framework for revealing where business incentives and restoration objectives align or diverge. Conducting sectoral VCA helps NbS advocates, environmental policymakers and restoration practitioners better understand the perspective and interest of sectoral actors in restoration projects. This approach can enable the engagement of sectoral actors to identify where NbS can add economic value and facilitate integration of NbS in business models.

Second, standards play a crucial role in mainstreaming NbS, particularly when they can enable the acknowledgement of restoration efforts within existing commercial systems. The most illustrative showcase is from the agriculture section, in which certification, such as EU Organic Farming, has shown how complex ecological practices can be translated into consumer-facing labels.

Third, multi-actor and cross-value-chain coordination is central to mainstreaming NbS in restoration projects. In agriculture, partnerships between farmers and external actors (e.g. municipal water providers in Munich) illustrate how NbS adoption can emerge through aligned incentives. In peat extraction, third-party certifiers (e.g. RPP or Veriflora) serve a key role in coordinating actors across the value chain. In insurance sector, collaborative arrangements involve insurers, sectoral practitioners, NGOs, and local governments and allow them to co-design NbS-integrated financial products. It is through the broader VCA that we can identify those opportunities for collaboration and develop a more inclusive approach for restoring freshwater ecosystem.

Fourth, financial mechanisms are a critical enabler across all three sectors. In our cases, agriculture benefits from decentralised financing through cooperative models, enabling small-scale actors to share investment burdens during organic practice transition. Peatland restoration demands capital-intensive operations involving machinery and long-term land use planning. In the insurance sector, NbS are increasingly supported through innovative financial products such as parametric or CAR insurance, which help de-risk ecosystem restoration projects and support long-term ecological recovery.

Finally, **realising the full potential of NbS integration requires systemic change**. Beyond technical feasibility and proof-of-concept pilots, widespread adoption depends on aligning institutional incentives, updating sectoral standards, strengthening stakeholder engagement, and recognising value beyond short-term profit. **The value chain approach employed in this report offers a pragmatic yet flexible framework to identify such leverage points—illustrating how business-as-usual models can evolve into sustainable development models that generate ecological, social and economic value**.

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7 Annexes

The annexes provide supplementary materials that support and expand upon the main content of the report without interrupting the flow of the narrative. They include detailed tables, figures, and additional analyses referenced throughout the report, offering readers the opportunity to explore specific components in depth.

7.1 Annex 1: Additional information from agriculture sector

Table 4 provides the full list of standards revised for chapter 2 on Agriculture.

Table 4. Results of standards review from agriculture sector

Name of Standard	Category	NbS-Related	WSS-Related	Agriculture-Related
1. Bio-Knospe	Organic	Promotes soil health through natural methods, emphasises buffer zones to protect water bodies.	In risk areas, a water management plan is required. No effluents or seepage must impair water.	No chemical-synthetic fertilisers or pesticides are allowed. Crop rotation and humus management to improve soil health and reduce erosion.
2. EU Organic Farming	Organic	Integrates NbS by enhancing soil organic matter, avoiding synthetic inputs, and improving water retention.	Effluents must be filtered and monitored. Water cycle protection via soil retention and erosion prevention.	Enhancement of soil life, fertility, and biodiversity; use of authorised fertilisers; crop rotation to improve soil health.
3. FairWild	Fair Trade	Limited NbS-related measures, primarily focused on non-organic input control.	Not covered.	Only known non-organic inputs in defined spots; limited impact on agriculture.
4. Fairtrade International - Agricultural Standards	Fair Trade	Establishes buffer zones and promotes rational water use to protect ecosystems.	Efficient and rational use of water sources.	Soil erosion prevention, enhancing soil fertility, buffer zones around water bodies.
5. For Life	Private	Emphasises buffer zones and agrochemical reduction, aligning with NbS principles.	Surface and groundwater use must be permitted and managed. Water contamination must be minimised.	Crop rotation, reduced use of synthetic agrochemicals, buffer zones to protect water bodies.
6. GLOBAL G.A.P.	Industry	Supports NbS through crop rotation, soil health improvement, and buffer zone establishment.	Valid permits for water use are required. Wastewater must not pose a risk to water sources.	Soil health and biodiversity management via crop rotation; use of authorised plant protection products; buffer zones along aquatic ecosystems.
7. IFOAM Standard	Organic	NbS integrated via erosion prevention, nutrient management, and biodiversity protection.	Prevent excessive water resource exploitation, preserve water quality, minimise nutrient release.	Erosion prevention, reduced soil degradation, allowed inputs to maintain soil fertility; maintaining on-farm wildlife refuge habitats.
8. IFS Food	Industry	Limited focus on NbS; emphasis on preventing contamination in manufacturing processes.	Water management focused on hygienic disposal, preventing contamination, and ensuring safe drainage.	Value chain focus on manufacturing, pest control compliance with local laws.

