D3.2 Review of innovative public funding, finance and provisioning arrangements

30/11/2023

WP3

Lead beneficiary: GCF

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REST-COAST

Large Scale RESToration of COASTal Ecosystems through Rivers to Sea Connectivity

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Preface

The Rest-Coast Project (Large scale RESToration of COASTal ecosystems through rivers to sea connectivity) is an EU Horizon 2020 research project (Grant agreement No. 101037097) whose overall goal is to address with effective and innovative tools the key challenges faced by coastal ecosystem restoration across Europe. The approach chosen for this project will deliver a highly interdisciplinary contribution, with the demonstration of improved practices and techniques for hands-on ecosystem restoration across several Pilot sites, supported by the co-design of innovative governance and financial arrangements, as well as an effective strategy for the dissemination of results.

Summary

This deliverable (D3.2) is the second contribution of Work Package 3 to the REST-COAST Project. The overarching purpose of REST-COAST is to provide the tools to address some of the key challenges faced by coastal ecosystems restoration. To achieve this objective, REST-COAST will improve coastal restoration practice and techniques through new hands-on restoration Pilot projects, co-design effective governance arrangements and policies, and generate new tools and data for risk reduction assessment. In addition to these activities, Work Package 3 will design innovative financial arrangements and bankable business plans to support the implementation and the scaling up of coastal ecosystem restoration.

This deliverable provides the following three foundational contributions to the future work of WP3:

1. Based on a review of the literature on NBS finance and economic theory, identify financial barriers that can be addressed by innovating financial arrangements (Section 4.1)

2. Identify innovative and transferable financial solutions that have been successfully implemented in sectors related to restoration, NBS, coastal adaptation and climate mitigation (Section 4.2)

3. Identify most promising solutions for the co-development of tailored business models in the Pilots (Section 5)

The review of literature on NBS finance revealed that mobilising private investments represents one of the most promising approaches to bridge the NBS finance gap. While financial innovation is recognised as a potential solution to existing challenges, this issue has not been comprehensively studied yet. In particular, it is not yet clear which financial barriers can be addressed through innovative financial solutions, nor which factors can affect the applicability of these solutions across different restoration projects.

We have identified a set of financial barriers and 10 innovative financial solutions to address them. The latter comprise green bonds, environmental impact bonds, project bundling, smart contracts, blockchain tokens, public private partnerships, carbon credits, eco-labels, ecotourism user fees and betterment levies. Specific attention was placed on solutions that leverage private investments, as this can significantly upscale investments in coastal restoration. Empirical evidence for each innovative financial solution was collected in a case study database, annexed to the present deliverable (Annex 1).

Variety within the selected group of solutions was achieved by looking at different financial functions (Financing arrangements, value-capture arrangements, procurement arrangements), and sourcing empirical evidence from various geographical locations (Europe, North America,

Latin America, Australia, Africa, Asia) and types of NBS projects (Mangrove restoration, seagrass restoration, wetland restoration, watershed management, urban NBS, etc.). Overall, we find that identified solutions can be a useful tool to achieve restoration upscaling, yet their practical implementation is challenged by several, interconnected barriers.

The assessment over the extent to which the innovative solutions fit restoration upscaling and institutional context in the Pilots was successful in identifying promising arrangements for the co-development of tailored NBS business models. Given the overall lack of revenue generation mechanisms evidenced in D3.1, priority should be placed on proposed solutions of the value-capture kind. Restoration values related to eco-tourism, offset and cost-avoidance business models appear to be the most promising assets for the establishing of value-capture arrangements across several of the REST-COAST Pilots.

List of abbreviations

BIORESILMED	Promoting BIOeconomy and climate RESILience in MEDiterranean landscapes
CSR	Corporate Social Responsibility
EDF	Environmental Defense Fund
EIB	Environmental Impact Bond(s)
ESS	Ecosystem Service(s)
EU	European Union
GCF	Global Climate Forum
GHG	GreenHouse Gas(es)
GPC	Green Purposes Company
IUCN	International Union for Conservation of Nature
MPA	Marine Protected Area(s)
NAIAD	NAture Insurance value: Assessment and Demonstration
NBS	Nature-based Solution(s)
NBS BMF	Nature-based Solutions Business Model Framework
NGO	Non-Governmental Organisation(s)
OECD	Organisation for Economic Cooperation and Development
PPP	Public-Private Partnership(s)
REST-COAST	Large Scale RESToration of COASTal Ecosystems through Rivers to Sea Connectivity
TNC	The Nature Conservancy
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
WP3	Work Package 3
WWF	World Wide Fund for Nature

1. Introduction

The implementation of nature-based solutions (NBS) for coastal adaptation is limited by a well-documented lack of funding and financing. Today, NBS are generally funded through government grants and, to a lesser extent, philanthropic sources (UNEP, 2022). Given the characteristics of grant-based public funding (limited budgets, competing policy priorities, short-term decision-making cycles) (Deutz et al., 2018; Droste et al., 2017), NBS finance is limited in size and only available for specific and relatively short funding cycles (Altamirano et al., 2021; EIB, 2020). As evidenced in D3.1, this situation is also visible in the REST-COAST Pilots, which almost exclusively rely on medium/short-term cycles of public granting.

At the same time, the use of alternative funding and financing models is challenged by a range of financial barriers associated to measuring and capturing the value of ecosystem services due to the public good character of coastal adaptation and ecosystem restoration, as well as the multiple stakeholders involved (Eiselin et al., 2022; König et al., 2020). Financial innovation has captured significant attention within the academic and policy community as a promising approach to solve this issue. A range of innovative financial solutions have been developed to increase project efficiency, reduce transaction costs and, in particular, to mobilise new financial resources from the private sector (Kapos et al., 2019; Sánchez-Arcilla et al., 2022; Seddon et al., 2020). Examples include thematic bonds such as green bonds and blue bonds to target finance for sustainable projects, crowd-funding to raise funds and enhance local ownership, environmental credits to stimulate investments in ecosystem services (ESS).

Despite its growing relevance, the current academic discourse on innovative financial solutions is limited by some important knowledge gaps. To date, there have been no attempts to classify financial barriers. In particular, innovative financial solutions have not been systematically mapped in terms of the financial barriers they address. Consequently, it remains unclear how exactly innovative solutions address the specific barriers found in NBS projects and, given the distinctive local dimension of restoration projects, to what extent successful innovations can be transferred and replicated.

This deliverable (D3.2) addresses these limitations by:

- Developing a systematic typology of financial barriers to implementing NBS;
- Identifying innovative funding, financing and procurement solutions applied or applicable to coastal restoration at different spatial scales throughout the world;
- Exploring, for each solution under review, identified factors that enable and hinder the transfer of these solutions to other NBS cases.

By drawing upon transaction cost economics, we thereby seek to better understand when and how identified innovative financial solutions can effectively overcome financial barriers. Given the persistent lack of private investments in NBS, particular focus will be placed on solutions aimed at stimulating private sector involvement.

With its work D3.2 draws upon and contributes to the overall objective of **Work Package 3 (WP3) of the Rest-Coast project, which** addresses the need for effective financial means for the promotion of large-scale coastal restoration in the face of global changes (Figure 1.1). A first deliverable (D3.1) has developed a NBS business model framework (BMF) which systematically defines concepts and categories for funding and financing NBS. D3.2 builds on D3.1 by adopting the terminology and categories established by the NBS BMF framework (see D3.1), and sets the ground for the subsequent task T3.3 dedicated to the co-development of tailor-made financial arrangements, business plans and financial scalability plans for each REST-COAST Pilot. In particular, D3.2 contains a proposal of selected solutions that fits the context and needs of each Pilot, based on the review and analysis of successfully implemented innovative financial solutions. These proposed solutions are to be discussed and evaluated among WP3, Pilots and stakeholders for the co-development of tailored financial arrangements, related NBS business models and financial scalability plans in D3.3. Finally, D3.4 will address scaling-out, i.e. extending funding and financing beyond the Pilots, by making the results of previous deliverables accessible, replicable and transferable to coastal regions worldwide.

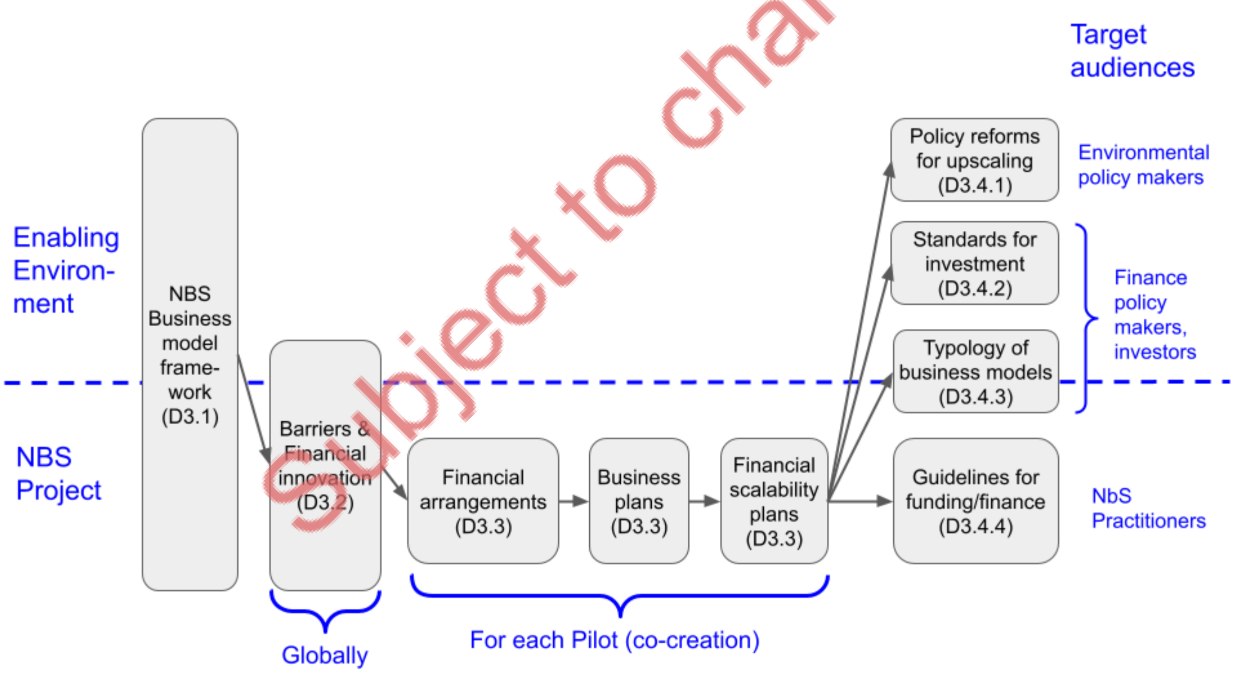

Figure 1.1 WP3 project tasks and workflow

2. State of the art

Our departing point is an overview of literature on NBS finance and financial innovation, with a specific emphasis on studies that identify and analyse financial barriers and related solutions. Our objective is to uncover gaps regarding the scope of financial innovation in addressing these barriers.

2.1. Barriers to funding and financing of NBS

The literature on NBS was initially dedicated to the definition of what NBS are and to highlight what makes them attractive (Cohen-Shacham et al., 2016; Nesshöver et al., 2017), in particular as an alternative to grey, engineered coastal infrastructures (Sutton-Grier et al., 2018). In this perspective, much attention has been dedicated to the demonstration of cost-effectiveness of NBS through collections of best practices (Faivre et al., 2017) and by identifying indicators of effectiveness (Kabisch et al., 2016; Narayan et al., 2016).

Within the last decade, attention was brought to the definition of barriers to the implementation of NBS (Egusquiza et al., 2019; Sánchez-Arcilla et al., 2022; Sarabi et al., 2019; Seddon et al., 2020). Overall, scholars agree in distinguishing four categories of NBS implementation barriers:

- Technical/knowledge barriers: Impediments that arise due to limited expertise, technology, information and data.
- Governance barriers: Impediments that arise due to fragmented and incoherent policy frameworks, social inertia and conflicts among stakeholders.
- Economic/effectiveness barriers: Impediments that arise when the sum of benefits that are relevant to NBS implementers are inferior to the overall costs.
- Financial barriers: Impediments that arise in accessing sufficient financial resources for implementing the NBS, including from public budgets, development and climate aid and private investments.

Barriers to the implementation of NBS, including those of different kinds, are deeply intertwined (Sánchez-Arcilla et al., 2022). For instance, lack of appropriate technology (technical barrier) may result in additional costs (financial barrier), and an uneven distribution of project costs and benefits (economic barrier) has the potential to generate opposition from specific social groups (governance barrier).

Many authors find financial barriers to be particularly crucial and challenging, as they persistently represent a leading cause for the lack of large-scale implementation of NBS (Frantzeskaki et al., 2019; Sarabi et al., 2019; Seddon et al., 2020).

At present, NBS are predominantly funded by public entities and, to a lesser extent, philanthropic donations (UNEP, 2022). Tight budgets under the pressure of competing policy priorities (e.g. health and education) and contingency on relatively short political cycles are some of the characteristics that limit the capacity of public funding to close the substantial financial gap for NBS implementation (Droste et al., 2017; Mayor et al., 2021; Sarabi et al., 2019). Furthermore, NBS are rarely perceived as a spending priority (Egusquiza et al., 2019), and these limitations have been exacerbated by the consolidation of fiscal austerity regimes (Bisaro and Hinkel, 2018). It is clear that public finance alone does not have the capacity to deliver large-scale implementation of NBS.

The prevailing prescription to upscale finance for NBS is to actively involve the private sector to attract additional (private) financial resources (EIB, 2023; OECD, 2020; TNC, 2019; UNEP, 2022). This approach recognizes the potential for aligning environmental goals with economic interests, exploring NBS as a potential opportunity for private investment. In addition to the increased pool of available capital, private investments in NBS would allow a diversification of funding sources, the establishment of partnerships for resilience, and a more efficient deployment of capital thanks to the capabilities and non-financial resources of market actors.

The market for NBS is however markedly underdeveloped, and development trends have been rather timid. The NBS literature has managed to collect a wide array of financial barriers that prevent the large-scale deployment of private investments in NBS. A first critical issue is that, while the global value of an NBS often exceeds its costs, individual actors (investors) find it challenging to reap a sufficient amount of benefits, as these are distributed across several actors and groups (EIB, 2023). Consequently, generated cash flows are too low to attract investors. In addition, these benefits are subject to relatively high risks due to the innovative nature of NBS, the lack of track record of (financial and non-financial) NBS performances (Sarabi et al., 2019; Seddon et al., 2020), and the uncertainties related to the development of ecosystem processes and the impacts of climate change (Sánchez-Arcilla et al., 2022). This is compounded by the long time horizons involved in the production of ESS via ecosystem restoration (WWF, 2022), which amplify risks, conflicts with investors' preference for higher and short-term returns, and poses questions on how to balance present costs with future, sometimes very distant, benefits. Furthermore, NBS usually consists of small-scale projects, for which due diligence and other investment-related transaction costs are often not justifiable (Shilland et al., 2021). Another key financial barrier is represented by current methods for the valuation and accounting of NBS benefits. Several benefits provided by NBS (e.g. public health, biodiversity, carbon sequestration, food and water security, etc.) are not taken into consideration by prevailing accounting methodologies for investment decisions (Toxopeus and Polzin, 2021). Furthermore, the valuation and monetisation itself of NBS benefits is often challenging (Dworczyk and Burkhard, 2022). Private investors lament a lack of a pipeline of "investment-ready" projects (Adhikari and Safaee Chalkasra, 2021). Most of the current NBS projects are structured coherently to prevailing funding models based on public grants (EIB, 2023), and rarely meet the financial requirements of commercial investors due to a lack of financial expertise in structuring attractive business models and missed opportunities in adopting standards for performance metrics and financial arrangements (Eiselin et al., 2022). This challenging landscape is further complicated by the absence of an appropriate enabling environment in terms of public policy, which can be attributed to path dependencies whereby established approaches are preferred over innovations (Davies and Lafortezza, 2019), complex and at times incoherent policy frameworks (Eiselin et al., 2022), lack of appropriate regulatory incentives (EIB, 2023), and challenges in coordinating broader partnerships involving private investors (Toxopeus and Polzin, 2021).

2.2. Solutions for overcoming barriers to funding and financing NBS

The emerging literature on financing NBS has proposed several ways for overcoming financial barriers. A first approach aims at increasing private funding of NBS for Corporate Social Responsibility (CSR). This strategy is founded on the premise that the multiple values delivered by NBS well align with the rising inclination of businesses to integrate sustainability objectives into their business strategies. Regulatory requirements on disclosures of financial entities' impact on biodiversity (EIB, 2023) is expected to contribute to this objective. The development, improvement and adoption of standards on what constitutes an NBS and how performances can be tracked would be beneficial, especially when combined with NBS databases for the collection of information on project impacts (WWF, 2022).

Besides CSR, private investors can engage in NBS financing and funding to avoid future damages and costs, to offset negative environmental impacts of their activities, or to gain profits through the selling of ESS. Investments by the private sector in natural assets are expected to rise with the increase of climate risks due to climate change (Colgan, 2017). Disclosure requirements on climate risks and dependency on ESS and the introduction of regulatory incentives (e.g. tax breaks and subsidies) are expected to accelerate this process (EIB, 2020). Furthermore, adopting NBS business models that precisely structure NBS projects in terms of value proposition, delivery and capture generates more appealing and understandable NBS investment proposals (Altamirano et al., 2021; Mayor et al., 2021). In particular, business models that combine NBS with grey infrastructure elements might help in reducing performance uncertainty while addressing diverging preferences of stakeholders (Seddon et al., 2020). Investment opportunities would also benefit from enhanced policy coherence, the removal of administrative barriers (Egusquiza et al., 2019), the inclusion of natural capital in accounting models, and the development (and aggregation) of comparable data on NBS financial outcomes (GPC, 2021). The layering and diversification of funding sources is proposed as a financial approach that coherently matches the multifunctionality aspect of NBS (EIB, 2023; Eiselin et al., 2022). To this end, but also in more general terms, scholars support the establishment of broad consortia for public-private financial coordination and the involvement of stakeholders (GPC, 2021). Partnerships leveraging private investments through blended finance approaches attracted particular interest (Barkley et al., 2022; Earth Security, 2021). Blended finance refers to the strategic deployment of public funding with the purpose of improving the risk-return profile of an NBS (de-risking), thus making it more attractive to commercial investors. An example would be public grants funding an early-stage, pre-feasibility phase of an NBS setting the ground for a revenue-generating NBS business model, or the deployment of guarantees. Finally, a number of innovative financial solutions have been developed with the purpose of upscaling finance for NBS (Agardy and Pascal, 2014; Baroni et al., 2019; Brears, 2022), including for instance green bonds, environmental credits, public-private partnerships and smart contracts. Experimenting with these is transversally recognised as an useful approach to improve NBS project investment attractiveness under several points of view, by aggregating projects, bridging long time horizons, distributing risks and establishing innovative value capture and business models (EIB, 2023; Eiselin et al., 2022; Kok et al., 2021; Sánchez-Arcilla et al., 2022; Toxopeus and Polzin, 2021).

Despite these suggested solutions for overcoming financial barriers to implementing NBS, private financial flows remain marginal as of today (UNEP, 2022). This underscores the necessity for further research into understanding these financial barriers and effective strategies to overcome them. As most authors agree, one largely unexplored avenue for overcoming financial barriers and attracting private investments to NBS are innovative financial solutions. The existing literature on financial barriers and innovative financial solutions often presents them in isolation, lacking a comprehensive framework that clearly delineates which specific solutions are most effective in addressing corresponding barriers. This separation hinders a detailed understanding of how to strategically match solutions with barriers. Furthermore, despite NBS being characterised by place-based complexities, proposals for financial solutions ignore the challenges to direct replications, as factors affecting applicability are not discussed (Den Heijer and Coppens, 2023). These gaps could be bridged by analysing these solutions from a financial and economic point of view. Frameworks and theories of institutional economic analysis have not been applied to the study of financial innovation in NBS as an instance of institutional change. The next section digs a bit deeper into this issue by reviewing the financial economics literature on financial innovations.

2.3. Financial innovation as solution for overcoming financial barriers

Financial innovation is a complex, multi-actor process that consists of the introduction and diffusion of new financial instruments, processes, markets, actors and institutions in a given economic sector (Lerner and Tufano, 2011). One example is crowdfunding, which allows individuals or businesses to raise funds for projects or ventures by collecting small contributions from a large number of people, typically via online platforms. This financial innovation has increased the accessibility of funding to entrepreneurs, artists, and various projects that might have struggled to secure traditional financing from banks or investors.