Name of Standard	Category	NbS-Related	WSS-Related	Agriculture-Related
9. Naturland Organic Aquaculture	Organic	Strong NbS focus on ecological function protection, water management, and biodiversity promotion.	Ensure no significant deterioration of water quality, manage water extraction responsibly.	Use of organic fertilisers, protection of ecological functions in farm areas, promoting biodiversity through natural vegetation management.
10. Naturland Standards on Production	Organic	Promotes NbS through sustainable water use, biodiversity conservation, and natural vegetation.	Avoid excessive water exploitation, maintain water quality, prevent salinisation.	Prohibition of synthetic chemical fertilisers, promotion of biodiversity through buffer zones, maintaining natural vegetation along water bodies.
11. Soil Association Organic Standards	Organic	NbS principles applied via water management, pollution minimisation, and organic soil practices.	Minimise pollution to watercourses, clean and reuse water where possible, maintain efficient irrigation.	Management of soil fertility, prevention of nutrient loss, restricted use of pesticides, and maintaining soil health through organic practices.
12. Sustainable Outcomes in Agriculture Standard (Syngenta)	Industry	Integrates NbS through efficient water use, crop rotation, and targeted pest management to enhance sustainability.	Efficient water use, irrigation planning, drainage management to protect water quality.	Crop rotation, management of soil health, targeted pest management, conservation practices for biodiversity and water quality.
13. Unilever Sustainable Agriculture Code	Private	Focus on NbS via biodiversity action plans, wildlife corridor maintenance, and sustainable nutrient management.	Sustainable water supply management, minimisation of nutrient loss, and prevention of water pollution.	Implementation of soil conservation plans, biodiversity action plans, maintenance of wildlife corridors, and appropriate nutrient management.
14. Demeter	Organic	NbS incorporated through biodynamic practices, soil improvement, and dedicated biodiversity areas.	Responsible water extraction and irrigation management to prevent erosion and salinisation.	Biodynamic soil management to improve water retention, strict fertiliser rules, maintenance of 10% of farm land as biodiversity areas.
15. Bioland	Organic	NbS included through water conservation, organic fertilisation, and diverse crop rotation to enhance biodiversity.	Use water sparingly, observe effects of water extraction, collect and use rainwater where possible.	Prohibition of synthetic pesticides, promotion of biodiversity through diverse crop rotation, using organic material from the farm for fertilisation.
16. Bio Austria	Organic	Supports NbS via organic methods, biodiversity promotion, and avoidance of synthetic inputs.	Measures related to water management not clearly specified, focus on preventing water contamination.	Prohibition of chemical-synthetic plant protection agents, enhancement of soil fertility, promotion of biodiversity through crop rotation and point system.

Name of Standard	Category	NbS-Related	WSS-Related	Agriculture-Related
17. Regionalfenster	Regional	Not covered	Not applicable - only covers statements on origin and processing location.	Not applicable - only covers origin of agricultural ingredients used, location of processing, and proportion of regional raw materials.

7.2 Annex 2: Additional information from the peat extraction sector

Here further technical details are provided on:

- Demand for growing media
- Analysis of RPP's after-use measures against the IUCN global standard for NbS
- Review of international standards

7.2.1 Growing Media

In terms of the importance of peat as growing media, Table 5. Estimate world volume of growing media used globally with projection for 2050Table 5 shows the projection and relative importance of the product and hence the importance of the value chain.

Table 5. Estimate world volume of growing media used globally with projection for 2050.

Growing media component	2017 (Mm^3 y^{-1})	2050 (Mm^3 y^{-1})
Peat	40	80
Coir	11	46
Wood fibre	3	30
Bark	2	10
Compost	1	5
Perlite	1.5	10
Stone wool	0.9	4
Soils / tuffs	8	33
New	0	65
Total	67	283

Source: Blok et al. (2019)[10]

7.2.2 How RPP meets IUCN Standards

The RPP's measures in the after-use stage of the value chain (see Figure 5) could be considered as a NbS per the IUCN NbS criteria (see definitions) since it is an action to restore nature. The preferred approach is restoration, which helps create habitats for related species, thereby preserving biodiversity; and this may have co-benefits for recreational activities or provides economic benefits and supports local employment. However, there are nuances and variation when compared with each criterion of the IUCN Global Standard for NbS. This section briefly assesses the extent to which RPP certification supports NbS and the corresponding value chain steps where these could occur:

- NbS effectively addresses societal challenges: The restoration of peatlands following extraction (step 7) through the RPP focuses on climate mitigation by addressing peatland degradation and carbon emissions. The main targeted benefit is carbon sequestration.

[10] Updated Growing Media estimates for 2050 are due to be published later in 2025.

- NbS is designed and implemented across scale: Presently, designing the restoration (step 1) and the actual implementation (step 7) is based on the site certified for peat extraction. Therefore, restoration beyond the extraction site and cross-sectoral consideration is not clear in the RPP approach. However, there is ongoing exploration of how the peat extraction sector could support large-scale restoration.
- NbS leads to biodiversity net gain: While regulations for the after-use of peat extraction sites vary between different countries, RPP requires that the condition of the peatland after extraction (step 6 & 7) is better than before extraction by undertaking restoration measures or maintaining the wetness of the peatland to ensure biodiversity net gain. An example is sphagnum-farming, which can keep the land wet while remaining productive. However, the impact on habitats and species is not specified.
- NbS is economically viable: Funding model and its feasibility for restoration is not clearly detailed under the RPP, but the responsibility usually lies with the individual companies with guidance from RPP.
- NbS is inclusive and transparent: RPP requires that selection of sites for peat extraction and undertaking of after-use, whether or not restoration, goes through consultation with stakeholders, including local authorities, environmental NGOs and local communities.
- NbS is managed adaptively: It is not clear how restored peatlands following extraction can be maintained and adapted to changing circumstances.
- NbS equitably balances trade-offs: While the actual trade-offs involved are not mentioned explicitly the decision on selecting a site for extraction and the after-use option will need to balance the interests of different stakeholders, particularly landowners, focusing on whether the land should be used for peatland restoration to enhance biodiversity and sequester carbon or for cultivation.
- NbS sustainable and mainstreamed: The selection of sites for peat extraction (step 1) needs to comply with Member State regulations and EU Directives. Thus, for a company to receive RPP certification, they should have a "valid license for extraction and land rental or ownership". Moreover, RPP is recognised across Europe and their framework is being mainstreamed through the Dutch Covenant on the Environmental Impact of Potting Soil and Substrates (2022). However, there is still work to do to embed the RPP led restoration of peat extraction sites within implementation of large-scale landscape restoration. A strategy to close this gap has been generated as part of the MERLIN project (Ibrahim et al., 2025).

7.2.3 Brief description of standards and their focus

Six relevant standards were retrieved from the ITC and reviewed as follows:

- GLOBALG.A.P. Crops (The GLOBALG.A.P. Integrated Farm Assurance (IFA) Standard): The main sectors are the agriculture and Floriculture & Horticulture, covering the production and manufacturing stages of the value chain. The standard is about responsible farming practices. Their impact areas include food safety, environmental sustainability and production process. Although it mentions fertiliser and bio stimulants as part of its core topics in the impact areas, there is no direct mention of the use of horticultural peat or other growing media in their supply chain (ITC, 2023).
- Naturland Production Standard: Promotes organic agriculture, restricting peat use primarily for soil enhancement, allowing a maximum 80% peat composition for seedlings, but lacks specific guidelines for sustainable peat production practices (Naturland, 2023).
- Naturland Fair: Complements Naturland standards and concerns a fair trading of Naturland certified organic products through enhanced networking between actors in the value chain to enhance economic sustainability. Therefore, it does not mention anything about use of peat or a direct relation with restoration.by fostering fair trade within organic product value chains but makes no mention of peat use or restoration practices (Naturland, 2023).
- Sustainably Grown (Veriflora): Explicitly addresses peat management through the "Responsibly Managed Peatlands" certification, covering activities from peat extraction to restoration and rehabilitation, ensuring responsible peat moss production and community welfare. Its scope covers peatland-related issues, including preparing the peat production site, extraction, restoration and rehabilitation activities (ITC, 2023).
- EU Organic Farming (Regulation EU 2018/848): Defines organic production standards, mentioning peat indirectly by prohibiting chemically treated peat substrates for organic

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mushrooms. However, it does not address post-extraction peatland restoration explicitly (EU Regulation 2018/848).