The purpose of financial innovation is that of enhancing the functions of financial systems, which include moving funds across time and space, pooling funds, managing risks, extracting information for decision making, addressing moral hazards/asymmetric information, provision of payment systems, etc. (Merton, 1995). Financial innovation achieves this primarily by reducing (or avoiding) transaction costs that market actors face due to the existence of market imperfections and other types of barriers (Silber, 1983), moving the overall system towards an idealised goal of "full efficiency" (Merton, 1995, p. 26). For instance, new financial products can set incentives for interest alignment in case of agency conflicts, or provide tools for risk sharing in markets characterised by high uncertainty.

Despite what the definition might suggest, financial innovation rarely consists of entirely new financial instruments, but more often of evolutionary adaptations of already existing instruments, extensions of existing products from other markets, or the reassembly of known elements in new conformations (Tufano, 2003). A distinguishing feature of financial innovation is indeed its combinatorial nature: financial instruments' core characteristics can be disaggregated and reassembled to deliver products that are tailored to a specific need. This makes new financial instruments highly customizable and adaptive (Khraisha and Arthur, 2018), and the process of creation of financial innovation a highly complex and dynamic phenomenon (Lerner and Tufano, 2011).

In terms of drivers of financial innovation, the issue has surely garnered considerable attention from scholars, yet it remains only partially understood, particularly due to the scarcity of empirical studies (Frame and White, 2004). Generally speaking, high costs associated with existing financial barriers drive financial innovation. This occurs on the condition that transaction costs of creating and implementing new innovative contracts are low enough to outweigh the overall benefits (Silber, 1983). Other important factors driving financial innovations are technological change and public regulation (ibid.).

In NBS finance, the purpose of financial innovation would thus be overcoming financial barriers, therefore improving the efficiency of financial functions within the NBS sector (transfer of funds, management of risks, etc.). What is not clear however is which financial barriers can be addressed by financial innovation, which innovative financial solutions are implemented to overcome these barriers, and which conditions (enabling or hindering) affect the applicability and transfer of these solutions. The goal of this deliverable is precisely to address these questions.

3. Methodology and theoretical framework

In this chapter, we outline the methodology and theoretical tools employed to achieve the objectives of D3.2.

We start by delimiting the scope of our study with key definitions and a simple typology of barriers and solutions to the implementation of NBS. We then develop a theoretical framework based on transaction cost economics. We use the framework to identify a set of financial barriers through a three-step process: pinpointing key transactions within NBS business models, identifying key properties of these transactions, and developing a typology of financial barriers relevant to the scope of our study. We then draw a set of innovative financial solutions that have been implemented in NBS projects. We proceed with a review of the identified innovative financial solutions in relation to the identified financial barriers. This involves highlighting innovative elements of contractual design that address the identified financial barriers. Additionally, we empirically identify conditions for applicability for each innovative solution. Finally, we assess the potential transferability of innovative financial solutions to the REST-COAST Pilots.

3.1. Barriers and solutions considered in this study

As discussed in the last section, different types of barriers and solutions can be distinguished within the complex issue of NBS implementation (Figure 3.1), with financial barriers being only one kind of barrier that contributes to the persistence of the NBS implementation gap. Other types of implementation barriers include governance barriers, technical barriers, economic barriers.

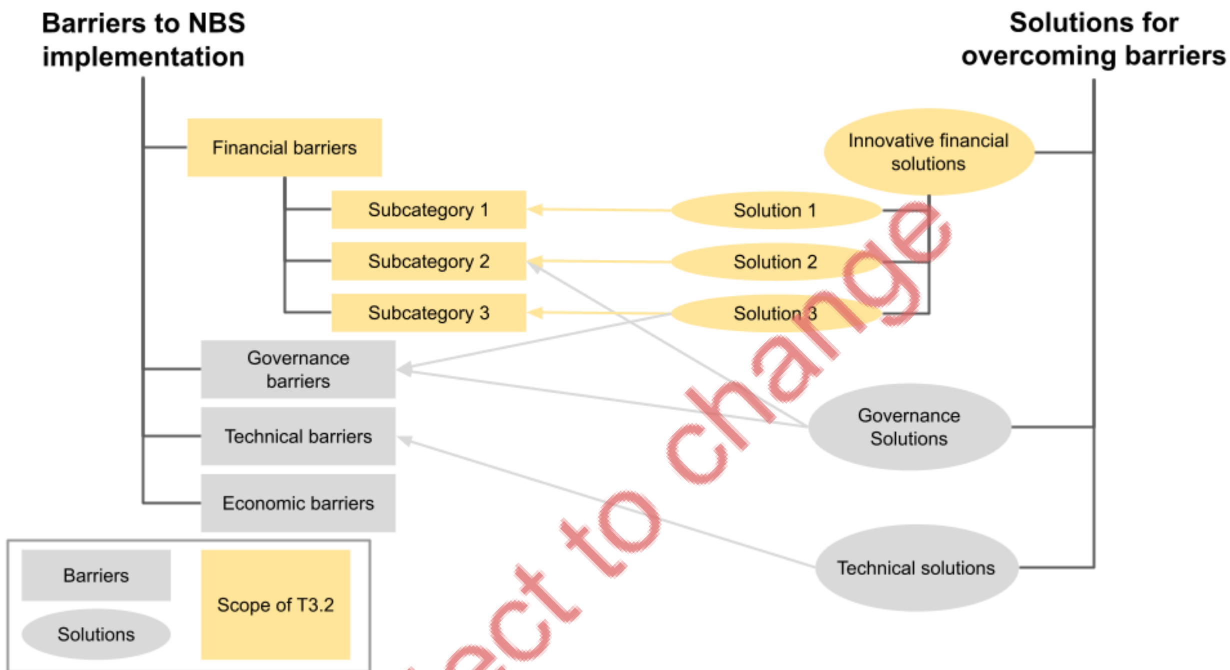

Figure 3.1 - Scope of D3.2 within the system of barriers and solutions for the implementation of NBS. The figure highlights the interconnectedness of barriers and solutions, where solutions designed for one type of barrier often contribute to addressing others.

Note that there is no one-to-one correspondence between different types of barriers and solutions. For example, one solution may address several barriers or one barrier may be addressed by several solutions. This also holds true for the top level categories, i.e. the different types of barriers and solutions such as governance, technology, finance etc., For example, some financial barriers can be addressed by technical measures such as new cost-reducing monitoring tools, policy measures such as environmental standards and long-term budgeting that expand NBS funding, or new governance procedures that reduce the risk of litigation.

Our study focuses on a specific type of solution, that is **innovative financial solutions**, defined as instruments that allow the overcoming of financial barriers by means of (innovative) contractual structuring. **Financial barriers** are constraints that individuals or entities face when trying to engage in economic activities and benefiting from the functions of the financial system in an efficient way.

3.2. Transaction cost economics as theoretical framework

3.2.1. Transactions

Given that the role of financial innovation is primarily that of reducing transaction costs (see Section 2.3), transaction cost economics (Hagedorn, 2008; North, 1990; Williamson, 1985) provides a suitable theoretical framework for the purpose of understanding financial barriers and solutions.

Transactions are the basic unit underlying any economic or financial activity. They are **defined as exchanges among participating actors by which goods, services, resources, benefits and disbenefits are allocated** (Williamson, 2000). We can further distinguish transactions in financial transactions, which exchange financial values (i.e. exchange of money or other financial assets), and economic transactions, which exchange a broader range of values including goods, services, economic rights and other types of benefits.

Two different kinds of costs are associated with every transaction. The first kind is the production cost, which consists of direct costs associated with the production process of goods and services. The second kind is **transaction costs**, which include the costs of gathering information, protecting property rights and negotiating agreements or contracts and enforcing these (North, 1990).

Transaction properties play a crucial role in determining transaction costs. For example, routine transactions, which occur regularly and repeatedly, tend to be more predictable and may lead to the development of conventions (i.e. informal contracts) for reducing transaction costs. In contrast, impersonal and unique exchanges typically involve incomplete information and greater uncertainty, leading to higher costs.

3.2.2. Four main transactions in implementing NBS

In NBS projects we can identify four main types of financial and economic transactions: financing transactions, granting transactions, procurement transactions, and value capture transactions (Figure 3.2).

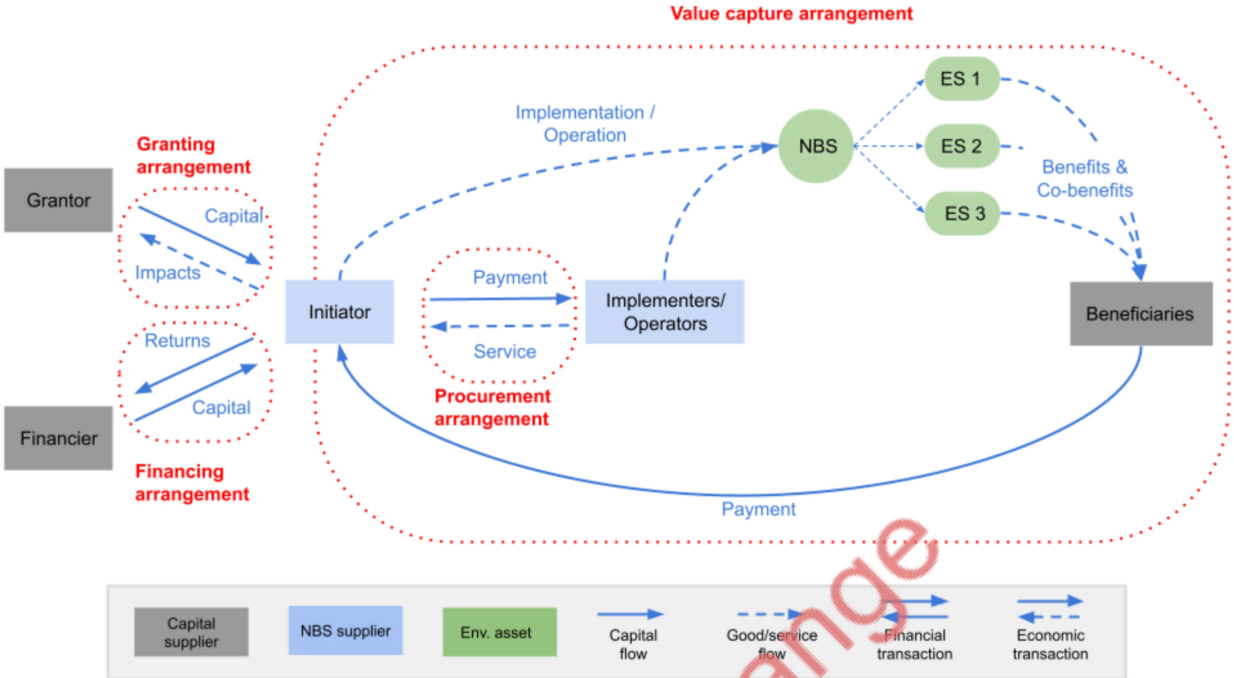

Figure 3.2 - Fundamental transactions and related financial arrangements in NBS projects.

A **financing transaction** allows a financier to provide capital to an initiator to cover up-front project costs. This capital needs to be repaid to the financier at a later moment in time, typically with interests. The initiator is the actor who manages project-level NBS finance and holds ultimate responsibility for its implementation. The financier is interested in making a productive use of its available capital, while also supporting the NBS.

The second type of transaction is the **granting transaction**, which occurs between the initiator and a grantor. The grantor, much like the financier, provides capital to the initiator, but this is not to be returned, and can be used to cover and pay the NBS implementation and operation costs. The third type of transaction is the **value capture transaction**. This transaction is aimed at establishing revenue streams, which turn the values and benefits generated by the NBS into cash-flows, typically by having identified beneficiaries contribute financially for the welfare they receive. Granting and value capture transactions fall under the broader category of **funding**, which means paying for the NBS costs. NBS can be thus funded either *ex ante* through grants (i.e. granting transaction) or *ex post* through payments provided by the beneficiaries of the NBS (i.e., value capture transaction). Funding further allows to acquire the capital required to repay financiers.

The fourth and last type of transaction is the **procurement transaction**, which outlines the acquisition and delivery of resources and services needed for the realisation of the NBS through the subcontracting of specialised actors.

More detailed information regarding the fundamental types of transaction involved in NBS projects can be found in D3.1.

3.2.3. Alignment between transactions properties and financial instruments

Since (formal and informal) constraints reduce the costs of human interaction when information is limited (North, 1990), "**Transaction costs are economised by assigning transactions (which differ in their attributes) to governance structures (the adaptive capacities and associated costs of which differ) in a discriminating way**" (Williamson, 1985, p. 18). Key governance structures in this sense are contracts, which constitute tools for aligning the interests of parties who may have conflicting objectives when conducting transactions. Each type of transaction is thus assigned to a corresponding contractual arrangement (financing arrangement, granting arrangement, value capture arrangement, procurement arrangement), which establishes formal constraints for the efficient governance of the underlying transaction.

In practice, the efficient conduction of these transactions is hindered by the presence of financial barriers. In particular, as mentioned in section 2.1, NBS projects over-rely on granting arrangements mainly from public sector sources (UNEP, 2022). Financing arrangements to convey investments in NBS and value capture arrangements for the generation of cash flows are often missing.

Tailoring financial arrangements to align with the specific properties of underlying transactions enables the removal of financial barriers presented by those properties, and the achievement of more efficient transactions (Hagedorn, 2008). Based on this, we therefore hypothesise that financial innovation that adapts financial arrangements to the properties of the underlying transactions can be a solution to overcome those financial barriers that arise due to said transaction properties, thus allowing an efficient execution of NBS business models.

3.2.4. Core properties of nature-related transactions

In the transaction cost literature the following three core properties of transactions are generally listed as influencing transaction costs (Williamson, 1979):

1. **Frequency**. The frequency of a transaction refers to how often it occurs. Frequent transactions tend to have lower transaction costs because parties acquire knowledge, standardised processes can be established, and the need for continuous negotiation is reduced. In contrast, infrequent transactions may require more negotiation and information gathering for each occurrence, leading to higher transaction costs. For example, a manufacturing company that regularly purchases large quantities of raw materials for its production process engages in periodic, bulk purchase transactions with its suppliers. In contrast to one-time purchases, long-term contracts and the negotiation of favourable terms are possible due to the predictable and regular nature of the transaction.

2. **Uncertainty**. Uncertainty in transactions relates to the level of risk and unpredictability involved. High uncertainty transactions typically result in higher transaction costs due to the need for more extensive information gathering, risk mitigation measures, and potentially costly enforcement mechanisms. For example, a company engaging in an international business transaction with an entity located in a politically unstable country will need to invest in extensive due diligence to mitigate the uncertainty produced by factors such as currency exchange risks, regulatory uncertainty and possible enforcement issues.
3. **Asset specificity**. Asset specificity refers to how specialised the assets involved in a transaction are. Higher asset specificity can lead to higher transaction costs, as assets are not easily redeployed for other uses, the parties become more dependent on each other, and this dependence can lead to opportunistic behaviour. This, in turn, may necessitate more detailed contracts and monitoring, increasing transaction costs. For example, a supplier company's highly specialised production of a unique component crucial for a manufacturing company's product results in high asset specificity. This specificity creates a strong dependence on the supplier company, leading to the need for detailed contracts and continuous monitoring to prevent opportunistic behaviours.

These categories have been formulated in the context of industrial organisation, where transactions are highly modular and independent. Transactions that occur in NBS and other nature-related sectors display additional properties that emerge due to the interconnectedness and complexity of natural systems. Core (additional) characteristics of transactions that rely on natural systems include (Hagedorn, 2008; Thiel et al., 2016):

4. **Excludability**. Transaction costs are lower when access to environmental goods can be restricted and property rights are well-defined. Well-defined property rights and clearly delineated access rules reduce the potential for conflicts and the need for costly monitoring and enforcement. However, when access to environmental goods is open and non-excludable, transaction costs increase due to costly monitoring and enforcement activities, and high incentives to free riding.
5. **Rivalry**. When multiple users compete for a limited amount of environmental resources, rivalry can lead to higher transaction costs as negotiations, monitoring and enforcement are needed to manage conflicts over resource allocation, overuse and degradation.
6. **Separability**. Separability refers to the degree of functional interdependence of a transaction with other transactions that originate within the same biophysical system. Highly interconnected systems result in transactions with low separability, which in return require additional efforts in coordinating different activities.
7. **Modularity**. Modularity refers to the decomposability of structures of transactions, or the possibility to reduce a system in smaller sub-parts that are practically independent from one another. Modular structures allow for less complex transactions that can be managed more easily.
8. **Observability**. Observability refers to the degree to which transaction-relevant conditions, activities and outcomes can be monitored and assessed. The lower the

observability property, the higher the transaction costs will be for accessing these types of information.

9. **Dimensions of time and scale**. Time and scale dimensions play a critical role in transactions. Longer time horizons and larger spatial scales generally results in higher transaction costs. The former require long-term planning and coordination, and possibly adaptive management and periodic reassessment, while the latter might imply physical-relational distance (Thiel et al., 2016) and other coordination issues related to cross-scale dynamics.

3.3. Literature selection and coding

We reviewed the grey and peer-reviewed literature covering both the general literature on funding and financing NBS (for references see Sections 2.1 and 2.2), as well as the literature on specific NBS funding and financing case studies (for references see Annex 1).

Generation of a systematic list of financial barriers. In our literature review we used the 9 properties of NBS transactions listed in the previous subsection to systematically identify a list of financial barriers that can be effectively addressed through the implementation of innovative financial solutions. Financial barriers found in literature that originated from the same property of transaction have been clustered in our typology as financial challenges associated with a single, overarching financial barrier. Through this approach, we not only articulate key challenges in NBS finance, but also provide a framework for reviewing and analysing innovative financial solutions.

Selection of financial innovations. We consider proposed solutions to be innovative when they are not mainstream instruments within the coastal restoration sector. Due to its combinatorial and dynamic nature, financial innovation unfolds in a broad multitude of possible arrangements and variations (see Section 2.3) . As a consequence, it is impossible to exhaustively cover all financial innovation. Rather we focused on innovative financial instruments proposed in the existing NBS literature (Altamirano et al., 2021; Baroni et al., 2019; Brears, 2022; GPC, 2021; Kok et al., 2021; Marsters et al., 2021; Schletz et al., 2020; Somarakis et al., 2019, among others) that are supported by empirical evidence of practical implementation. We thereby focused specifically on innovations aimed at leveraging investments and other resources from the private sector, given the acknowledged potential for significant upscaling of NBS finance. We have therefore excluded from our selection innovative financial solutions such as (government intermediated) payments for ESS, debt-for-nature swaps, ecological fiscal transfers and crowd-funding as they are associated with the currently prevailing financial model based on public/philanthropic granting.

Coding of financial innovations. For each innovative financial solution found, we identified which innovative design features allow us the adaptation of contractual structures to the properties of underlying transactions, thus overcoming existing financial barriers. Furthermore, we coded contextual factors such as country, type of NBS, project size, project status, involvement of financial service providers and support of public/philanthropic granting. Finally, we recorded conditions to their applicability, i.e. factors that typically affect (positively or negatively) their implementation and transfer in other NBS projects, based on lessons learned from a collection of empirical evidence of practical implementations. An overview of the reviewed case studies is found in Annex 1.

Assessment of promising solutions for the REST-COAST Pilots. Our assessment of the potential transferability of innovative financial solutions to the REST-COAST Pilots was based on the conditions for applicability collected for each innovative solution from the reviewed case studies and NBS literature. We compared these factors with local conditions of each Pilot, based on information collected through questionnaires, past REST-COAST milestones and deliverable documents, as well as bilateral interviews with Pilot leaders.

4. Results

4.1. Financial barriers

Our review yielded seven distinct financial barriers, which are summarised in Table 4.1 and further explained below. In view of our theoretical framework, we believe these particular financial barriers can be successfully mitigated through the implementation of contractual governance, in particular by financial innovation.

Table 4.1 - Overview of Financial Barriers to private investment in NBS, with details on the type of NBS transaction affected and the properties of transaction that lead to the emergence of each barrier.

	Financial barrier	**Description**	**Affected NBS transactions**	**Properties of transactions**
1	High performance risks	Uncertainty in mapping and modelling ecosystem services flows, and consequently in projecting NBS impacts and revenues	☑ Granting ☑ Financing ☑ Procurement ☑ Value capture	Uncertainty, Frequency
2	Low measurability of impacts	Challenges in quantifying impacts, particularly for less-countable and instrumental services.	☑ Granting ☑ Financing ☑ Procurement ☑ Value capture	Observability, modularity
3	Site-specificity of NBS assets	Illiquidity of NBS-related investments due to their site-specificity, leading to hold-up problems, higher	☑ Granting ☑ Financing ☑ Procurement ☐ Value capture	Asset-specificity

		risks and higher transaction costs.		
4	Long lead time	NBS impacts and revenues are generated over a long time horizon, causing uncertainty and mismatched investors preferences	☑ Granting ☑ Financing ☐ Procurement ☐ Value capture	Dimensions of time and scale, Uncertainty
5	Insufficient project size	The small scale of NBS projects limits investment size and the involvement of larger investors	☐ Granting ☑ Financing ☑ Procurement ☐ Value capture	Dimensions of time and scale
6	Jointness	The multifunctionality of NBS imply interdependent and inseparable transactions that affects multiple stakeholders in different ways	☑ Granting ☑ Financing ☑ Procurement ☑ Value capture	Separability
7	Low revenues	The establishment and enforcement of exclusive ownership rights over some ecosystem services is difficult, leading to free-riding and reduced investment returns	☐ Granting ☐ Financing ☐ Procurement ☑ Value capture	Excludability

Financial barrier 1 - High performance risks:

Description: The transaction properties of uncertainty and low frequency translates to high performance risks in NBS. The ecosystem processes hosted by coastal environments follow particularly complex dynamics, as compared for example to terrestrial ecosystems such as watersheds and inland forests (Shilland et al., 2021). Data limitations and dynamic interactions amount to uncertainties in the mapping and modelling of ecosystem services flows, in particular when climate change and anthropogenic pressures are considered (Seddon et al., 2020).

Associated financial challenges: As a consequence of these challenges, the financial and non-financial performance risks of coastal NBS projects are rather high, with a negative impact on the overall risk-return profile.

Financial barrier 2 - Low measurability of impacts:

Description: The transaction properties of low modularity and low observability in ecological and social systems results in low measurability of NBS impacts. While new metrics and methodologies are being developed for the quantification of ecosystem services and the valuation of their impact (Bordt and Saner, 2018), significant gaps and challenges persist for intangible services such as biodiversity and cultural values (Mayor et al., 2021). The achievement of impact milestones, the demonstration of additionality and the objective assessment of the overall value generated by a NBS are therefore often challenging (Kedward et al., 2022).

Associated financial challenges: Low measurability of ESS results in higher risks and uncertainty in NBS transactions, thus worsening the NBS risk-return profile.

- Low measurability of ESS and related impacts represents a disincentive for those categories of investors that prioritise not only financial returns but also positive social and environmental investment outcomes. In other words, the inability to effectively measure and quantify the social and environmental benefits undermines their ability to assess the success and effectiveness of their investments
- Low measurability of ESS furthermore implies some limitations to contractual design. Since contractual arrangements often rely on clear and measurable indicators to set goals, define success, outline penalties and incentives, low measurability may hinder the ability of the parties to incorporate precise performance metrics into their contractual relations. Such circumstances introduce ambiguity and make it difficult to clearly define and enforce contractual obligations.
- Outcomes that are difficult to measure tend to be sacrificed when competing with other outcomes that can be easily quantified (e.g. provisional services, cost-saving and other financial goals) (Holmstrom and Milgrom, 1991), leading for instance to trade-offs between public interests and (private) cost-saving interests that could hinder cooperation.
- Low measurability of impacts can also lead to the emergence of principal-agent problems. Principal-agent problems resulting in moral hazard can arise when a principal (who delegates a task) cannot monitor the activity of an agent (who performs the task) nor assess its outcomes. This may result in conflicts of interests and moral hazard whereby the agent prioritises personal interests over those of the principal.

Financial barrier 3 - Site-specificity of NBS assets:

Description: Due to the transaction property of asset-specificity, NBS assets are site-specific. Due to the locally determined interactions between various ecosystem processes, landscape geography and human activities, NBS need to be designed and implemented in a site-specific manner, taking into account the unique characteristics and conditions of a particular location (Cohen-Shacham et al., 2019). Consequently, some of the investments deployed for the design and implementation of a NBS are specific to that project or site. Site-specific investments for a NBS project include the acquisition of physical assets such as the land to implement the NBS, but also intangible asset investments as in the case of research and information gathering regarding the specific features of the site.

Associated financial challenges: Site specificity of NBS assets contributes to worsening the risk return profile of investment by increasing risks and transaction costs to manage them.

- Site specificity of NBS makes related investment illiquid, as it is difficult to redeploy these to alternative productive uses or convert them into cash without losing significant value (Williamson, 1985). This represents a problem for investors because in case of necessity they would not be able to rely on a safe exit strategy and they would be exposed to losses (Cooper and Trémolet, 2019).

- Site specificity implies that NBS investments are difficult to scale by means of direct replications in other locations (EIB, 2023).
- Site specificity may also result in hold-up problems (Schmitz, 2001). A holdup problem occurs when the asset-specificity of an investment also implies specificity to the relationship with certain actors. In the case of NBS, this would typically be the relationship with the owner of the site, the suppliers of particular products, services or information, or other key stakeholders. These irreplaceable partners therefore acquire a disproportionate bargaining power once the illiquid investment is made, which could be exploited through an opportunistic renegotiation of contractual terms (Williamson, 1985).

Financial barrier 4 - Long lead time:

Description: The transaction property of long time scale results in long lead time in NBS investments. The restoration of degraded ecosystems and ecosystem growth are processes that require time to develop. Consequently, considerable time lag between the initial NBS investment and the generation of financial and non-financial outcomes generally occurs.

Associated financial challenges: Overall, time lags for project impacts contribute to the uncertainty of impacts and to worsen the risk return profile of investment by increasing risks.

- Longer time horizons require equally long-lasting financial commitments for ongoing development and maintenance costs (Mayor et al., 2021), as well as long-term research and monitoring to assess project success (Bayraktarov et al., 2016).
- Private investment opportunities are affected as the longer the time range, the greater the uncertainty surrounding ecosystem dynamics, policy and regulatory changes, market conditions, and other factors affecting project effectiveness and financial outcomes.
- The delayed generation of revenues and profits generally mismatches with investors' preference for near-term, competitive returns (Kedward et al., 2022).
- The long-term nature of NBS projects may require sustained cooperation and commitment from various stakeholders. Lack of trust among stakeholders, especially in the context of new partnerships, can constitute a financial barrier if there are doubts about the reliability of others in fulfilling their long-term commitments.

Financial barrier 5 - Insufficient project size:

Description: The transaction property of small spatial scale results in insufficient NBS project sizes. ESS produced by NBS typically span across different spatial scales (Gómez-Baggethun et al., 2013). Nevertheless, most NBS projects are characterised by small scales (EIB, 2023).

Associated financial challenges: Small project size, coupled with high risks, worsen NBS overall risk-return profiles.

- Lack of access to large-scale investment opportunities is one of the most relevant barriers that prevents asset owners and managers from increasing their natural capital investments (Cooper and Trémolet, 2019). Although the long-term liabilities of institutional investors align well with projects with long time horizons (Bisaro and Hinkel, 2018), small investment sizes and related low rates of return do not fit with the requirements of institutional investors (Mayor et al., 2021).
- Transaction costs are high relative to project size and project revenues, and hence worsen the risk-return profile of smaller-sized projects, due to constrained budgets and the lack of economies of scale (EIB, 2023).

Financial barrier 6 - Jointness:
Description: The transaction property of low separability results in problem of jointness in NBS. Multifunctionality, i.e. the joint production of multiple ESS, is one of the distinguishing features of NBS. Each ESS produces its own set of benefits (and disbenefits), which have an impact on specific groups of beneficiaries. The fact that multifunctionality leads to interdependent and inseparable transactions is known as the problem of jointness (Hagedorn, 2008).

Associated financial challenges: Jointness in NBS requires coordination efforts, thus resulting in higher transaction costs.

- Each ESS can potentially be subject to its own property right regime (access, management, withdrawal, exclusion, alienation rights), so the interdependencies between the flows of ESS and the related transactions can result in a complex legal and administrative environment.
- In addition to co-benefits, ESS can result in disbenefits for certain stakeholders (Ommer et al., 2022), for instance due to increased pollen and/or mosquitos, or social displacement due to increased property prices. The inseparability of NBS benefits and disbenefits may result in conflicts and trade-offs, thus requiring coordination efforts.
- Due to multiple, distributed NBS benefits that yield low returns, the diversification and stacking of multiple sources of funding and financing is considered as an useful approach to cover all relevant activities and potential values (Earth Security, 2021; EIB, 2023; Eiselin et al., 2022). However, coordinating multiple funders and financiers can be a complex and time-consuming challenge (Kedward et al., 2022), as different funders and financiers may have different criteria and conditions for supporting or investing in a project. In particular, the coordination of private and public preferences is particularly delicate due to the existence of trade-offs between profitability and welfare generation (Toxopeus and Polzin, 2021). The initiator might therefore have the capacity to secure a first source of funding, but lack the resources and/or the financial know-how to organise and coordinate further arrangements.

Financial barrier 7 - Low revenues:
Description: The transaction property of low excludability results in distributed benefits and low revenues. Some ESS are characterised by low degrees of excludability (Altamirano et al., 2021). Non-excludability implies that it is difficult to establish exclusive ownership rights over the service.

Associated financial challenges: This characteristic creates challenges for private investment because of the inability to charge beneficiaries for the services they receive, and the high incentives to free ride (Toxopeus and Polzin, 2021). Without the ability to capture the full financial value of the NBS, private investors may find it difficult to generate sufficient returns on their investment. Difficulties in establishing and enforcing property rights regimes thus can worsen the risk-return profile of a NBS investment by amplifying transaction costs or by preventing the capturing and monetization of certain co-benefits.

4.2. Financial innovations

4.2.1. Overview

Our review of financial innovation identified 10 different types of financial innovations. This section will delve into the description and analysis of each instrument, specifically focusing on how they address various financial barriers. Empirical evidence showcasing the successful integration of these instruments within (coastal adaptation) NBS will be provided (with reference to the annexed case study database), along with contextual conditions of applicability experienced across the different case studies. An overview of the reviewed case studies is found in Annex 1.

The case studies identified cover a diverse range of instruments that span different financial functions (financing, granting, value capture, procurement), geographical regions (North America, Latin America, Europe, Africa, South-east Asia, Oceania) and types of NBS (Mangrove restoration, seagrass restoration, beach nourishment, green corridors, reforestation, etc.) (Table 4.2).

Table 4.2 - Overview of main innovative financial instruments identified

	NBS Transaction affected:	(Collected evidence) Implemented in:	
Green Bonds	Financing	Europe, Africa, North America	Ecosystem restoration, coastal adaptation
Environmental Impact Bonds	Financing	North America, Africa	Stormwater management, ecosystem restoration
Project Bundlings	Financing Granting	South-east Asia, Africa, Latin America	Ecosystem conservation and restoration, coastal adaptation
Smart contracts	Financing Granting Value capture Procurement	South America, Europe, Africa, South-east Asia	Reforestation, Ecosystem conservation
Blockchain tokens	Financing Value capture	Africa, Oceania, Latin America, Europe, South-east Asia	Reforestation, sustainable agriculture, ecosystem restoration
Public Private Partnerships	Financing Procurement	Europe, Oceania, North America	Beach nourishment, green corridors
Carbon credits	Value capture	South-east Asia, North America, Latin America, Africa	Mangrove, seagrass and wetland restoration, reforestation
Eco-labels	Value capture	South-east Asia, Latin America, Africa	Sustainable fisheries, mangrove restoration, ecosystem restoration
Ecotourism user fees	Value capture	Latin America, Oceania	Marine and coastal ecosystem conservation
Betterment levies	Value capture	North America, Europe	Beach nourishment, coastal adaptation

4.2.2. Green Bonds

Description: Bonds issued to raise capital for projects with specific environmental benefits. Funds raised from their issuance are earmarked for projects that promote sustainability, address climate change, and have a positive impact on the environment. Criteria for labelling are set in dedicated standards, and compliance is verified by independent third parties.

Innovative features addressing financial barriers: Project initiators can use green bonds to demonstrate their commitment to pursuing environmental sustainability. At the same time, the green bond standard reassures financiers of the genuinity of a project that would otherwise be questionable of green-washing due to the low measurability of outcomes and the low monitorability of agents (Financial barrier 2). Green bonds can enhance investor confidence in investing in NBS projects, particularly for those who may not be familiar with the NBS approach. The well-known green bond standard provides investors with a familiar framework and clear guidelines, instilling trust and reassurance in their investment decisions. As tradable debt instruments, green bonds are also rather liquid financial assets (Financial barrier 3), and performance risks are for the most part shifted to the issuer, who can rely on revenues external to the project to repay financiers (Financial barrier 1).

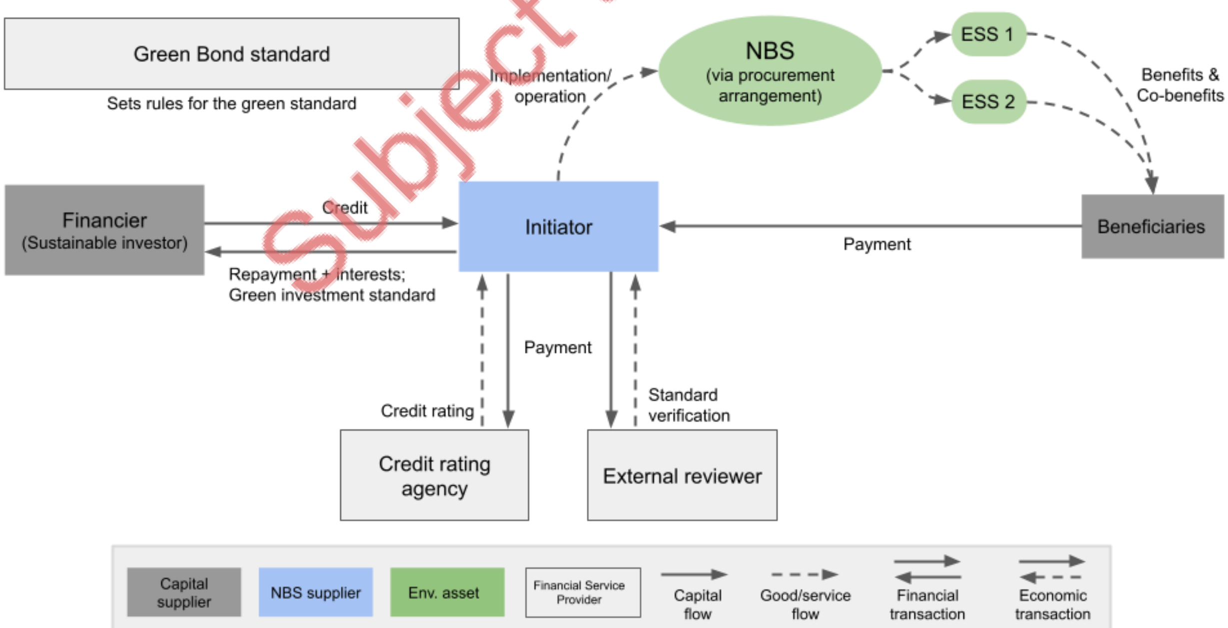

Figure 4.1 - Transactions involved in a Green Bond

Empirical evidence: Green bonds have been implemented in different ways for the financing of NBS. One of the major cases of implementation has been the sovereign green bond issued for the “Netherlands Delta Program”, which financed a comprehensive array of green and grey infrastructures specifically targeting coastal adaptation (Case study 1). In other cases, such as in the Seychelles (Case study 2) and the Baltic region (Denmark, Finland, Iceland, Norway, and Sweden) (Case study 3), the specific targeting of coastal and marine areas of intervention has been made explicit by issuing “blue bonds”. Blue bonds are a subcategory of green bonds where proceeds are dedicated to the protection and conservation of marine ecosystems. Utilities and municipalities have also issued green bonds, as in the case of a green bond issued by the Central Arkansas Water drinking water utility to improve water quality through a NBS approach (Case study 4).

Conditions to applicability: The compliance of NBS projects with the criteria set out in the prevalent green bond standards should not pose major barriers. This is due to the fact that NBS, whose aim is to address environmental and other societal challenges through sustainable practices and natural assets, are well-aligned with common requirements of green taxonomies (European Commission, 2022). However, there are other challenges that need to be addressed.

The issuance process of green bonds requires significant financial capacity and resources to cover upfront and ongoing transaction costs for green labelling and the associated certification, reporting, verification and monitoring obligations. These costs can pose a barrier for small to medium-sized projects, which is often the case with NBS (Financial barrier 5). To achieve the required size for cost-effectiveness (€15-100 million), it may be necessary to bundle multiple projects together into a single bond (Tuhkanen, 2020). The "Netherlands Delta Program" serves as an example of this approach. Since most of these costs are incurred during the setup process, further issuances could benefit from economies of scale, which would be attractive to governments committed to long-term adaptation and NBS upscaling (OECD, 2015).

Another common issue is that a high credit rating of the issuer is needed for the green bond to be attractive to investors. For issuers with insufficient credit ratings, development banks and conservation funds can provide credit enhancement instruments such as guarantees to reduce interest rates. The Seychelles' issuance of a national blue bond is an example of this solution, made possible through the de-risking support of the World Bank, the Global Environmental Facility, and other financial institutions (Case study 2).

Transferability to REST-COAST Pilots: With regards to the transferability of green bonds in the REST-COAST project, the lack of value capture arrangements and the limited ticket size constitute major barriers. As a consequence, this type of financial arrangement will be most relevant in the co-development of financial scalability plans (T3.3.3), as at this stage funding models and sources will have been identified (T3.3.1) and translated into business plans (T3.3.2), and it will be possible to adopt a larger scale and longer term perspective.

4.2.3. Environmental Impact Bonds

Description: Debt instrument that incorporates pay-for-success mechanisms which links the arrangement's interest rate to an indicator representing the level of performance reached by the project. If the indicator fails to reach a predetermined threshold, a below-market rate of interest will be applied, while if expectations are exceeded and the threshold is reached, a higher interest rate will reward the investors.

Innovative features addressing financial barriers: Environmental Impact Bonds (EIB) shift part of the risk of project performance from the initiator to the investors (Financial barrier 1), which are rewarded in the case of overperformance. The transfer of risks is particularly beneficial when private investors have the possibility to leverage specific financial capacity and other types of expertise to absorb and effectively manage the risk (World Bank Group, 2017). In particular, (additional) a pay-for-success mechanism could be applied in the procurement arrangement (EDF, 2018), providing incentives for a delivery of effective restoration that mitigate principal-agent problems (Financial barrier 2).

One of the most attractive features of an EIB for impact investors is the commitment of the issuer to post-implementation impact measurement and disclosure, as auditing and monitoring processes are pre-arranged and included in the structure for service delivery (Financial barriers 1 and 2) (Hall et al., 2017). The fact that the process of identifying, achieving and measuring the performances of NBS is systematically monitored and documented makes EIB a very useful instrument in the generation of comparable data that can be transferred to other projects.

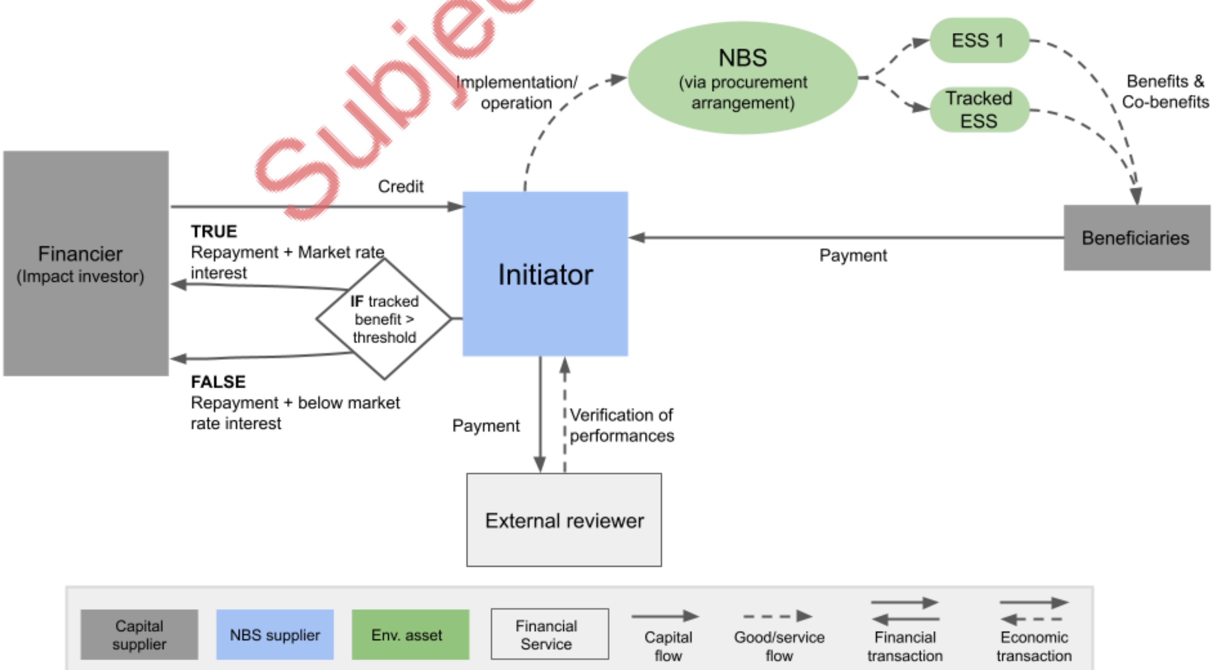

Figure 4.2 - Transactions involved in an Environmental Impact Bond

Empirical evidence: The first EIB, the DC Water Bond, was issued in 2016 with the goal of reducing stormwater risks through a NBS approach (Case study 5). Quantified Ventures, the provider of financial services for outcome-based finance who designed and structured the arrangement, replicated it successfully for NBS stormwater management in Hampton, Buffalo, and Atlanta (Case studies 6, 7, 8). The Atlanta EIB in particular was the first impact bond to use a public offering, i.e. was available for purchase by the general public. An EIB for coastal wetland restoration was also structured in Louisiana (Case study 9), but unfortunately the implementation phase was never reached due to changes in the political context. An EIB was also deployed in California to secure private investments for the financing of forest restoration along the Yuba watershed. Repayments to investors were contingent on project performance, and were paid by public agencies who benefited from the fire risk reduction and the downstream water quantity and quality improvements (Case study 10). Outside the USA, EIBs have been developed in Canada (Case study 11), South Africa (Case study 12) and (proposed in) New Zealand (Case study 13).