- ISCC EU (The International Sustainability and Carbon Certification): Focuses on greenhouse gas reduction through the bioeconomy supply chain yet notably excludes peat products. Given significant peatland degradation (e.g., 100,000 hectares in Finland), this omission limits the standard's alignment with carbon capture and sustainability goals (ITC, 2023).

Three key standards emerged from further stakeholder engagement and review. The **Responsibly Produced Peat (RPP)** certification explicitly targets sustainable peat extraction, ensuring peatlands with high conservation value remain protected and that restoration activities follow extraction. Conversely, the **RHP** standard focuses primarily on the quality and safety of growing media—including peat—through rigorous testing procedures for contaminants such as weeds, pathogens, and insects, but it does not address peatland restoration or environmental impacts explicitly. A similar standard (RAL) exists in Germany. Lastly, **Horticert** encourages the development of ecologically and economically viable peat substitutes, such as coconut, wood fibre, or compost. Although this indirectly supports peatland conservation by reducing peat extraction demand, it lacks direct guidelines for responsible peat production or associated restoration efforts. It is also a pilot scheme that only applied in Germany at the time of writing.

Table 6 assesses key attributes of RPP and Veriflora, their similarities and differences, and measures to support restoration.

Table 6. Core attributes of Veriflora and RPP Certification

Criteria assessed	Comparative analyses
Similarities	Both standards promote responsible peat production for horticulture. Both standards promote after-use restoration and rehabilitation. Both are voluntary standards. Main value chain stages covered are pre-production, extraction and rehabilitation and restoration/after-use.[11] Both use 'self-improving systems' with strict deadlines to show improvement or implement corrective actions. Both standards provide labelling for certified products.
Differences	Veriflora mostly operates in Canada and USA (although it claims to be a global standard), while RPP operates in Europe. Veriflora includes quality and fair labour practices, RPP does not. RPP reaches to other actors beyond the peat production companies, while Veriflora focuses on peat producers.
Requirement for restoration and conditions	Both standards require post-extraction restoration, subject to site-specific conditions, national regulations, and land ownership arrangements. Certified companies are not held responsible for restoration during the active peat extraction phase, which may span several years or decades, depending on the peat depth.
Responsibilities	RPP's responsibilities for pre-production and after-use measures are assigned to the peat extraction companies, certain labelling responsibilities are assigned to other actors like traders, retailers, and other growing media companies who do not extract peat. This includes applying labelling of raw peat or peat-based materials based on specified rules and documenting their sources. In Veriflora, responsibilities are mostly assigned to the peat production companies, including adopting responsible production, restoration, ecosystem management and protection and traceability of certified peat.

[11] In Veriflora the terms used are opening, harvesting, and restoration or rehabilitation.

7.3 Annex 3: Replies to reviewers' comments

This Annex contains the response to reviewers and how the deliverable has been revised.

Table 7. General and detailed replies to reviewer's comments

Reviewers' comments	Reply
General comments: Deliverable 4.4 unfortunately stands out as an outlier and requires a major rethink. It does not articulate well the method (value chain analysis), contribution and value added of the exercise. The document is way too long yet there is no proper problem description on the basis of which the selected method could be justified. We recommend focusing on two stronger cases, shortening the introduction and focusing in on the potential of the method for use in specific cases, giving detailed recommendations for uptake (e.g. through WPs2-3). Alternatively D4.4 could perhaps reflect on whether this is in fact an appropriate method for the problem at hand. **Recommendations concerning the period covered by the report** D4.4 - Request for revision (significant revision). Value Chain Analysis in Key Economic Sectors. This deliverable shows potential but quality is inconsistent between chapters. The introductory sections can be rationalised, with more referencing to source material provided. Certain sector analyses can be removed or heavily revised drawing on the very good example of the peat sector. Some assumptions can be challenged/revisited in the core of the report and these are highlighted in the comments section for the deliverable assessment. It is recommended to edit the material considerably to produce a much shorter deliverable (e.g. 8-16pp) and in the conclusions to reflect on the applicability of the methods within Merlin's approach.	**Overall Response to Reviewers – D4.4** We would like to sincerely thank the reviewers for their thorough and constructive feedback on Deliverable 4.4. We have carefully considered all comments and taken significant steps to address the concerns raised, improve the structure, and enhance the clarity and consistency of the report. Below, we summarise the major improvements made: **Clarification of the Problem Statement and Methodology:** The introduction has been substantially revised to include a clear problem statement—the disconnection between restoration projects and business sectors—and to explain how VCA could be adopted as a method to bridge this gap. We have also restructured the methodology section to clearly describe the overall approach, and the multi-step process used, providing a stronger justification for the method's relevance to MERLIN's WP4 objectives. **Refinement of Case Selection and Sectoral Focus:** Based on reviewer advice, we have reduced the number of sectoral analyses by removing the WSS section, thus focusing the deliverable on the stronger cases of agriculture, peat extraction, and insurance. We have enhanced the consistency across these chapters, following an order from mature integration (agriculture) to emerging innovation (insurance). **Length and Structure Adjustments:** While a reduction to the suggested length was not feasible, we have condensed the main body to around 30 pages. Sectoral chapters have been tightened, unnecessary contextual material has been removed, and the overall narrative is now more direct and structured. **Strengthened Evidence Base and Referencing:** We have added more academic references and links to MERLIN deliverables (particularly D3.5 and the Sectoral Strategies, which were not available at the time of the initial deliverable). Sectoral findings are now better grounded in both external sources and internal project outputs. See the updated list of references (section 6). **Clarification on Insurance Sector Analysis:** We acknowledge the limitation that no MERLIN case specifically addressed insurance. However, we adopted a forward-looking approach based on external best practices and non-MERLIN case