Conditions to applicability: EIBs are particularly complex financial mechanisms that require substantial financial know-how, and therefore the involvement of specialised financial service providers with experience in structuring performance-based financing arrangements need to be involved. Associated high transaction costs might limit the scope of EIB to larger projects (Financial barrier 5). At the same time, investors prefer simple and familiar kinds of financing arrangements, so it is generally advisable to avoid over-complicated EIB structures that would be costly for financiers to analyse (EDF, 2018).

As financial outcomes are contingent on a particular ESS outcome, the identification of adequate performance metrics is a crucial step in the development of an EIB. Targeted ESS should be a) Directly attributable to the NBS b) highly valued by stakeholders (and investors); c) Easily measurable and verifiable (Financial barrier 2). Proxy metrics might be used to overcome measurability issues, when deemed satisfactory by investors and stakeholders.

When the aim of the NBS is to avoid future damages and costs, EIBs could represent a fitting solution (Hall et al., 2017). In several case studies (Case studies 5, 7, 8, 9, 10), this circumstance allowed the initiator to fund the EIB's higher financial rewards to investors using part of the cost savings incurred due to the project's good performance.

Transferability to REST-COAST Pilots: With regards to the transferability of green bonds in the REST-COAST project, the lack of value capture arrangements and the limited ticket size constitute major barriers. As a consequence, this type of financial arrangement will be most relevant in the co-development of financial scalability plans (T3.3.3), as at this stage funding models and revenue sources will have been identified (T3.3.1) and translated into business plans (T3.3.2), and it will be possible to adopt a larger scale and longer term perspective. Nevertheless, funding arrangements (granting and value-capture) that integrate similar outcome-based mechanisms could be considered for the development of tailored financial arrangements (T3.3.1) built on simple transactions (e.g. a single ESS output and a single paying beneficiary), especially in those cases where restoration ESS result in measurable future cost savings and damage avoidance for a certain stakeholder.

4.2.4. Project bundling

Description: Aggregation of distinct yet complementary projects into a single investment product. In practice, this approach is often implemented in the form of a restoration fund or trust which, on top of financing and granting an aggregation of similar projects, pools and manages capital from different sources.

Innovative features addressing financial barriers: By bundling projects together, the risks related to the individual NBS projects are diversified, which reduces the overall risk and hence provides a more attractive investment opportunities (Financial barrier 1). NBS can also be bundled with projects from other sectors with more predictable cash-flows (e.g. energy efficiency, climate change mitigation, water management etc.) in order to diversify risks and adapt the overall risk-return profile of investment to the preferences of financiers. In particular, green-grey hybrid projects can enhance investors' confidence by combining the best characteristics of both nature-based and conventional infrastructure approaches at site level (Seddon et al., 2020; Sutton-Grier et al., 2015). Moreover, bundling projects increases overall ticket sizes, unlocking economies of scale and enhancing the financial viability of NBS initiatives (Financial barrier 5). Financing NBS through project bundling and restoration funds can also be an effective approach to overcome obstacles related to the lack of market maturity, as mainstream investors are familiar with funds and their risk-diversification mechanisms (Credit Suisse, 2016).

In practice, funds that bundle several projects are often structured as to offer different tiers of investment products, opening up the possibility of adopting blended finance approaches, whereby granting and concessionary capital are strategically deployed to provide credit enhancements and guarantees (Süring et al., 2021). This, in turn, attracts additional commercial and impact investments to participate in less exposed tranches (Financial barrier 1).

Empirical evidence: The Netherland Delta Program, along with the other examples highlighted in the "green bond" section (section 4.2.1), serve also as case studies that demonstrate the value of aggregation of diverse projects encompassing different revenue structures and impacts (Case Study 1).

The bundling of projects and the pooling of their revenues into structured financial products is often carried out by impact investment funds committed to the restoration and conservation of nature. Among other examples, the Fondo Acción in Colombia (Fondo para la Acción Ambiental y la Niñez) (Case Study 14) and the Althelia's Climate fund and Madagascar climate and conservation investment fund (Case study 15) rely on a diversified portfolio of adaptation, mitigation and restoration projects that aim at both positive socio-environmental impacts as well as sustainable financial returns.

According to Conservation Finance Alliance's 2020 report review on Conservation Trust Funds (Bath et al., 2020), more than 45% of the funds covered by the study invests in the conservation and restoration of coastal and marine ecosystems. Examples of funds that target marine and coastal areas specifically can be found. The Meloy Fund by Conservation International and Rare (Case study 17) makes debt and equity investments in businesses related to coastal ecosystems, mostly fisheries and aquaculture, to improve their business practices, their supply-chain and to reduce pressures on coastal ecosystems. Increased productivity and product quality (e.g. through eco-labels) allow to fund investors' return on investments. Another example is the Althelia's Sustainable Ocean Fund (Case study 16), which invests through loans and equities in a portfolio of sustainable seafood, blue circular economy and ocean conservation projects, catalysing private investments with the support of USAID's guarantees. Pooled revenues are generated via improvement of productivity, market access and quality of small sustainable businesses and tourism user fees for marine protected areas' (MPA) access.

Conditions to applicability: Net of the risk diversification effect, projects included in a bundled portfolio need to be financially viable and profitable (generating revenues) (Rode et al., 2019). In other words, each project should contribute positively to the financial performance of the bundled portfolio. Financial expertise is a determining factor for successfully combining various NBS projects to generate collective revenues and mitigate risks. Real-world examples demonstrate that the capacity to consolidate assets and create financial products that align with investor expectations is primarily accessible to large entities such as governments and major corporations capable of issuing green bonds, and specialised restoration investment funds. Project initiators without the know-how and resources to bundle projects and structure financial products would need the support of financial intermediaries. Bundling several smaller projects into a larger investment product also entails more complex coordination challenges across a larger and more diverse set of stakeholders (Financial barrier 5). Different projects may also have different timeframes for delivering value and returns on investment, which may represent a disincentive for investors with different expectations. Generally speaking, homogeneous projects with respect to ESS delivered, type of NBS, used methodologies etc. are easier to bundle than highly specific and diverse projects (Financial barrier 3).

Transferability to REST-COAST Pilots: With regards to the transferability of project bundling in the REST-COAST project, the lack of value capture arrangements constitutes a major barrier. As a consequence, this type of financial arrangement will be most relevant in the co-development of financial scalability plans (T3.3.3), as at this stage funding models and revenue sources will have been identified (T3.3.1) and translated into business plans (T3.3.2), and it will be possible to adopt a larger scale and longer term perspective. External support for the aggregation of different projects will be necessary. The identification of a set of analogous projects, for instance in terms of ESS produced or used methodologies for performance measurement, as well as the involvement of financial intermediaries for their aggregation will be needed.

4.2.5. Smart contracts

Description: Blockchain-based applications that automatically execute (part of) a contractual agreement based on predefined algorithmic rules. Once the pre-codified set of inputs are provided (e.g. sensors' measurements, digital index value, digital signals provided by human agents etc.), a defined action is executed automatically and irreversibly.

Innovative features addressing financial barriers: The automatic execution of pre-established coded rules in smart contracts brings several advantages. Firstly, it prevents renegotiations as the terms specified within a smart contract are unalterable once the original agreement is made (Halaburda et al., 2019). This eliminates the risk of hold-up problems (Financial barrier 3), as actors cannot redefine contractual terms from a dominant bargaining position after the fact (Casey and Niblett, 2017). Secondly, it prevents contract breaching, as the specified conditions trigger the automatic execution of pre-established actions. This eliminates the need for trust among contracting parties or the need for legal measures to secure obligations, such as collaterals, remedies, and guarantees, and removes the requirement for involving third parties for judicial enforcement (Financial barrier 4) (Savelyev, 2017). Lastly, smart contracts lower contract monitoring costs. The digitally encoded predetermined inputs that initiate the implementation of the agreement leave no room for dispute regarding compliance with the contractual terms (Halaburda et al., 2019). Because of these unique features, smart contracts have been indicated as innovative instruments for the structuring of reliable performance-based contracts in contexts of low governance standards (Somarakis et al., 2019). The elimination of intermediaries can bring considerable reduction in transaction costs, thus improving the risk-return profile of NBS, with particular benefits to smaller-sized projects (Financial barrier 5) (Czura, 2022).

Empirical evidence: Smart contract implementation in NBS is currently in the early stage of development. A number of case studies such as the Regen Network (Case study 18), GainForest (Case study 19) and FLRChain (Case study 20), highlight the pursuit of enhancing transparency, incentives and efficiency in granting arrangements. The FLRchain Pilot in particular highlighted how smart contracts can be a useful tool to reduce transaction costs facilitating implementation and aggregation of small-size restoration.

Attempts at integrating smart contracting in financing arrangements have also been made, specifically for the structuring of green bonds that rely on immutable agreements and certain compliance (Case study 21, Czura, 2022; Zhang et al., 2018).

Conditions to applicability: While the advantages of the reduction of transaction costs and the prevention of renegotiation align particularly well with the site-specific nature of NBS, it is important to consider the limitations of smart contracts. One of the prerequisites for smart contracting is an *ex ante* and precise specification of future contingencies and outcomes, which may pose significant implementation challenges in the context of NBS where, as discussed, uncertainty and complexity are typical features (Financial barriers 1, 2 and 4) (Howell and Potgieter, 2019). However, in cases where simple, short-term and deterministic transactions can be identified within the NBS project, smart contracts might indeed be a viable option to consider. In the FLRchain case study, for instance, while the transaction for rewarding individual tree planting was successfully codified and automated, the development of smart contracts to fund more complex and long-term ecosystem management activities has proven to be a difficult task (Mulley, 2022). The case of blockchain-based green bonds faced similar challenges, and the verification process was still carried out through standard third party validation (Czura, 2022).

While smart contracts have not yet gained extensive adoption in NBS projects, their distinctive characteristics provide new opportunities to align financial arrangements to some of the key financial challenges we have identified. As a result, we can anticipate further experimentation and broader dissemination of smart contracts within the NBS domain in the future.

<u>Transferability to REST-COAST Pilots</u>: With regards to the transferability of smart contracting in the REST-COAST project, the key challenge would be the identification of simple, predictable, preferably repeatable transactions based on straightforward measurements. Given its highly innovative nature, the experimentation of smart contracting within REST-COAST would greatly contribute to the understanding of the potential of such arrangement in the domain of coastal restoration.

4.2.6. Blockchain Tokens

<u>Description</u>: Digital tokens that can be stored and transferred on blockchain platforms, which represent (tangible or intangible) assets. The value of the tokens is directly tied to that of the represented asset. A wide range of additional information such as legal status and environmental and social indicators can also be attached.

<u>Innovative features addressing financial barriers:</u> One notable advantage of blockchain tokens is their capacity to enable fractional ownership. By dividing assets into smaller units, tokens allow individuals to own a fraction or share of an asset that may have been otherwise inaccessible due to high costs or regulatory constraints. This fractional ownership model increases accessibility to assets, unlocking opportunities for a broader range of investors to participate in markets traditionally dominated by larger entities. The tokenisation of NBS projects can also help them access affordable finance, as blockchain has the ability to reduce the high transaction costs typically associated with small project scales (Financial barrier 5) (Uzsoki, 2019).

By leveraging blockchain technology, which ensures transparency, security, and immutability, tokenized assets can be traded efficiently and securely on decentralised platforms. This facilitates cheaper and seamless transactions, lowers barriers to entry, with positive effects on market liquidity (Financial barrier 3) (Schletz et al., 2020).

Empirical evidence: Overall, blockchain tokens are still an experimental solution in the domain of coastal restoration, and practical implementation is limited to very few case studies. A range of tokens have been developed for carbon emission offsetting via blockchain transactions (Kotsialou et al., 2021), including via coastal restoration (Case study 22). Another offsetting application, although less frequent, consists in the tokenisation of biodiversity credits. The Commonwealth Bank of Australia, in collaboration with the firm BioDiversity Solutions Australia, has developed BioTokens representing positive biodiversity impacts of restoration projects (Case study 23). These BioTokens can be traded transparently and in a verifiable way within the New South Wales Government's Biodiversity Offset Scheme transactions.

Tokens have also been implemented as tools for project financing and for the generation of revenues for the investors. One example is Treecycle, a project that developed and deployed blockchain security tokens for sustainable Eucalyptus plantation in Paraguay (Case study 24). Digital tokens representing fractional ownership of planted trees are issued and sold to investors. Revenues generated through the harvesting and sale of trees are later shared with investors as dividends, while a portion of these is reserved for reinvestments in further reforestation. Despite the existence of projects reporting the implementation of blockchain tokens for nature restoration and conservation, these are for the most part in proposal or Pilot stages, and data on financial and non-financial outcomes from their implementation is lacking.

Conditions to applicability: Most jurisdictions have not yet produced comprehensive and coherent regulatory frameworks for digital tokens and other blockchain-based technologies. The regulatory uncertainty and ambiguity regarding tokenised securities has been identified as a major obstacle to their diffusion as an innovative financial solution. In order to ensure regulatory compliance, current initiatives often choose to combine blockchain applications with off-chain components, while making an effort in retaining (most of) the value proposition of tokenised assets (Uzsoki, 2019).

Transferability to REST-COAST Pilots: At the present time, we cannot rely on sufficient information regarding enabling conditions and barriers to the implementation of blockchain tokens, nor on comparable data regarding their performance in attracting financial investments. It is therefore difficult to assess the transferability of these solutions to the REST-COAST project. Nevertheless, given its highly innovative nature, the experimentation of blockchain tokenisation within REST-COAST would greatly contribute to the understanding of the potential of such arrangements in the domain of coastal restoration.

4.2.7. Public-private Partnerships

Description: Cooperative partnership between a government or public sector agency and a private sector entity for the provision of public services or infrastructures. They are characterised by long term, bundled contracts, functional/performance indicators rather than technical requirements, and sharing of risks and financial responsibilities.

Innovative features addressing financial barriers: One of the most important advantages brought by PPP is the optimal allocation and sharing of risks, in that risks are assigned to the party that can best manage them (Financial barrier 1) (World Bank Group, 2017). The private partner of a PPP usually bears significant risk and management responsibilities throughout the contract's lifespan (e.g. design, construction, operation and maintenance, financing cost), while the government retains the ultimate responsibility for service quality (project specifications) and residual categories of risks that cannot be properly managed by the private partner of the PPP (e.g. regulatory risks, uninsurable "act of nature" risks) (De Palma et al., 2012). Against the relatively high upfront costs of drafting such a complex contract, the bundling of multiple project aspects into a single contract reduces subsequent transaction costs due to more efficient and stream-lined project management, decision-making and coordination (Financial barrier 8). Bundling several small contracts into a single, larger call for tender also increases the overall contract value, therefore increasing the likelihood of attracting experienced and qualified suppliers who might otherwise overlook smaller contracts (Financial barrier 5) (European Commission, 2020). The delegation of major responsibilities to the private partner for project risks, such as construction, maintenance, and operational risks, reduces the burden of performance risks that is typically shouldered by the public sector (Financial barrier 1) (Matsumoto et al., 2021). Once again, the private partner's business-oriented approach and expertise in risk management enable them to address these risks effectively, resulting in better resource allocation and reduced transaction costs.

The bundling of contracts and the long-term relationship is also aimed at achieving an alignment of interests among the partners through a whole-life cost approach (Financial barrier 5). Whole-life costing consists in the evaluation of the total costs associated with the project over its entire lifecycle, incentivising the private partner to deliver a project that is cost-effective and effective in the delivery of services. Under a standard procurement arrangement the private contractor has an incentive to save costs, at the expense of the quantity and/or quality of service delivered by the project. By including construction, operating, and maintenance costs in the cost evaluation and contractually formalising the commitment to project performances, the interests of the public and private sectors are aligned, facilitating long-term value for money (Matsumoto et al., 2021).

Empirical evidence: PPP have been widely used by governments to deliver a range of public services (transport infrastructure, prisons, water management, etc.) (Riess, 2005). Nevertheless, implementation in ecosystem restoration and other NBS is rather scarce. Difficulties in monetizing the benefits of restoration, externalities, uncertainty of project contingencies, low measurability of ESS, along with the shortage of firms with experience in NBS supply, are all typical features of NBS projects that weaken the case for a PPP vis a vis traditional procurement contracting. Isolated case studies have been found for the realisation of beach nourishment (Case study 25), green corridors (Case study 26), sediment bypass (Case study 27), Flood-bank restoration (Case study 29), Urban riverfront flood protection (Case study 28).

Conditions to applicability: As we have said, PPP consists of complex contractual arrangements which come with high transaction costs. The main prerequisite for considering PPPs would therefore be that the benefits in terms of quality and volume of services provided outweigh additional costs involved (Financial Barrier 5). Factors that play a role in determining such an outcome include the economic and financial sustainability of the underlying project (Thomson, 2005), as well as the high potential for life-cycle cost savings (Riess, 2005). Meaningful competition in the PPP bidding process is a key determinant for the generation of cost savings and the share of these with service users. Due to the high commitment in terms of financial investment and planning demanded by PPP arrangements, fewer firms are expected to compete for the tender, as compared to traditional procurement calls. Lack of competition may therefore emerge as a contextual factor limiting the applicability of PPP (Bloomfield, 2006). Contractual complexity of PPP also means that amending them is expansive. Project should have well-defined scopes, definition and specification from the outset, in particular with regards to outputs (Thomson, 2005). Part of the complexity in PPP financial structures is given by the need to allocate risks and to manage the potentially diverging interests between public and private partners. In particular, in order to avoid potential trade-offs between service quality and cost saving benefits, the quality of public service (ESS in the case of NBS) should be relatively easy to contract on, i.e. measurable (Riess, 2005). More generally, clear performance metrics are important to guarantee accountability between public and private partners, and, since success is tied to meeting specific targets, to incentivise efficiency (Financial barrier 2).

Transferability to REST-COAST Pilots: With regards to the transferability of PPP in the REST-COAST project, these arrangements would acquire relevance only during the co-development of financial scalability plans (T3.3.3), as at this stage funding models and revenue sources will have been identified (T3.3.1) and translated into business plans (T3.3.2), and it will be possible to adopt a larger scale and longer term perspective.

4.2.8. Carbon Credits

Description: Financial assets that represent units of removal of greenhouse gas emissions from the atmosphere. Carbon credits, as well as the requirements for their issuance, are produced by dedicated organisations known as carbon standards, and verified by independent third parties. Carbon credits can be sold and retired to offset emissions, or held as financial assets.

Innovative features addressing financial barriers: Carbon credits are intangible financial assets that represent real, quantified and monetized amounts of sequestered carbon. As such, they constitute an innovative financial solution as they allow the assignment of clear property rights (carbon rights) and therefore the market trading of an ecosystem service, i.e. carbon sequestration, that would otherwise be a non-excludable global public good (Financial Barrier 7). In addition, the market of forestry-based carbon credits is fairly mature, and financiers would recognize the familiar structure of investments in blue carbon projects.

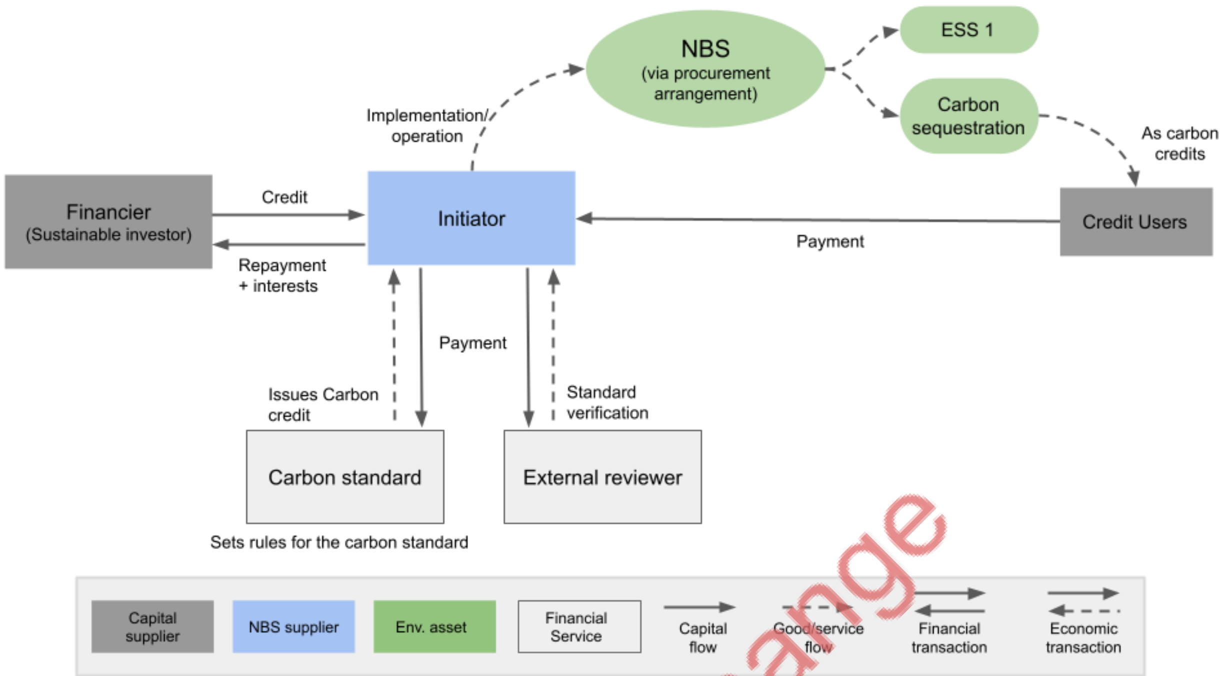

Figure 4.3 - Transactions involved in Carbon Credits

Empirical evidence: Overall, carbon credits represent one of the most diffused solutions for the generation of revenues in inland and coastal restoration projects, and they can rely on a rather mature market and consolidated standards. Carbon credits have been used extensively in inland reforestation projects (Van Der Gaast et al., 2018). More recently, coastal ecosystem restoration and conservation have also been used to issue carbon credits, also thanks to the development of dedicated accounting methodologies (VERRA, 2021, 2014). The vast majority of implementation relates to mangrove restoration (Case studies 30, 31, 33, 38), but cases of sea-grass (Case studies 34, 35, 36) and tidal wetland restoration (Case study 37) can also be found. Crediting of other ESS is also possible, as in the case of Biodiversity credits (Case study 23), although the related markets are not as developed as for carbon credits and typically rely on the existence of local/regional/national level markets established through public regulations.

Conditions to applicability: Clear information about project requirements is readily available due to the relative maturity of the carbon credit market (See IUCN 2021). Multiple standard methodologies for the issuance of carbon credits are available, including those specifically targeting blue carbon projects (Verra's VM0033, Verra's VM0007, Verra's VM0024, Clean Development Mechanism's AR-AM0003). Each methodology comes with specific project applicability conditions that must be verified by the initiator. While it is also possible to develop new, *ad hoc* methodologies, this usually substantially increases the costs and timeframes of the carbon project.

The development of carbon credits is a process that requires technical capacity, auditing, and contracting with third parties. Transaction costs incurred in carbon crediting are rather high, posing challenges to small to medium scale projects (Financial barrier 5) (IUCN, 2021).

Revenues from the sale of carbon credits must be greater than the sum of the costs for their development and a fraction of the overall project activity. An early estimation of the potential amount of carbon credit produced can be drafted with the tools provided by the methodology of choice, while expected sale price can be defined with the aid of market reports and potential buyers' willingness to pay (potential buyers should be identified and contacted early on).

Transferability to REST-COAST Pilots: With regards to the transferability of carbon credits in the REST-COAST project, these represent one of the most attractive options for the establishment of revenue streams, as methodologies for the quantification of carbon sequestration are being developed and their adoption across several Pilots is being considered. As such, carbon credits should be considered, when suitable, in T3.3.1. Given the average small size of the REST-COAST Pilots, the possibility to set up joint applications should be explored. In addition, other types of environmental credits (e.g. biodiversity credits as in Case Study 23) or offset arrangements (e.g. water footprint offsets as in the Rhone Delta Pilot) should be considered, in particular if regulatory programs establishing ESS markets exist locally or at national level.

4.2.9. Eco-labels

Description: Certifications applied to products, services, or practices in various industries to indicate that they meet specific environmental criteria or standards. The specific requirements are defined by a standard-setting entity and verified by an independent third party. Eco-labelled products are usually sold at a premium price, but can also serve as a marketing tool.

Innovative features addressing financial barriers: Eco-labels allow the establishment of additional revenue streams by linking the well-functioning market for provisional goods (e.g. fish, fibres, timber) with that of public goods whose value is difficult to capture (e.g. biodiversity, social well-being) (Ribaudo et al., 2010) (Financial barrier 7). The effectiveness of such an arrangement is solidified by the fact that consumers are familiar with the labelling of products and understand the underlying fundamental mechanism of linked provision (Froger et al., 2015).

The revenues generated through eco-labelling mainly depend on factors such as the type of label, the quality of the products, the market demand. Depending on the specific requirements of the eco-label standard, the intensity of ecosystem services tracked might not affect the price of labelled products nor revenues more generally (Le Coq et al., 2011) (Financial barrier 1). This is particularly evident when the certification of products is contingent on processes (adoption of sustainable production practices) rather than outcomes (ecosystem services and impacts), which are assumed as a consequence (Froger et al., 2015) (Financial barrier 2).

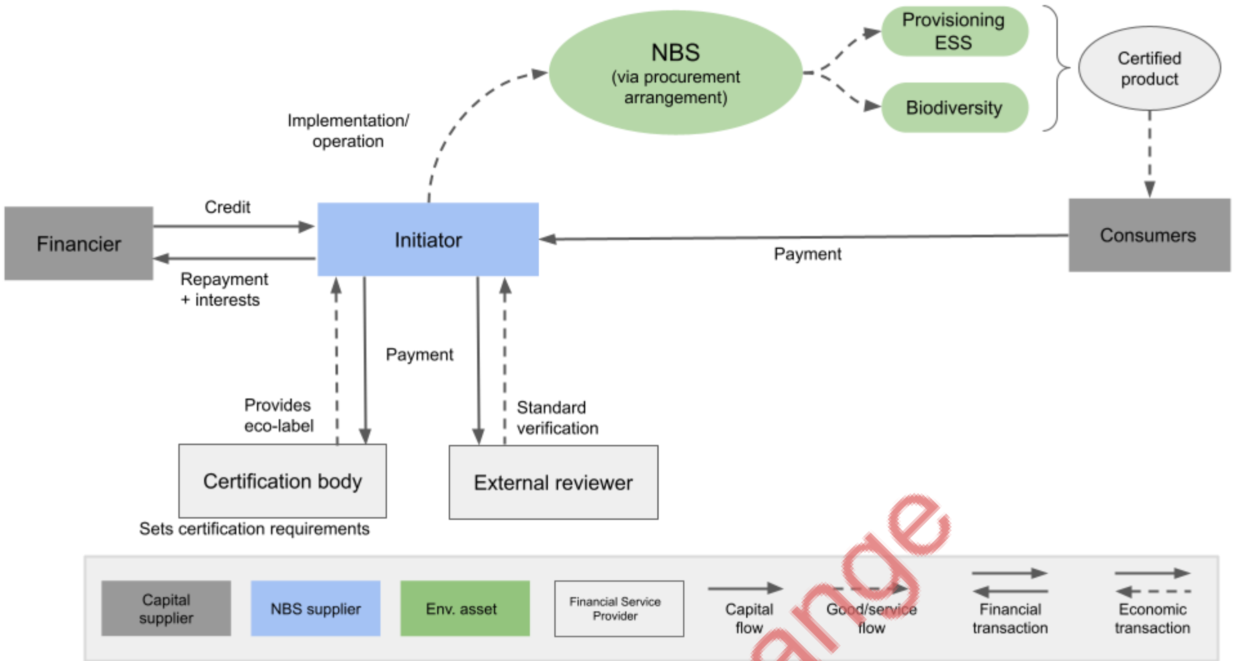

Figure 4.4 - Transactions involved in Eco-labels

Empirical evidence: While certification for food, forest and timber products are often found in inland conservation and reforestation projects (Case studies 4, 39, 48), the prevalent form of eco-label implemented in the context of coastal restoration is the certification of aquaculture products. Organic shrimps labels linked to mangrove afforestation in Vietnam (Case study 32), Indonesia (Case study 41) show the potential of this tool to achieve synergies among coastal restoration, improved business, and local communities' social resilience. Eco-labels have been used in combination with carbon credits (Case study 39), or as a better alternative to the same (Case study 32). Ecosystem restoration has also been targeted indirectly by fishery eco-labels by requiring the adoption of more sustainable business practices and therefore the reduction of pressures on the environment (Boyd et al., 2022, Case study 16). Examples of certification of sustainably managed beaches to attract tourists can also be found (Capacci et al., 2015), but the link to both ecosystem restoration and revenue generation is more indirect.

Conditions to applicability: Overall, eco-labels are a flexible instrument for marketing and capturing values related to restoration, and they come in a wide range of different certifications. The effectiveness of certifications relies on the assumption that consumers are willing to pay premiums for certified products, but this premise does not always hold true (Jaung et al., 2019). Therefore, eco-labels should be thoroughly studied on a case-by-case basis to assess their viability and impact (Agardy and Pascal, 2014). Eco-labels can be successful in setting up sufficient economic incentives for private actors to voluntarily implement restoration. However, a possible barrier in these cases could be the lack of environmental management skills (Purbawiyatna and Simula, 2008), or the trade-offs between the adopted sustainable practices for the production of provisioning ESS and other economic activities (Case Study 48). Private actors are particularly interested in the level of credibility of certifying bodies (Rode et al. 2019). Depending on the type of certification and its requirements, the size of the restoration project might be a relevant factor: in some cases, a smaller size could allow more detailed certification procedures and monitoring criteria. In other cases, stringent requirements for certification might result in high transaction costs, which could turn into a barrier for smaller projects if no external support is provided (Tacconi et al., 2004).

Transferability to REST-COAST Pilots: With regards to the transferability of eco-labels in the REST-COAST project, these could represent a viable option for the establishment of revenue streams, in particular if provisioning ESS are produced and a demand for certified products can be identified. As such, eco-labels should be considered, when suitable, in T3.3.1.

4.2.10. Ecotourism user fees

Description: Charges levied on visitors for the use of specific facilities, services, or attractions in a destination. As a value capture instrument for NBS, it is only relevant if revenues are earmarked for the funding of management and maintenance of the NBS. The size of the fee usually depends on the willingness to pay of users as well as the budgetary needs for the maintenance of the infrastructure.

Innovative features addressing financial barriers: The primary role of tourism user fees is of course that of generating revenues by capturing cultural/recreational values which are usually perceived as public goods (Financial barrier 7). In contrast to other forms of value-capture instruments, the implementation of user fees is relatively cheap and straightforward, at least in their most simple form (Emerton, 2006). Another important advantage is that they can generate revenues relatively shortly after the start of a NBS project (Financial barrier 4) (Pascal et al., 2021). In areas where tourism represents an important source of pressure on the environment, user fees can also be used as a visitor management tool to control and reduce the negative impacts of tourism on the ecosystems (Lindberg, 2001).

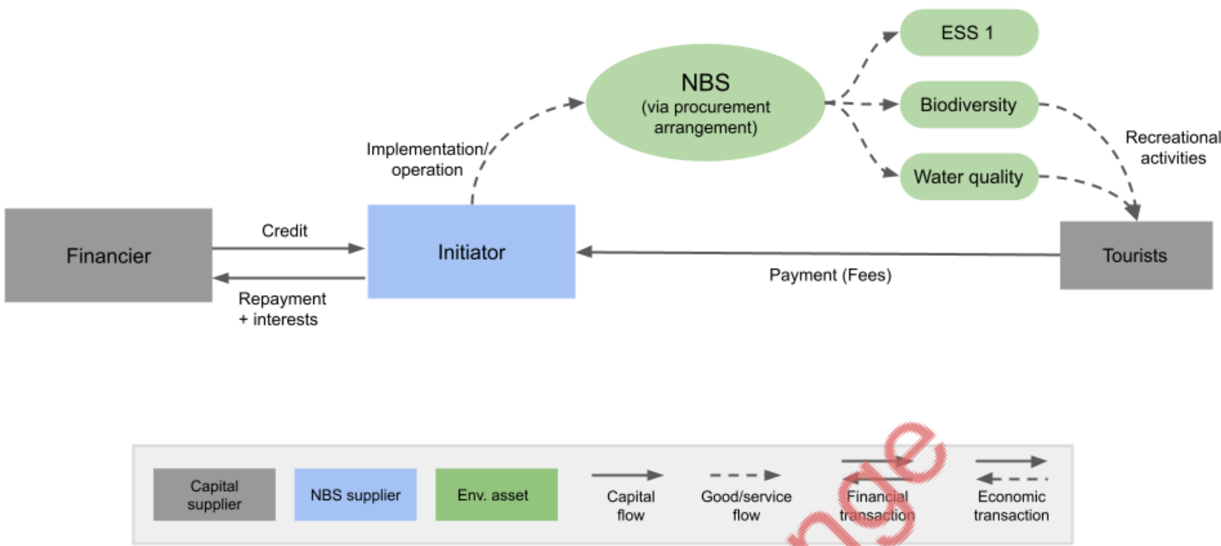

Figure 4.5 - Transactions involved in (eco)Tourism user fees

<u>Empirical evidence</u>: Overall, tourism user fees represent one of the most diffused solutions for the generation of revenues in inland and coastal restoration projects. Virtuous examples of user fees implementation are usually found in MPA, which represent for most visitors a trademark for a pristine marine environment (Pascal et al., 2021). Under particularly favourable environmental and market conditions, natural parks such as the Bonaire marine park and the Galapagos National Park (Case studies 42 and 43) could develop well structured user fee schemes that cover a large part of the environmental management financing needs. Outside of MPA and temperate regions, however, empirical evidence of successful tourism user fees is scarce, and eco-tourism is likely to be insufficient to cover costs for restoration (Gelcich et al., 2013).

Visitors fees can also be applied at jurisdiction level, instead of at single site level (Von Saltza and Kittinger, 2022). These fees, known as green fees, can be implemented both at national level, as in the case of the International Visitor Conservation and Tourism Levy in New Zealand (Case study 44), or at local level, as in Bombinhas (Santa Catarina, Brazil) (Case study 45), where a levy for the maintenance of the coastal ecosystems is charged on visitors accessing the municipality during the summer season.

<u>Conditions to applicability</u>: The important precondition for establishing ecotourism user fees is the existence (or potential emergence) of touristic value in the area where restoration takes place. This condition is typically more prevalent in the context of coastal and marine ecosystems when compared to other types of ecosystems, given that coastal areas and beaches inherently hold significant appeal as tourist attractions. While simple visitor fees for entry are relatively cheap and easy to set up and implement (Emerton, 2006), more complex

pricing structures and services require sufficient tourist volume to offset increased operating costs (Brenes Vega, 2004). A precondition for the upscaling of tourism user fee revenues is the presence of high-value ecosystems, rich flora and fauna and the presence of iconic species such as dolphins, sea turtles and flamingos. When upscaling user fee schemes, precise earmarking, willingness to pay surveys, marketing, differentiated pricing and monitoring activity are important measures for revenue optimization. Monitoring can be particularly relevant in marine and coastal areas as these are often accessible from multiple entry points (Brenes Vega, 2004). As user fee schemes are based on the exclusion of access to ecosystem services to the general public, a common risk is that of alienating local communities that used to access the area freely. Social acceptance by local stakeholders is therefore an important factor to be considered (UNEP, 2001).

Transferability to REST-COAST Pilots: With regards to the transferability of tourism user fees in the REST-COAST project, these represent a viable option for the establishment of revenue streams, especially for Pilots located in areas of high touristic values and where iconic bird species can be observed. In these cases these solutions should be considered for value capture in T3.3.1.

4.2.11. Betterment levies

Description: Fees imposed by local authorities on local residents for the purpose of funding public infrastructures that benefit their properties or the surrounding area. The amount of a betterment levy is typically based on the increased value that the property will derive from the infrastructure improvements.

Innovative features addressing financial barriers: Betterment levies serve as a mechanism to capture the value of local public goods. Local public goods are a subset of public goods that are non-excludable and non-rivalrous at the local level. While they share the same characteristics as public goods, they are limited to a specific geographical area or community. Betterment levies ensure that the costs associated with development of infrastructures, in this case coastal restoration, are shared by property owners who directly benefit from the improvements, rather than placing the entire burden on the broader taxpayer base (Financial barrier 7). In many cases, betterment levies are introduced as part of the approval process for a development project, and they are typically imposed at the time of approval or permitting (Financial barrier 4).

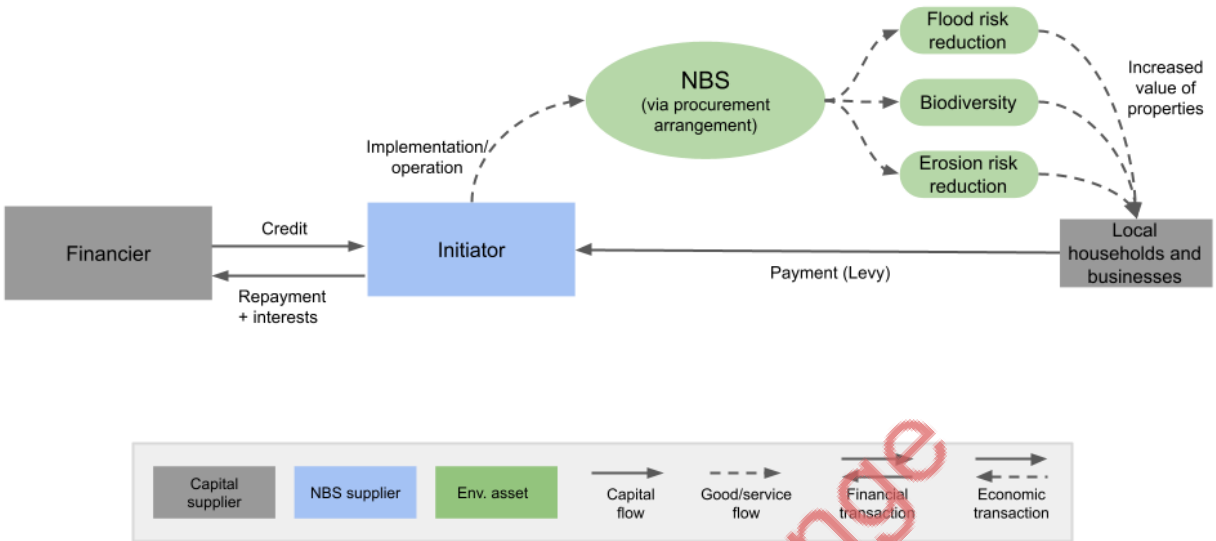

Figure 4.6 - Transactions involved in Betterment levies

Empirical evidence: Betterment levies have been implemented to fund beach nourishment against coastal erosion. Several municipalities in North Carolina have implemented a property tax to fund the recurring nourishment projects, in some cases with a differentiated structure that charges higher taxes on oceanfront properties that benefit the most from the intervention (Case study 46). In Marche (Italy), 4% of the costs for the implementation of various interventions against coastal erosion (beach nourishment, cliff stabilisation, removal of artificial reef) have been covered by levies on the local tourism business, which benefited directly from beach protection and improvement (Case study 47).