	studies. We clarified that the insurance analysis identifies potential pathways, and we now better explain the systemic issues (such as the lack of monetary transaction systems for restoration beneficiaries and providers) that justify this forward-looking perspective. **Annexes Section Improved:** A proper introductory statement and structure for the annexes have been added to enhance reader navigation and ensure that supplementary materials do not disrupt the main flow of the report. In general, we have taken a systematic approach to strengthening D4.4 by addressing both structural and substantive issues. We believe the revised version now provides a clearer, better-supported, and more useful contribution to MERLIN's aims. We again thank the reviewers for their detailed and helpful feedback, which has greatly improved the quality of this deliverable.
The document is overly long.	We acknowledge the reviewers' concern regarding the length of the deliverable. While we recognise the importance of conciseness, we consider that the complexity of the subject matter—particularly the need to present sector-specific value chain analyses, case studies, and standard reviews—requires a more extensive treatment to maintain clarity and ensure full understanding. Nevertheless, **we have significantly condensed and restructured the document**. The length of the initial version was 76 pages (78 pages with annexes). The main body is now streamlined to 37 pages including imprint and table of content (53 pages with annexes), with each sectoral chapter limited to around 8–9 pages, alongside a focused introduction and conclusion. Additional detailed material that could disrupt the flow has been moved to annexes. We believe this structure strikes a balance between the need for comprehensive coverage and the request for improved readability.
The cases are of inconsistent quality and require editing. The solid cases of peat and insurance are more convincing; for the former the material is excellent.	We have **restructured the analysis for the agriculture sector for better clarity**, particularly by improving the presentation of the standard review and the articulation of links between value chain mechanisms and freshwater ecosystem restorations. This ensures that the quality of all chapters is now aligned.
Exec Summary should come first.	This has been rectified following the comments
Much introductory material is provided without referencing or sources. Considerable repetition. The document is way too long, especially compared with the deliverable description in GA.	We have revised the introduction and sectoral chapters to **remove unnecessary contextual information and repetition**.
The deliverable does not make reference to the project's work on cost-benefit analysis. It is	At the time the first version of this deliverable was completed, D3.5 (on financing strategies) was not