Conditions to applicability: Overall, betterment levies represent an option for value capture for governments with sufficient fiscal capacity, and where clear economic values can be linked to the NBS. Betterment levies are particularly fitting in urban areas or in contexts of ongoing development, which present more opportunities to harness the increase of value of contiguous properties (Dunning and Lord, 2020). while their implementation in sparsely populated coastal areas is rather limited, especially in the context of protected areas due to related land-use limitations. As with other fiscal instruments, the possibly low social acceptability of a betterment levy can constitute a strong political barrier to its implementation. For example, the regional council in Wellington (New Zealand) considered charging those at higher risk of flooding with higher property taxes, as a way to increase fairness in the distribution of costs for coastal flood protection, yet the measure was never implemented due to the opposition of residents who would have faced higher taxes (Woodruff et al., 2020). Demonstrating a clear link between the NBS investment and the increased value of properties is central in securing social acceptance of impacted residents. Flood risk reduction and passive recreational value (e.g. presence of landscape features, beaches, green areas) have been identified as the most relevant ESS driving increased value of near-by real estates (Grafakos et al., 2019). In some cases, it may be necessary to bundle restoration with value-enhancing development projects to make the value proposition more compelling, a strategy that has been implemented in the Netherlands to fund local adaptation through public land development schemes (Root et al., 2015).

Transferability to REST-COAST Pilots: With regards to the transferability of betterment levies in the REST-COAST project, based on current information these solutions appear to be the least promising option for value capture, but could nevertheless be discussed within the T3.3.1 co-development process.

4.2.12. Discussing innovative finance for NBS upscaling

Our review shows how the identified set of innovative financial solutions in fact address financial barriers that are caused by inherent properties of key NBS transactions (Table 4.3). Different solutions are possible to address a single barrier, and a single solution can address several barriers simultaneously.

Empirical evidence of actual implementation in NBS projects was identified for various innovative solutions. However, the quality of this empirical evidence varies across cases. In some instances, the evidence is relatively weak, predominantly relying on experimental Pilots (blockchain tokens and smart contracts), or isolated cases (EIB, PPP and betterment levies). These gaps are even more evident when looking at cases of implementation of NBS in coastal areas, specifically.

Table 4.3 - Overview of financial barriers and innovative financial solutions for NBS. An "x" indicates which barriers are lowered by a certain solution, while a "-" represents a hindering condition to the applicability of the solution.

	Green Bonds	EIB	Project Bundling	Smart contracts	Blockchain Tokens	PPP	Carbon Credits	Eco-Labels	Ecotourism User Fees	Betterment Levies
High performance risk	x	x	x	-		x		x		
Low measurability of impacts	x	-		-		-		x		
Site-specificity of NBS assets	x		-	x	x					
Long lead time				-					x	x
Insufficient project size	-	-	x	x	x	x	-			
Jointness			-			x				
Low revenues							x	x	x	x
Case studies in coastal restoration	**	*	**			*	***	**	**	*

Indeed, we highlight how, despite the availability of solutions, their implementation and transfer faces several challenges. In particular, our study provided **insights on the interconnected nature of financial challenges and solutions**. Certain financial barriers might hinder the ability to implement a financial solution meant for a different challenge. For example, carbon credits lower financial barriers related to the low excludability of mitigation ESS, but their applicability is hindered by insufficient project size.

In addition, contextual factors such as social acceptance, regulatory and policy impediments, technological limitations and lack of market maturity can represent hindering conditions to the applicability of innovative financial solutions in other settings. For example, social acceptance and low population density can hinder the implementation of betterment levies and similar land-value capture fiscal instruments, while the lack of regulatory frameworks constitute a limiting factor to the potential of tokenization.

Avoiding financial barriers is easier than overcoming them. Taking proactive measures to avoid getting into difficult financial situations may be more manageable and less resource-intensive than dealing with the complexities and hardships associated with overcoming financial barriers once they have already arisen. We thus encourage NBS initiators to improve the planning and structuring of NBS projects, considering and assessing opportunities and barriers to the implementation/transfer of innovative business models when making decisions on site identification, NBS design, goal setting, and stakeholder engagement.

Addressing case-specific interplays between financial barriers and solutions require creative and strategic thinking in developing tailored financial arrangements, which needs to be reconciled with investors' preference for familiar and simple transaction structures, as increasingly complex arrangements imply higher due diligence costs. Our study showcases how these challenges led to the **emergence of private financial service providers and financial intermediaries** with specialised expertise in transaction structuring, standard setting, project bundling and performance measurement/verification as a new category of actors for the governance of NBS finance. These actors often acquire a dominant role within project settings, suggesting that their influence in the NBS sector will likely increase as financial innovation consolidates as a solution for NBS financial upscaling.

The primary goal of financial innovation in NBS is to tap into new sources of capital by engaging the private sector. However, successful cases implementing innovative solutions underscore that the **role of the public sector in funding projects and enabling private investments remains indispensable**. This in all likelihood remains true given that many of the innovative financial solutions currently in use are designed to mobilise private capital from the impact investment market, whose limited size constrains its potential for financial upscaling. In addition, given the prevalent public nature of many ESS, **governments should strive to maintain an alignment of NBS with public interest goals and societal benefits**, even as the private sector becomes increasingly involved in the governance of NBS finance. This includes measures such as setting clear goals and objectives, increasing strategic public investments in NBS, and working closely with private financial service providers and intermediaries in defining innovative NBS governance models (co-developing standards and performance metrics, establishing mechanisms for transparency and accountability, establishing regulatory frameworks for project structuring, performance measurement, verification processes). Future research should explore possible welfare and ecological impacts of financial innovation applied to NBS, in order to define the need for policy safeguards and support their development.

When defining the scope of our study, we have focused on innovative financial solutions with the potential of mobilising private investments, as these diverge markedly from traditional NBS financial models based on public granting. Consequently, innovative financial solutions applied to granting transactions (e.g. payments for ESS, offsets, crowd-funding, etc.) have not been considered.

With regards to local barriers to the transfer of innovative financial solutions, governments have certainly an important role in shaping an enabling environment (e.g. cross-sectoral integration of NBS, fiscal incentives, top-down regulation, bottom-up engagement etc.). The scope of our research did not allow us to delve into this issue, however a separate analysis of constraints and opportunities provided by regulatory and policy frameworks will be needed to gain a more comprehensive understanding of the governance of innovative finance for NBS.

5. Promising financial innovation for REST-COST Pilots

This chapter discusses, for each of the nine REST-COAST Pilots, which of the financial solutions identified above may be applicable for enhancing or upscaling the Pilot. Proposed solutions have been selected on the basis of the alignment of conditions of applicability identified for each innovative financial instrument with the available information on Pilot's local conditions which was collected through surveys, previous project deliverables and bilateral interviews with Pilot leaders.

As delineated in our prior deliverable (D3.1, section 3.10), the predominant funding model among the REST-COAST coastal restoration Pilots relies on public grants and, to a lesser extent, private donations. Despite the wide array of benefits (including economic benefits) generated by the various coastal restoration initiatives, value-capture arrangements for the generation of revenues are generally lacking. As a consequence, one of the priorities in the current phase of the project is the evaluation of applicability of innovative financial solutions of the value-capturing kind (Table 5.1). Innovations in financing and procurement arrangements will acquire relevance for the development of upscaling narratives (T3.3.3), once value-capturing NBS business models are defined.

Table 5.1 Overview of promising innovative financial solutions for the REST-COAST Pilots.

	Green Bonds	EIB	Project bundling	Smart contracts	Blockchain tokens	PPP	Carbon credits	Eco-labels	Eco-Tourism user fees	Betterment levies
Wadden sea			x				x			
Ebro delta		x	x	x			x		x	
Venice		x	x	x			x		x	
Vistula lagoon							x	x		
Foros Bay		x		x				x		
Rhone delta							x		x	
Sicily		x							x	
Arcachon		x		x			x		x	
Nahal Dalia		x	x				x	x	x	

5.1. Wadden Sea

Several restoration interventions are included in the Wadden Sea Pilot. Based on the produced ESS and contextual factors, the following innovative financial solutions could be discussed for a tailored NBS business model.

Carbon credits. The restoration activities in the Wadden Sea Pilot are expected to deliver climate mitigation ESS, thanks to the reduction of carbon emissions associated with the use of construction resources (sediments) sourced locally.

Carbon emission reductions will be quantified and monitored with dedicated methodologies. Carbon credits could be thus considered to capture this value. Fundamental requirements (and thus potentially relevant implementation barriers) for carbon crediting are:

a. The demonstration of additionality, i.e. positive levels of carbon emission reductions when compared to a baseline scenario.

b. The production of sufficient levels of ESS output, i.e. the reduction of carbon emissions, and therefore the issuance of an amount of carbon credits, sufficient to overcome the high transaction costs associated with the carbon crediting process (Financial Barrier 5).

c. The identification of a suitable carbon standard, and the alignment of the methodologies used by the Pilot for the quantification of carbon emission reductions with said carbon standard.

Should carbon emission reduction output levels not be enough to cover the transaction costs associated with carbon crediting, the possibility for the aggregation of several restoration projects into a joint application should be explored. To this end, other REST-COAST Pilots (e.g. Venice, Ebro Delta, Arcachon, Rhone Delta) or other restoration projects outside the project (including those implemented in the Wadden Sea region) could be considered.

Table 5.2 Enablers and barrier to carbon credits in the Wadden Sea Pilot

Carbon Credits	
Financial barrier addressed: Low excludability	
Transfer enablers	Transfer barriers
Climate mitigation ESS produced and monitored/quantified	Potential insufficient ESS output High transaction costs Provider of financial services (carbon standard) not identified yet

Project bundling. In the Wadden Sea Pilot, several restoration activities are coordinated within the EMS Dollard program. All the program activities focus on the same core objectives: (1) Reduction of turbidity/restoration of natural dynamics (2) Beneficial use of sediments (clay, levelling low area's or building materials), (3) Habitat development in the coastal zone. The existence of an overarching institutional structure and the underlying homogeneity of the single initiatives in terms of goals, geography and institutional context facilitates the institution of a fund. A dedicated fund would allow the collection of a diverse pool of funding and financing sources to cover the different aspects of the program, while also making the formulation of bundled investment proposals possible.

Table 5.3 Enablers and barrier to project bundling in the Wadden Sea Pilot

Project bundling	
Financial barrier addressed: Uncertain ESS performance, ticket size mismatches	
Transfer enablers	Transfer barriers
Existence of program-level institutional structure Homogeneity among restoration initiatives	Provider of financial services (bundling intermediary) not identified yet Limited revenue generation

5.2. Ebro Delta

Several restoration interventions are included in the Ebro Delta Pilot. Based on the produced ESS and contextual factors, the following innovative financial solutions could be discussed for a tailored NBS business model.

Tourism user fees. The unique landscape and biodiversity that characterise the Ebro Delta makes it a popular tourist destination. For this reason, an eco-tourism business model based on user fees would be a suitable approach for restoration upscaling. This approach would also build on previous similar efforts that have been implemented in the delta. Previous wetland restoration activities have successfully captured ESS value from benefiting visitors through entrance fees, service facilities and recreational activities such as birdwatching. At present, the project BIORESILMED is active in the promotion of a local bioeconomy and green infrastructures, an effort which encompasses supporting ecotourism through improved navigational accessibility and the construction of biking trails. These past and present initiatives contribute to creating an enabling environment for the adoption of an eco-tourism business model based on user fees and establishing partnerships to support this effort.

Table 5.4 Enablers and barrier to tourism user fees in the Ebro Delta Pilot

Tourism user fees	
Financial barrier addressed: (Long) time lag for impact	
Transfer enablers	Transfer barriers
Biodiversity ESS produced Beneficiary identified Well-developed local tourism sector	Social acceptance

Carbon credits. The restoration activities in the Ebro Delta Pilot are expected to deliver climate mitigation ESS. Carbon sequestration will be quantified and monitored with dedicated methodologies. Carbon credits could be thus considered to capture this value. Fundamental requirements (and thus potentially relevant implementation barriers) for carbon crediting are:

a. The demonstration of carbon sequestration additionality, i.e. positive levels of carbon sequestration when compared to a baseline scenario.

b. The production of sufficient levels of ESS output, i.e. the sequestration of an amount of carbon-equivalent GHG, and therefore the issuance of an amount of carbon credits, sufficient to overcome the high transaction costs associated with the carbon crediting process (Financial Barrier 5).

c. The identification of a suitable carbon standard, and the alignment of the methodologies used by the Pilot for the quantification of carbon sequestration with said carbon standard.

Should carbon sequestration output levels not be enough to cover the transaction costs associated with carbon crediting, the possibility for the aggregation of several restoration projects into a joint application should be explored. To this end, other REST-COAST Pilots (e.g. Venice, Wadden Sea, Arcachon, Rhone Delta) or other restoration projects outside the project (including those implemented in the Ebro Delta) could be considered.

In addition to carbon credits, the Pilot has also identified the potential to offer water footprint compensations to local companies interested in offsetting negative environmental impacts or high levels of water consumption associated with their activities.

Table 5.5 Enablers and barrier to carbon credits in the Ebro Delta Pilot

Carbon Credits	
Financial barrier addressed: Low excludability	
Transfer enablers	Transfer barriers
Climate mitigation ESS produced and monitored/quantified	Potential insufficient ESS output High transaction costs Provider of financial services (carbon standard) not identified yet

Project bundling. The REST-COAST Ebro Delta Pilot is not the only restoration project operating in the area. Other initiatives are currently implementing coastal restoration techniques and putting efforts into experimenting innovative financial approaches and NBS business models. Common project goals and geographical scope suggest that synergies among the different projects should be explored, in particular with regards to the possibility of aggregating the different initiatives as a bundled investment proposal.

Table 5.6 Enablers and barrier to project bundling in the Ebro delta Pilot

Project bundling	
Financial barrier addressed: Uncertain ESS performance, ticket size mismatches	
Transfer enablers	Transfer barriers
Presence of several restoration projects in the area Homogeneity among restoration initiatives	Provider of financial services (bundling intermediary) not identified yet Lack of revenue generation

Environmental Impact Bonds (EIB) (or other outcome-based instrument) and smart contracts.

The restoration activities in the Ebro Delta are expected to deliver flood risk reduction and erosion risk reduction ESS, which will benefit all the delta area, including local farmers and other businesses. A specific actor/group of actors who particularly benefit from these ESS should be identified and targeted for the establishment of value-capture arrangements. Methodologies for the quantification and projection of flood and erosion risk reduction ESS are being developed by the Pilot.

The precondition for establishing a value-capture arrangement (with payments from the beneficiary) to fund future restoration upscaling is essentially the demonstration of a sufficient level of ESS delivery to justify the investment. Assuming that the link between flood risk reduction and/or erosion risk reduction and restoration can be demonstrated and that these indeed result in cost saving for targeted actors, a value capture transaction could in principle be efficient without the need to implement innovative financial solutions. Two financial barriers can be nevertheless envisaged as potentially relevant:

a. ESS outputs could be irregular and/or uncertain (Barrier 1). In this case, outcome-based innovative financial solutions that include mechanisms similar to those found in EIBs could be considered to distribute performance risks. As the EIB case studies suggested, cost-saving ESS such as those discussed here are particularly suited to arrangements of this kind. Another enabling factor is that these ESS are readily measurable and monitorable, as methodologies for this purpose have been already developed.

b. Cost savings are not sufficient to cover transaction costs (Financial Barrier 5). Transaction costs could be high, in particular if outcome-based arrangements are considered. Smart contracts could in this case be a potential solution to lower transaction costs. The high measurability and monitorability of the ESS discussed here is seen as an enabling factor, yet simple and modular transactions should be defined to allow smart contracting. The sediment bypass project appears to have promising characteristics (up-stream/down-stream dynamics, "countable" provisioning service, risk reduction/cost saving benefits) to set up such transactions.

Table 5.7 Enablers and barrier to Environmental Impact Bonds or other outcome-based financial instrument in the Ebro Delta Pilot

Environmental Impact Bond (EIB) or other outcome-based financial instrument	
Financial barrier addressed: Uncertain ESS performance	
Transfer enablers	Transfer barriers
ESS (Flood risk reduction, erosion risk reduction and/or sediment provision) produced and quantified Cost-saving/damage avoidance, category of beneficiary identified	Potential insufficient ESS output High transaction costs Potential provider of financial services (transaction structuring) not identified yet

Table 5.8 Enablers and barrier to smart contracts in the Ebro Delta Pilot

Smart contracts	
Financial barrier addressed: Ticket size mismatches/high transaction costs	
Transfer enablers	Transfer barriers
ESS (Flood risk reduction, erosion risk reduction and/or sediment provision) produced and quantified	Potential insufficient ESS output Potential provider of financial services (transaction structuring, smart contracting platform) not identified yet Simple and modular type of transaction not identified yet

5.3. Venice

The main economic values produced by restoration activities in the Venice Lagoon have been identified, as well as the links to broad categories of beneficiaries. Specific beneficiary actors or organisations that could be involved in value-capture arrangements have not been identified yet. Based on the ESS produced and local context, several innovative financial solutions for value-capturing could be considered in Venice.

Tourism user fees. The restoration and protection of the lagoon ecosystems is expected to increase the biodiversity, in particular in terms of number of bird species and abundance. Enhanced biodiversity creates new opportunities for recreational activities for residents and tourists such as birdwatching and boat tours of the lagoon. Despite the large amounts of tourists visiting the city of Venice, other areas of the Lagoon, in particular the saltmarsh ecosystems, are rarely visited and these opportunities remain unexploited. The promotion of eco-tourism and the establishment of user fees for related activities in the lagoon is a clear opportunity for a NBS business model.

When considering the eco-tourism approach, however, WP3 and the Venice Pilot should take into account the potential impacts of increased boat traffic near restored salt marshes. Balancing tourism user fees revenue generation and ecosystem health preservation poses a challenge for this type of NBS business model.

Table 5.9 Enablers and barrier to tourism user fees in the Venice Pilot

Tourism user fees	
Financial barrier addressed: (Long) Time lag for impact	
Transfer enablers	Transfer barriers
Biodiversity ESS produced Beneficiary identified Well-developed local tourism sector	Possible negative environmental impact

Carbon credits. The restoration of salt marshes in the Venice Pilot is expected to deliver climate mitigation ESS. Carbon sequestration, taking into account GHG emissions, will be quantified and monitored with dedicated methodologies. Carbon credits could be thus considered to capture this value. Fundamental requirements (and thus potentially relevant implementation barriers) for carbon crediting are:

a. The demonstration of carbon sequestration additionality, i.e. positive levels of carbon sequestration when compared to a baseline scenario.

b. The production of sufficient levels of ESS output, i.e. the sequestration of an amount of carbon-equivalent GHG, and therefore the issuance of an amount of carbon credits, sufficient to overcome the high transaction costs associated with the carbon crediting process (Financial Barrier 5).

c. The identification of a suitable carbon standard, and the alignment of the methodologies used by the Pilot for the quantification of carbon sequestration with the carbon standard.

Should carbon sequestration output levels not be enough to cover the transaction costs associated with carbon crediting, the possibility for the aggregation of several restoration projects into a joint application should be explored. To this end, other REST-COAST Pilots (e.g. Wadden Sea, Ebro Delta, Arcachon Bay, Rhone Delta) or other salt marsh restoration projects in the Venice lagoon could be considered.

Table 5.10 Enablers and barrier to carbon credits in the Venice Pilot

Carbon Credits	
Financial barrier addressed: Low excludability	
Transfer enablers	Transfer barriers
Climate mitigation ESS produced and quantified	Potential insufficient ESS output High transaction costs Provider of financial services (carbon standard) not identified yet

Project bundling. The REST-COAST Venice Pilot is not the only restoration project operating in the Venice lagoon. Several initiatives are currently implementing wetland restoration techniques and putting efforts into experimenting innovative financial approaches and NBS business models. Common project goals and geographical scope suggest that synergies among the different projects should be explored, in particular with regards to the possibility of aggregating the different initiatives as a bundled investment proposal.

Table 5.11 Enablers and barrier to project bundling in the Venice Pilot

Project bundling	
Financial barrier addressed: Uncertain ESS performance, ticket size mismatches	
Transfer enablers	Transfer barriers
Presence of several restoration projects in the area Homogeneity among restoration initiatives	Provider of financial services (bundling intermediary) not identified yet Lack of revenue generation

Environmental Impact Bonds (EIB) (or other outcome-based instrument) and smart contracts. The restoration of salt marshes in the Venice Pilot is expected to deliver flood risk reduction and erosion risk reduction ESS, which will benefit all the lagoon area, including the city of Venice, local residents and businesses. A specific actor who particularly benefits from this ESS should be identified and targeted for the establishment of value-capture arrangements. This would ideally be the authority in charge of covering the costs of floods and erosion, or, given the diffused nature of the above mentioned benefits, the local government.