important to address the value proposition for NBS put to the sectors or co-developed with them. This can make reference to the work of WP3	yet available. The CBA analysis results are due later in 2025 and will not not decompose the costs and benefits to individual economic sectors as they focus on overall social welfare. . In this revision, we have now **created connections to WP3 financing activities** in the introduction, clarifying the methodological connections between VCA and MERLIN case studies seeking business opportunities. In addition, we have aligned the sectoral analyses with the newly available MERLIN Sectoral Strategies to strengthen the integration within the work package.
The peat case (section 5) is very good and can serve as an exemplar, e.g. through more direct engagement with MERLIN sectors and partners in revising D4.4 (and/or alternatively reducing the number of cases to focus on the more robust ones). This case has clearly benefited from the author's direct participation in co-productive dialogues presumably through the sector coordination.	Thanks for the positive feedback. We appreciate that the peat extraction sector case was recognised as a strong example. As suggested, we have **used the peat case as a reference point to strengthen the consistency and quality** of the other sectoral analyses.
WSS is not a single step problem – sanitation omitted? Single-actor management? This is untrue. A single actor does not 'manage the entire value system'. This oversimplifies and misrepresents water cycle management, water treatment and drainage. Therefore the case should be re-examined within the alternative (multi actor) framework or a different case should be selected for the single actor paradigm. Why not develop a new case, bottom up from MERLIN investments and considerable datasets/evidence?	Following the advice to focus on the more robust examples, we have **removed the WSS section from the deliverable**. Our sectoral partner was unable to support the development of a new case study, and without additional expert input, we could not address the complexity of WSS (including sanitation and multi-actor management) to a satisfactory standard.
Organic farming is not an NbS stricto sensu. What are the NbS in case study 2? Many different NbS aspects are covered in a rather generic way, meaning the research is insufficiently deep and therefore of limited value/additionality for the project/partners. Here the opportunity has not been taken to pursue an invaluable novel case through fundamental/empirical research coproduced with the Merlin partners and this is a shame.	We acknowledge that organic farming is not categorised as a full NbS under the strict IUCN criteria. However, it represents one of **the most widely accepted and commercially successful ecological approaches in the market**. In this deliverable, the organic farming case was intentionally used to illustrate how ecological practices that benefit freshwater ecosystems can align with economic value creation within a mature and operational system. This choice serves to **provide a practical and accessible reference point for demonstrating potential pathways to mainstream NbS** The section was co-produced with the sectoral partner in MERLIN (see authorship), specifically a non-academic organisation tasked with contributing empirical and practical insights, who felt the case study was an important example to share. To address this more clearly, we have added content in the introduction and restructured the report to better show the analytical progression: starting from a well-established ecological method (organic farming), moving through a currently evolving integration of NbS into value chains (peat extraction), and concluding with a future-oriented

	exploration of NbS integration into insurance models.
For the insurance sector it is understandable that it was not possible to use a MERLIN case. But the recommendations that result for Insurance seem a bit speculative, standing on the sidelines flagging what should be done by other people, rather than engaging in genuine pathways to impact (again, since MERLIN case partners aren't obviously involved) eg. 'By learning from successful case studies... the insurance industry can enhance its role in promoting environmental NbS'. This is rather vague and not impactful.	We appreciate the reviewer's comment and have added further content related to the potential integration of innovative insurance approaches based on evidence from existing experimental cases. Our objective was to illustrate pathways toward future integration using external case evidence and established sectoral developments. In fact, a review of the existing literature shows that most analyses concerning insurance and NbS remain largely at the stage of identifying barriers and offering broad recommendations. Our research **goes a step further by demonstrating that the fundamental issue is a systemic disconnection between restoration projects and sectoral business activities on the value chain**, which achieved our initial objective set. We argue that without properly internalising tools or methods (such as the VCA) among restoration actors, clear pathways cannot be achieved, especially when engaging partners who are not familiar with those tools and methods. In this sense, our deliverable aims to point out the necessary conditions for meaningful integration of insurance and restoration activities. However, following the reviewer's advice, **we have further refined the conclusion of the insurance chapter to reflect this point more explicitly**.
p13 Table 1: Distribution of participants discussing policies: numbers in first and third columns don't add up? Also on p13, the limitation that one person reviewed documents means that this person's expertise will have driven her/his interpretation and another person might have come to other interpretation and findings. This is a rather disheartening statement. This question was asked in the online meeting and contradicted, so this should be clarified/corrected. p13 bottom: from longlist to shortlist: it is unclear on the basis of which criteria the longlist was converted into a short list. p20 Table 3: 4th IUCN criterion "Does the policy refer to economic feasibility?" What does economic feasibility mean here exactly? This is not a standard economic term. How do you measure this? Same applies to criterion 6: "Does the policy refer to balancing trade-offs?" What does this mean precisely? Trade-offs can be balanced in many different ways. Please clarify.	We could not identify any corresponding material in Deliverable D4.4 related to the reviewers' comments. In D4.4, Table 1 (p. 32) does not involve participant numbers, shortlists, longlists, or IUCN criteria. Therefore, we believe this comment was mistakenly associated with D4.4 and actually refers to Deliverable D4.3. **We will ensure this feedback is addressed under the correct deliverable**.

More references should be included throughout (apart from perhaps the peat case).	References have been systematically added across all sections to ensure a more consistent evidence base, **including external sources and internal MERLIN deliverables**.
Annexe (sic) lacks a title or introductory statement.	We have added **a clear title and an introductory paragraph** to the annexes, and restructured the content to improve readability and ensure coherence with the main body of the report.