Methodologies for the quantification and projection of flood and erosion risk reduction ESS are being developed by the Pilot.

The precondition for establishing a value-capture arrangement (with payments from the beneficiary) to fund future restoration upscaling is essentially the demonstration of a sufficient level of ESS delivery to justify the investment. Assuming that the link between flood risk reduction and/or erosion risk reduction and restoration can be demonstrated and that these indeed result in cost saving for targeted actors, a value capture transaction could in principle be efficient without the need to implement innovative financial solutions. Two financial barriers can be nevertheless envisaged as potentially relevant:

a. ESS outputs could be irregular and/or uncertain (Barrier 1). In this case, outcome-based innovative financial solutions that include mechanisms similar to those found in EIBs could be considered to distribute performance risks. As the EIB case studies suggested, cost-saving ESS such as those discussed here are particularly suited to arrangements of this kind. Another enabling factor is that these ESS are readily measurable and monitorable, as methodologies for this purpose have been already developed.

b. Cost savings are not sufficient to cover transaction costs (Financial Barrier 5). Transaction costs could be high, in particular if outcome-based arrangements are considered. Smart contracts could in this case be a potential solution to lower transaction costs. The high measurability and monitorability of the ESS discussed here is seen as an enabling factor, yet simple and modular transactions should be defined to allow smart contracting.

Table 5.12 Enablers and barrier to Environmental Impact Bonds or other outcome-based financial instrument in the Venice Pilot

Environmental Impact Bonds (EIB) or other outcome-based financial instrument	
Financial barrier addressed: Uncertain ESS performance	
Transfer enablers	Transfer barriers
Uncertain ESS performance ESS (Flood risk reduction and/or erosion risk reduction) produced and quantified Cost-saving/damage avoidance, category of beneficiary identified	Potential insufficient ESS output High transaction costs Potential provider of financial services (transaction structuring) not identified yet

Table 5.13 Enablers and barrier to smart contracts in the Venice Pilot

Smart contracts	
Financial barrier addressed: Ticket size mismatches/high transaction costs	
Transfer enablers	Transfer barriers
ESS (Flood risk reduction and/or erosion risk reduction) produced and quantified	Potential insufficient ESS output Potential provider of financial services (transaction structuring, smart contracting platform) not identified yet Simple and modular type of transaction not identified yet

5.4. Vistula Lagoon

The most prominent economic value entailed by the Vistula Lagoon restoration Pilot is the cost-saving achieved by transferring dredged sediments to the near-by artificial island, instead of a further and less accessible destination. This value was already captured by design, as the construction of the navigation channel and the construction of the artificial island are two components of the same project. In addition to the cost-saving value capturing mechanism already in place, other arrangements were foreseen by the stakeholders for a future stage of the project, yet their actual implementation is hindered by considerable barriers.

Carbon credits. Restoration activities, or habitat creation activities to be more precise, were expected to have a positive impact in terms of climate mitigation. A preliminary assessment of the impact of the restoration project on carbon sequestration nevertheless resulted in a reconsideration of potential ESS outputs. The extraction of wet sediments and their deposit on dry terrain actually produces carbon emissions, and the planned restored vegetation has limited capacity of sequestering carbon. Other vegetation mixes could be considered to address this problem, yet the margin for improvements appears to be rather short. Future assessments on carbon sequestration will clarify the feasibility of a blue carbon business model.

Table 5.14 Enablers and barrier to carbon credits in the Vistula Lagoon Pilot

Carbon Credits	
Financial barrier addressed: Low excludability	
Transfer enablers	Transfer barriers
Climate mitigation ESS quantified	Likely insufficient ESS output High transaction costs Provider of financial services (carbon standard) not identified yet

Eco-labels. Another ESS that was identified as a potential source of revenues was food (fish) provisioning, which would benefit local fishermen by increasing overall fish stocks. Indeed, the underwater portion of the artificial island can provide ground suitable for fish spawning. Eco-labels could be discussed in the future as instruments for capturing such value. A precondition for the establishment of such arrangements would be the quantification and monitoring of the increased fish stocks, which is however currently not available nor foreseen. Another option would be the certification of sustainably managed winter marinas. Although the relation to the ESS provided by the artificial island is more indirect, these infrastructures have been foreseen as part of the requalification plan of the lagoon area, and part of the revenues could be dedicated to the maintenance of restoration.

Table 5.15 Enablers and barrier to Payments for ESS and Eco-labels in the Vistula Lagoon Pilot

Eco-labels	
Financial barrier addressed: Low excludability/Uncertain ESS performance/Low measurability (depending on the specific eco-label requirements)	
Transfer enablers	Transfer barriers
ESS (Fish provisioning) produced Beneficiary identified	ESS not quantified yet Potential insufficient ESS output Potential provider of financial services (certification, transaction structuring) not identified yet

5.5. Foros Bay

The Foros Bay is still in an early phase of project development, and most of the restoration activities have not yet started. Some early-on considerations regarding potentially suitable innovative financial solutions can be drawn, based on the information on the context of the Pilot and the foreseen key benefits and ESS.

Eco-labels. In Foros Bay, restoration of seagrass bed is expected to deliver fish provisioning ESS, from which local fishing businesses would benefit. Nevertheless, as the restoration Pilot is pioneering the NBS approach in the Foros Bay, local fishermen are sceptical in recognising the economic value of ecosystem restoration for their activity. Quantifying and monitoring fish provisioning ESS would be a possible approach to demonstrate the economic benefits of coastal restoration to fishermen. An alternative option would be to search for applicable eco-labels that would allow fishermen to sell certified fish stocks with price premiums. The demand for certified fish in the market of reference is unknown, and could represent a barrier to the implementation of eco-labels.

Table 5.16 Enablers and barrier to Eco-labels in the Foros Bay Pilot

Eco-labels	
Financial barrier addressed: Low excludability/Uncertain ESS performance/Low measurability (depending on the specific eco-label requirements)	
Transfer enablers	Transfer barriers
Provisioning ESS (fish) produced	Provider of financial services (certification) not identified yet Potential lack of market maturity

Environmental Impact Bonds (EIB) and smart contracts. Part of the restoration activities planned in the Foros Bay Pilot are aimed at restoring the hydrological connectivity between the Bay and the adjacent lakes, which is currently hindered by sediment deposits and overgrown invasive vegetation. Clearing out the channel can only provide a temporary solution, and the municipal government of Burgas is interested in developing more long-term solutions. The restoration of the seagrass population in the Foros Bay is projected to have a positive impact on local sediment dynamics, and could ultimately result in decreasing rates of sediment deposits in the channel, thus saving costs for future dredging activities to the local government. If proved through the quantification of ESS, this benefit could be an opportunity to set value capture arrangements based on a paying beneficiary.

The precondition for establishing a value-capture arrangement (with payments from the beneficiary) to fund future restoration upscaling is essentially the demonstration of a sufficient level of ESS delivery to justify the investment. Assuming that the link between sediment deposit reduction ESS and restoration can be demonstrated and that these indeed result in cost saving for the municipality, a value capture transaction could in principle be efficient without the need to implement innovative financial solutions. Two financial barriers can be nevertheless envisaged as potentially relevant:

a. ESS outputs could be irregular and/or uncertain (Barrier 1). In this case, outcome-based innovative financial solutions that include mechanisms similar to those found in EIBs could be considered to distribute performance risks. As the EIB case studies suggested, cost-saving ESS such as those discussed here are particularly suited to arrangements of this kind. Another enabling factor is that sedimentation can be easily measured and monitored, as methodologies for this purpose will be developed and implemented.

b. Cost savings are not sufficient to cover transaction costs (Financial Barrier 5). Transaction costs could be high, in particular if outcome-based arrangements are considered. Smart contracts could in this case be a potential solution. The high measurability and monitorability of sediment deposition ESS, as well as the simple and periodic type of transaction based on dredging cost savings can be considered as enabling factors to smart contracting.

Table 5.17 Enablers and barrier to Environmental Impact Bond or other outcome-based financial instrument in the Foros Bay Pilot

Environmental Impact Bond or other outcome-based financial instrument	
Financial barrier addressed: Uncertain ESS performance	
Transfer enablers	Transfer barriers
ESS (sediment management) produced and quantified Cost-saving/damage avoidance, beneficiary identified	Potential insufficient ESS output High transaction costs Potential provider of financial services (transaction structuring) not identified yet

Table 5.18 Enablers and barrier to smart contracts in the Foros Bay Pilot

Smart contract	
Financial barrier addressed: Ticket size mismatch/High transaction costs	
Transfer enabler	Transfer Barriers
ESS (sediment management) produced and quantified Simple and repeated type of transaction	Potential insufficient ESS output Potential provider of financial services (transaction structuring, smart contracting platform) not identified yet

5.6. Rhone Delta

In the Rhone Delta Pilot, several ESS and clear linkages with the respective beneficiaries have been identified, offering several avenues for potential future value capture strategies. A key challenge for WP3 is brought by the fact that business models based on paying beneficiaries and the generation of private profit appear to be in contrast with the general narrative promoted by the NBS initiators and restoration co-managers. Since the beginning of restoration in 2011, the project has been framed as a solution for the reduction of expenses thanks to the passive restoration approach, and as an opportunity to deliver several public goods and to requalify the area from a social and economic point of view. Such context may constitute a cross-cutting governance barrier to the establishment of innovative financial arrangements aiming at leveraging private capital for restoration upscaling. Nevertheless, the following innovative financial solutions might be considered within the co-development process in T3.3.1, as they fit the contextual features of the Pilot.

Tourism user fees. Several ESS produced by the restoration of the Rhone Delta contribute to increasing its attractiveness to tourists. These include the enrichment and support of biodiversity, the increase of water quality (which in turn supports grazing), the restoration of natural coastal sediment dynamics and landscapes. The resulting benefits to the tourism sector are considerable, and thus constitute the main opportunity for the establishment of value capture instruments and related NBS business models. The above listed ESS and the benefits they produce already resulted in the emergence of small economic activities such as organised eco-touristic tours, fishing and angling for European Sea Bass, grazing, but these are external to the project and economic value has not been captured yet. These activities evidence the high recreational value of the site that will be enhanced by the Pilot's restoration activities. Further recreational activities could be developed following current efforts in promoting cycling and hiking activities and the organisation of car parking and public access to the beach. User fees could therefore represent a low-effort/high rewards instrument to support restoration, and could be a viable option to generate cash flows already in the short-term. Governance barriers and social acceptance of new fees and charges could nevertheless make the implementation of this solution challenging.

Table 5.19 Enablers and barrier to tourism user fees in the Rhone Delta Pilot

Tourism user fees	
Financial barrier addressed: (Long) Time lag for impact	
Transfer enablers	Transfer barriers
Water quality and biodiversity ESS produced Beneficiary identified Well-developed local tourism sector	Governance barriers Social acceptance

Carbon credits. The Rhone Delta Pilot has adopted a solid methodology for the quantification of carbon sequestering services, taking into account GHG emissions. The quantification of the overall carbon sequestering capacity of planned restoration is undergoing. Should additionality (positive net amount of carbon sequestration) be proved, carbon credits could be considered as an instrument to fund future activities. The most suitable provider for financial services (carbon standard) to achieve this objective would probably be the French public label "Bas-Carbone". Fundamental requirements (and thus potentially relevant implementation barriers) for carbon crediting are:

a. The demonstration of carbon sequestration additionality, i.e. positive levels of carbon sequestration when compared to a baseline scenario.

b. The production of sufficient levels of ESS output, i.e. the sequestration of an amount of carbon-equivalent GHG, and therefore the issuance of an amount of carbon credits, sufficient to overcome the high transaction costs associated with the carbon crediting process (Financial Barrier 5).

c. The alignment of the methodologies used by the Pilot for the quantification of carbon sequestration with the Bas-carbone label standards.

The Bas-Carbone label only accepts applications from projects located within French territory. The second French restoration Pilot in the REST-COAST project, the Arcachon Bay Pilot, is also planning the quantification of carbon sequestration generated by restoration, following the same methodology used in the Rhone Delta Pilot. As the label accepts "collective projects" (*projets collectifs*), the possibility for a joint project application for Bas-Carbone labelling and carbon credit issuance could therefore be explored.

Table 5.20 Enablers and barrier to carbon credits in the Rhone Delta Pilot

Carbon Credits	
Financial barrier addressed: Low excludability	
Transfer enablers	Transfer barriers
Climate mitigation ESS produced and quantified Potential provider of financial services (carbon standard) identified	Potential insufficient ESS output High transaction costs Governance barriers

Biodiversity credits. In June 2023, France and the United Kingdom launched a Global Biodiversity Credits Roadmap which foresees the establishment of a new biodiversity credits initiative. Similarly to the option of carbon credits, the fundamental requirements (and thus potentially relevant implementation barriers) are:

a. The development and implementation of a methodology for quantifying biodiversity benefits in line with the requirements of the Global Biodiversity Credits Roadmap standard.

b. The demonstration of biodiversity additionality, i.e. the improvement of biodiversity metrics when compared to a baseline scenario.

c. Producing levels of ESS output sufficient to issue enough biodiversity credits to overcome the high transaction costs associated with the biodiversity crediting process. (Financial Barrier 5).

As the initiative has been announced only recently, details such as project eligibility, applicable methodologies for ESS quantification, project bundling are not yet known. WP3 will follow future developments on this issue to better assess the feasibility of biodiversity crediting in Rhone delta and other Pilots.

Table 5.21 Enablers and barrier to biodiversity credits in the Rhone Delta Pilot

Biodiversity Credits	
Financial barrier addressed: Low excludability	
Transfer enablers	Transfer barriers
Biodiversity ESS produced and quantified Potential provider of financial services (Biodiversity credit standard) identified	Potential insufficient ESS output High transaction costs

5.7. Sicily

Based on the ESS targeted by restoration in the Cuba and Longarini lagoons (Biodiversity enhancement, flood risk reduction, erosion risk reduction, water purification), several innovative financial arrangements can be identified to support the establishment of a NBS business model for the Sicily Pilot. One cross-cutting challenge for the establishment of innovative business models and value-capture arrangements is the fact that the NBS initiator, an NGO, has a well-established business model based on public funds and donations from its supporter base, and may be reluctant to change this, particularly if private commercial investments and the generation of profit for third parties are involved.

Tourism user fees. The high touristic value of the Lagoons represents a strong asset for the potential future implementation of further value capture arrangements. Improvements to water quality and biodiversity are the most relevant ESS to the tourism sector. Currently, visitors are invited to voluntarily donate to the manager of the site (Stiftung Pro Artenvielfalt) and these could possibly be integrated with user fees.

Examples can be drawn by the benchmark site Vendicari Lagoon, where different services are offered to tourists, including snorkelling, trekking, birdwatching, hotels and car rentals. User fees are used in Vendicari Lagoon also as a tool to manage the flow and behaviour of visitors. These value-capture instruments would be easy to implement and could generate revenue in the short term, but lack of social acceptance of charging for activities that were previously free may be a barrier to implementation.

Table 5.22 Enablers and barrier to tourism user fees in the Sicily Pilot

Tourism user fees	
Financial barrier addressed: (Long) time lag for impact	
Transfer enablers	Transfer barriers
Water quality and biodiversity ESS produced Beneficiary identified Well-developed local tourism sector	NBS initiator reluctancy Social acceptance

Virtual Adoption of birds. The Sicily Pilot is located on a key juncture of the Eurasian main bird migratory route. As a consequence, this area is exceptionally rich in terms of its biodiversity. Iconic/rare bird species such as flamingos and herons can be found here, but their presence rely on the local maintenance of a solid ecological balance. These rare species represent a valuable resource not only as tourist attractions, but also to stimulate donations from companies and individuals. For example Tour du Valat, co-manager of the Rhone Delta Pilot, managed to leverage the presence of flamingos to generate additional revenue streams, by establishing partnerships with commercial companies (Française des Jeux) and by creating a digital platform for a donation-based flamingo adoption campaign (https://monflamant.com/en/). Similar initiatives could be considered in Sicily to support habitat conservation activities.

Virtual adoptions of bird species have not been included in the set of innovative financial solutions analysed in section 4.2, as we focused on value-capture and financing arrangements, as an alternative to traditional granting models. As a consequence, we don't have a clear view on implementation barriers for this type of instrument. Nevertheless, the project partner Tour du Valat has direct experience with this approach and could provide valuable support for the replication of this approach. Another clear advantage lies in the alignment of this approach with the NBS initiator's customary reliance on grant-based and donation-driven funding for restoration projects, avoiding the potential contrast that other value-capture options might introduce.

Table 5.23 Enablers and barrier to adoption of birds (donations) in the Sicily Pilot

Adoption of birds (donations)	
Financial barrier addressed: Low excludability	
Transfer enablers	Transfer barriers
Biodiversity ESS produced Presence of iconic/rare bird species (Flamingos, Heron etc.) Alignment with NBS initiator's customary financial model	Provider of financial services (transaction structuring, donation platform) not identified yet

Environmental Impact Bond (EIB). As mentioned above, the restoration activity in Sicily will deliver reduction of erosion and flooding risk ESS, which will benefit (reduce costs and damages) local farmers and residents. Methodologies for quantifying and projecting these have already been established. Actors within the above-mentioned categories that particularly benefit from these ESS could be identified for the establishment of value-capture arrangements. In addition, a precondition for establishing a value-capture arrangement (with payments from the beneficiary) to fund future restoration upscaling is the demonstration of a sufficient level of ESS delivery (cost saving/damage avoidance) to justify the investment. Assuming that the link between flood and/or erosion risk reduction ESS and restoration can be demonstrated and that these indeed result in cost saving for the identified actor, a value capture transaction could in principle be efficient without the need to implement innovative financial solutions. Nevertheless, in case of irregular and/or uncertain ESS output levels (Barrier 1), outcome-based mechanisms such as those found in EIB might be considered to distribute performance risks. As the EIB case studies suggested, cost-saving ESS such as flood/erosion risk reduction are particularly suited to arrangements of this kind.

Table 5.24 Enablers and barrier to Environmental Impact Bond or other outcome-based financial instrument in the Sicily Pilot

Environmental Impact Bond (EIB) or other outcome-based financial instrument	
Financial barrier addressed: Uncertain ESS performance	
Transfer enablers	Transfer barriers
ESS (Flood/erosion risk reduction) produced and quantified Cost-saving/damage avoidance, beneficiary (category) identified	Potential insufficient ESS output High transaction costs Potential paying-beneficiary not identified yet Provider of financial services (transaction structuring) not identified yet

5.8. Arcachon Bay

In Arcachon Bay, several ESS have been identified, along with clear links to the beneficiaries. This raises the opportunity to consider different alternative (or complementary) options in terms of innovative financial arrangements for the establishment and management of value capture and financing transactions. Due to the fact that the Pilot is located in an MPA, the applicable regulatory framework may impose restrictions on the implementation of financial arrangements that leverage private capital. This could represent a potential barrier to any innovative financial arrangement proposed below. Another potential cross-cutting barrier is the fact that the NBS initiator of the Arcachon Bay Pilot is not formally integrated in the governance structures for the MPA, thus limiting its capacity to influence future measures and financial models.

Below are listed potential options for innovative financial solutions to be considered when designing a restoration business model for the Arcachon Bay Pilot, based on the alignment with barriers and enabling factors detailed in section 4.2.

Carbon credits. The Pilot developed a solid methodology for the measurement of climate change mitigating ESS, i.e. carbon sequestration also considering the level of GHG emissions. The quantification of the overall carbon sequestering capacity of planned seagrass restoration is undergoing. Due to the particular focus of the Pilot on this ESS, the potential use of carbon credits has been already identified by the Pilot, looking at the French public label

“Bas-Carbone” as the most suitable carbon standard of reference. Fundamental requirements (and thus potentially relevant implementation barriers) for carbon crediting are:

a. The demonstration of carbon sequestration additionality, i.e. positive levels of carbon sequestration when compared to a baseline scenario.

b. The production of sufficient levels of ESS output, i.e. the sequestration of an amount of carbon-equivalent GHG, and therefore the issuance of an amount of carbon credits, sufficient to overcome the high transaction costs associated with the carbon crediting process (Financial Barrier 5).

c. The alignment of the methodologies used by the Pilot for the quantification of carbon sequestration with the Bas-carbone label standards.

The Bas-Carbone label only accepts applications from projects located within French territory. The second French restoration Pilot in the REST-COAST project, the Rhone Delta Pilot, is also planning the quantification of carbon sequestration generated by restoration, following the same methodology used in the Arcachon bay Pilot. As the label accepts “collective projects” (*projets collectifs*), the possibility for a joint project application for Bas-Carbone labelling and carbon credit issuance could therefore be explored.

Table 5.25 Enablers and barrier to carbon credits in the Arcachon Bay Pilot

Carbon Credits	
Financial barrier addressed: Low excludability	
Transfer enablers	Transfer barriers
Climate mitigation ESS produced and quantified Potential provider of financial services (carbon standard) identified	Potential insufficient ESS output High transaction costs Governance barriers

Biodiversity credits. In June 2023, France and the United Kingdom launched a Global Biodiversity Credits Roadmap which foresees the establishment of a new biodiversity credits initiative. Similarly to the option of carbon credits, the fundamental requirements (and thus potentially relevant implementation barriers) are:

d. The development and implementation of a methodology for quantifying biodiversity benefits in line with the requirements of the Global Biodiversity Credits Roadmap standard.

e. The demonstration of biodiversity additionality, i.e. the improvement of biodiversity metrics when compared to a baseline scenario.

f. Producing levels of ESS output sufficient to issue enough biodiversity credits to overcome the high transaction costs associated with the biodiversity crediting process. (Financial Barrier 5).

As the initiative has been announced only recently, details such as project eligibility, applicable methodologies for ESS quantification, project bundling are not yet known. WP3 will follow future developments on this issue to better assess the feasibility of biodiversity crediting in Arcachon Bay and other Pilots.

Table 5.26 Enablers and barrier to biodiversity credits in the Arcachon Bay Pilot

Biodiversity Credits	
Financial barrier addressed: Low excludability	
Transfer enablers	Transfer barriers
Biodiversity ESS produced and quantified Potential provider of financial services (Biodiversity credit standard) identified	Potential insufficient ESS output High transaction costs Governance barriers

Tourism user fees. The Arcachon Bay is a marine protected area with high touristic value. The positive influence of restoration on water quality and biodiversity will support the already well developed tourism economic sector. User fees can be established for granting access to specific areas of the Bay, or for new recreational activities linked to restoration. When restricting access in certain areas, the social acceptance of local residents accustomed to free access could be a barrier to implementation. User fees for tourists would be particularly useful to support the business model in the short-term, and could therefore complement other, more sophisticated arrangements that require longer time frames for their implementation (e.g. carbon credits).

Table 5.27 Enablers and barrier to tourism user fees in the Arcachon Bay Pilot

Tourism user fees	
Financial barrier addressed: (Long) Time lag for impact	
Transfer enablers	Transfer barriers
Water quality and biodiversity ESS produced Beneficiary identified Well-developed local tourism sector	Governance barriers Social acceptance

Environmental Impact Bonds (EIB) and smart contracts. The restoration of the seagrass bed in the Arcachon Bay offers sediment management, flood risk reduction and erosion risk reduction ESS, which are expected to benefit the Arcachon Basin Intercommunal Syndicate (SIBA), who is responsible for the management of these issues in the Bay. More specifically, the restored ESS will result in a reduction of future costs and damages associated with floods, coastal erosion and dredging of the bay’s navigation channels (including those granting access to the port). The precondition for establishing a value-capture arrangement (with payments from the beneficiary) to fund future restoration upscaling is essentially the demonstration of a sufficient level of ESS delivery to justify the investment. Assuming that the link between flood risk reduction, erosion risk reduction and sediment management ESS and restoration can be demonstrated and that these indeed result in cost saving for SIBA, a value capture transaction could in principle be efficient without the need to implement innovative financial solutions. Two financial barriers can be nevertheless envisaged as potentially relevant:

a. ESS outputs could be irregular and/or uncertain (Barrier 1). In this case, outcome-based innovative financial solutions that include mechanisms similar to those found in EIBs could be considered to distribute performance risks. As the EIB case studies suggested, cost-saving ESS such as those discussed here are particularly suited to arrangements of this kind. Another enabling factor is that these ESS are readily measurable and monitorable, as methodologies for this purpose have been already developed.

b. Cost savings are not sufficient to cover transaction costs (Financial Barrier 5). Transaction costs could be high, in particular if outcome-based arrangements are considered. Smart contracts could in this case be a potential solution. The high measurability and monitorability of the ESS discussed here is seen as an enabling factor. In particular, the reduction of sediment deposition would fit well with smart contracting, as it would also lead to simple and repeated transactions based on cost savings in periodic dredging operations.

Table 5.28 Enablers and barrier to Environmental Impact Bond or other outcome-based financial instrument in the Arcachon Pilot

Environmental Impact Bond or other outcome-based financial instrument	
Financial barrier addressed: Uncertain ESS performance	
Transfer enablers	Transfer barriers
ESS (Flood risk reduction, erosion risk reduction and/or sediment management) produced and quantified Cost-saving/damage avoidance, beneficiary identified	Potential insufficient ESS output High transaction costs Potential provider of financial services (transaction structuring) not identified yet Governance Barriers

Table 5.29 Enablers and barrier to smart contracts in the Arcachon Pilot

Smart contracts	
Financial barrier addressed: Ticket size mismatch/High transaction costs	
Transfer enablers	Transfer barriers
ESS (Flood risk reduction, erosion risk reduction and/or sediment management) produced and quantified Simple and repeated type of transaction	Potential insufficient ESS output Potential provider of financial services (transaction structuring, smart contracting platform) not identified yet Governance Barriers

5.9. Nahal Dalia

In Nahal Dalia, several ESS have been identified, along with clear links to the beneficiaries. Moreover, a considerable share of the overall economic value produced by restoration is expected to benefit a single actor, the Pilot site owner Kibbutz Ma'ayan Tzvi. These are favourable conditions for the financial upscaling of restoration and for the integration of innovative financial solutions in the NBS business model.

Below are listed potential options for innovative financial solutions to be considered when designing a restoration business model for the Nahal Dalia Pilot, based on the alignment with barriers and enabling factors detailed in section 4.2.

Tourism user fees. The comprehensive set of restoration activities encompassed in the Nahal Dalia Pilot is expected to make the site more appealing to tourists, in particular due to improved water quality and enhanced biodiversity. The Kibbutz Ma'ayan Tzvi, as the site owner, plans to capitalise on this potential by renovating its existing hospitality structure, anticipating an increase in income from this facility due to the enhanced attractiveness of the surroundings. In addition to this direct benefit, the implementation of various types of tourism user fees could be envisioned to strengthen the case for a eco-tourism business model. Social acceptance from local residents accustomed to free access to the area might pose challenges to the establishment of fees that restricts access to the site. An eco-tourism business model appears as an attractive option due to the ease of implementation (no major barriers, presence of a pre-existing hospitality facility), and it could establish revenue streams within shorter time horizons when compared to other options.

Table 5.30 Enablers and barrier to tourism user fees in the Nahal Dalia Pilot

Tourism user fees	
Financial barrier addressed: (Long) time lag for impact	
Transfer enablers	Transfer barriers
Water quality and biodiversity ESS produced Beneficiary identified Pre-existing hospitality facility	Social acceptance

Eco-labels. An additional benefit brought by the improvement of water quality is an increase in fish yields in the neighbouring fishing ponds run by the Kibbutz Dag'On. In addition, restoration ESS will also allow the treatment of fishpond effluents and the reduction of water abstraction, therefore mitigating the environmental impact and pollution generated by the fishponds business activities. The presence of (enhanced) provisioning ESS and the sustainability improvement in related business practices are enabling factors for the establishment of eco-labels for the certification of fish products sold on the market. Possible barriers to this approach are represented by the fact that a suitable financial service provider (certification) and label have not been identified yet, and that the demand for certified fish in the market of reference is unknown.

Table 5.31 Enablers and barrier to eco-labels in the Nahal Dalia Pilot

Eco-labels	
Financial barrier addressed: Uncertain ESS performance/Low measurability/Time lag for impact (Depending on the specific eco-label requirements)	
Transfer enablers	Transfer barriers
Provisioning ESS (fish) produced Improved sustainability of existing business	Financial service provider (certification) not identified yet Potential lack of market maturity

Carbon credits. The Nahal Dalia Pilot is currently considering the possibility of generating and selling carbon credits through ecosystem restoration. With the removal of the dam and the re-establishment of hydrologic connectivity, the construction of an alternative, artificial water reservoir will be required to sustain the operations of the contiguous fishponds. In order to enhance carbon sequestration, the NBS initiator is considering the plantation of reeds within the planned artificial water reservoir. WP3 has already presented the concept of carbon crediting, along with case study examples, to the Nahal Dalia stakeholders. The next planned step consists in a field visit in one of the few operating carbon projects in Israel, to acquire practical knowledge about the crediting process and identify potential barriers and enabling factors specific to the Israeli national context. In general terms, the fundamental requirements (and thus potentially relevant implementation barriers) to proceed with a blue carbon business model are:

a. The identification of a suitable financial service provider (carbon standard).

b. The demonstration of carbon sequestration additionality, i.e. positive levels of carbon sequestration when compared to a baseline scenario.

c. The production of sufficient levels of ESS output, i.e. the sequestration of an amount of carbon-equivalent GHG, and therefore the issuance of an amount of carbon credits, sufficient to overcome the high transaction costs associated with the carbon crediting process (Financial Barrier 5).

Table 5.32 Enablers and barrier to carbon credits in the Nahal Dalia Pilot

Carbon Credits	
Financial barrier addressed: Low excludability	
Transfer enablers	Transfer barriers
Stated interest from key stakeholders Planned activities to enhance ESS	Climate mitigation ESS not yet produced nor quantified Financial service provider (carbon standard) not identified yet Potential insufficient ESS output High transaction costs

Project bundling. The REST-COAST Nahal Dalia Pilot is not the only restoration project operating in the area. Other initiatives are currently implementing coastal restoration techniques and putting efforts into experimenting innovative financial approaches and NBS business models. Shared research goals and geographical scope suggest that synergies among the different projects should be explored, in particular with regards to the possibility of aggregating the different initiatives as a bundled investment proposal.

Table 5.33 Enablers and barrier to project bundling in the Nahal Dalia Pilot

Project bundling	
Financial barrier addressed: Uncertain ESS performance, ticket size mismatches	
Transfer enablers	Transfer barriers
Presence of several restoration projects in the area Homogeneity among restoration initiatives	Provider of financial services (bundling intermediary) not identified yet Lack of revenue generation

Environmental Impact Bonds (EIB). The restoration of Nahal Dalia will increase the resilience of the fishponds facilities, the contiguous road and railway infrastructures against floodings. The Carmel Drainage and Steams Authority, who already financially supports the Pilot through grants, is the main beneficiary from the reduction of flooding risks, as it is liable for related damages to properties in the area. The precondition for establishing a value-capture arrangement (with payments from the beneficiary) to fund future restoration upscaling is essentially the demonstration of a sufficient level of ESS delivery (cost saving/damage avoidance) to justify the investment. Assuming that the link between flood risk reduction ESS and restoration can be demonstrated and that these indeed result in cost saving for the Carmel Drainage and Steams Authority, a value capture transaction could in principle be efficient without the need to implement innovative financial solutions. Nevertheless, in case of irregular and/or uncertain ESS output levels (Barrier 1), outcome-based mechanisms such as those found in EIB might be considered to distribute performance risks. As the EIB case studies suggested, cost-saving ESS such as flood risk reduction are particularly suited to arrangements of this kind. Methodologies for quantifying and projecting flood risk reductions in the Pilot have not been established yet, and would be required for the measuring of performance indicators.

Table 5.34 Enablers and barrier to Environmental Impact Bond or other outcome-based financial instrument in the Nahal Dalia Pilot

EIB or other outcome-based financial instrument	
Financial barrier addressed: Uncertain ESS performance	
Transfer enablers	Transfer barriers
ESS (Flood risk reduction) produced Cost-saving/damage avoidance, beneficiary identified	ESS (Flood risk reduction) not quantified yet Potential insufficient ESS output High transaction costs Financial service provider (transaction structuring) not identified yet

5.10. Discussing financial innovation in the REST-COAST Pilots

In the previous deliverable D3.1, WP3 has reviewed the key financial arrangements already in place in the different restoration Pilots. Among these, no innovative financial arrangements were found, although some Pilots (in particular Nahal Dalia, Arcachon and Wadden Sea) have already started conceptualising possible strategies, introducing the topic of innovative instruments such as carbon credits and tourism user fees to the stakeholders. D3.1 has also evidenced how the REST-COAST restoration Pilots are aligned with the rest of the NBS sector in their over-reliance on public granting and lack of revenue generation.

Consequently, the most immediate contribution that financial innovation (and by extension, this deliverable) can bring is to present opportunities for capturing the values created by restoration and for leveraging resources from the private sector. We have identified several solutions that potentially fit with the context and the needs of each Pilot. The feasibility of innovative solutions critically depends on the characteristics of the Pilots (generated ESS, linked beneficiaries, geographical and landscape features, social-economic environment etc.), but also on the capacity of pilots and work packages to quantify and monitor ESS.

The proposed solutions discussed in this chapter will provide important tools for the co-development of tailored financing arrangements and NBS business models in each Pilot (T3.3.1). NBS business models based on eco-tourism, offsetting (carbon emissions, biodiversity or water footprint) and reduction of costs/damages (related to floods risk reduction, erosion risk reduction or sediment management) seems to be particularly promising in the context of restoration in coastal areas, and should be further examined and discussed in WP3 future work. Some of the innovative solutions that have been identified in section 4.2 seem to be not (yet) relevant or applicable in the current phase of the REST-COAST project. This includes arrangements like green bonds, tokenization, and PPP, which primarily pertain to the financing arrangements addressing financial barriers in the acquisition of up-front capital. These particular arrangements will likely become more relevant when considering larger-scale and longer term perspectives. Hence, the development and structuring of these mechanisms will likely be a key focus in Task T3.3.3 on financial scalability planning for restoration upscaling.

6. Conclusion

Goal of this deliverable. The overall objective of the present deliverable was the identification and analysis of promising innovative financial arrangements from around the world, and the assessment of the potential to transfer these to the REST-COAST Pilots, as well as other NBS projects.

Approach. By applying theories of financial and transaction cost economics to practical experiences in implementing innovative finance in NBS, we provided insights on the process of financial innovation for the financial upscaling of NBS. In particular, our study revealed a set of common barriers found in NBS finance that can be addressed by innovative financial solutions that have been implemented in real case studies of (coastal) nature restoration. We have thereby focused on solutions that leverage private sector investments and funding, as this is recognised as an especially promising approach for achieving financial upscaling in the sector. We further considered a series of conditions for the applicability of the reviewed innovative solutions to new NBS projects. Finally, we have compared these results with the context and needs of the REST-COAST restoration Pilots, identifying promising financial solutions for consideration in the co-development NBS business models in T3.3.1 and the financial scalability plans in T3.3.3.

Identified challenges. Our main conclusion is that, when it comes to implementing innovative financial solutions in coastal NBS, there are typically no low hanging fruits. Under most circumstances, successfully implemented innovative financial solutions cannot be simply transferred to new NBS projects. This is due to the presence of several interconnected barriers, most of which determined by local conditions, which limit the bankability of NBS and the applicability of innovative financial solutions for NBS financial upscaling. Moreover, with few exceptions such as carbon credits and eco-labels, innovative arrangements are not yet sufficiently standardised.

Way forward (T3.3). This deliverable has laid the groundwork for Task 3.3 by providing important tools for the development of tailored business models, bankable business plans and financial scalability plans leveraging innovative financial solutions in the REST-COAST restoration pilots.

Under current market conditions, the development of NBS business models that leverage innovative financial solutions needs to be based on in-depth assessments of financial barriers and business opportunities, tailored to the specific circumstances of each case. While NBS inherently deliver multiple values through multiple ESS, it is crucial to streamline business models to focus on the main relevant value proposition(s). In practice, this means identifying ESS (1) with significant economic value, (2) that can be quantified and measured effectively (3) for which solid value capture methods and other innovative financial solutions are available or can be developed. Focusing business models on the most relevant ESS (from the perspective of investment opportunities) also enables highly detailed business plans in terms of ESS quantification and revenue generation. Nonetheless, multi-functionality aspects should be emphasised in NBS business models, even when not comprehensively quantified and valued in monetary terms. This is important as multi-functionality represents a competitive advantage of NBS, as investors increasingly consider ESG factors in their decision-making. A descriptive assessment of generated ESS in this sense ensures a more comprehensive understanding of NBS overall impact on the environment and society.

In light of this, Task 3.3.1 should prioritise the identification of the most appealing economic values delivered by restoration in each Pilot, evaluating possible combinations with proposed innovative solutions. A collaborative scoping exercise involving Pilot leaders and local stakeholders will be instrumental in uncovering these values, guiding the development of effective and context-specific financial strategies for NBS. Progresses achieved in a given Pilot should be shared as learning lessons to the benefit of the others. Such exercise will produce new, valuable knowledge regarding the development of innovative NBS business models for upscaled coastal restoration. These lessons learned will be compounded in D3.4, which will contribute to the outscaling of NBS finance beyond our project thanks to the standardisation of applicable business models and to the definition of common financial criteria for bankable NBS.

By reviewing key innovative financial solutions implemented globally in restoration projects, and identifying those most suitable for the development of business models in each Pilot, this deliverable provided an important contribution to the achievement of objective 3 of the REST-COAST project, consisting in the “design and application of innovative financial arrangements and bankable business plans that support restoration upscaling in the Pilots”. As the work of WP3 progresses, the strategic implementation of innovative financial solutions within the restoration Pilots will evidence not only the possibility to unlock untapped sources of finance, but also the role of financial governance in catalysing transformational shifts towards long-term, upscaled restoration.

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8. Appendix 1 Case study database

This section presents a collection of case studies that have been used to review and assess the innovative financial solutions included in our analysis.

Table S1: Case study database, section 1

No.	Name of case study	Country	Type of NBS	Project size (Small < 1 million, medium < 20 million, large > 20 million)	Date and Project status
1	Zandmaas and Grensmaas public works projects (Netherland's Delta Program)	Netherlands	Coastal adaptation	Large	2019, implemented
2	Seychelles Blue bond	Seychelles	Coastal ecosystem conservation	Medium	2018, implemented
3	Nordic-Baltic Blue Bond	Denmark, Finland, Iceland, Norway, and Sweden	Coastal ecosystems conservation and restoration	Large	2019, implemented
4	Arkansas Water Utility Green Bond	Arkansas, USA	Watershed management	Large	2020, implemented
5	DC Water EIB	Washington D.C., USA	Stormwater management	Large	2016, implemented
6	Hampton EIB	Virginia, USA	Stormwater management	Medium	2020, implemented
7	Buffalo EIB	New York, USA	Stormwater management	Large	2014, implemented
8	Atlanta EIB	Georgia, USA	Stormwater management	Medium	2020, implemented
9	Louisiana wetlands EIB	Louisiana, USA	Coastal adaptation, Coastal ecosystem restoration (Wetlands)	Large	2017, withdrawn
10	Yuba Forest Resilience Bond	California, USA	Reforestation	Medium	2018, implemented
11	Deshkan Ziibi Conservation Impact Bond Project	Canada	Biodiversity conservation	Small	2019, implemented

12	Rhino Impact Investment Project	South Africa	Biodiversity conservation	Large	2021, implemented
13	Aotearoa permanent forest bond	New Zealand	Reforestation	Large	Planned
14	Fondo Acción (Fondo para la Acción Ambiental y la Niñez)	Colombia	Forest conservation and sustainable agriculture	Large	2000, implemented
15	Althelia's Climate Fund for Madagascar Climate and Conservation Investment Fund	Madagascar	Ecosystem conservation, reforestation	Large	2016, implemented
16	Althelia's Sustainable Ocean Fund	Focus areas in Latin America and the Caribbean, Africa and Asia	Coastal ecosystem conservation	Large	2017, implemented
17	Meloy Fund	Indonesia, Philippines	Coastal ecosystem conservation	Large	2017, implemented
18	Regen Network	Various	Forest conservation	Not mentioned	2017, implemented
19	GainForest	Various	Forest conservation	Not mentioned	2019, implemented
20	FLRChain	United Kingdom, Uganda	Reforestation	Not mentioned	2021, implemented
21	Project Genesis 2.0	Hong Kong	Forest conservation, reforestation	Not mentioned	2022, Planned
22	Papariko Blue Carbon project	Kenya	Coastal Adaptation, coastal ecosystem restoration (Mangroves)	Large	2021, implemented
23	BioTokens in Australia	Australia	Ecosystem conservation	Not mentioned	2017, implemented
24	Treecycle	Paraguay	Reforestation	Large	2018, implemented

25	PPP for sand nourishment in Pevensey Bay	United Kingdom	Coastal adaptation, sand nourishment	Large	2000, implemented
26	Oxley Creek green corridor	Australia	Ecosystem restoration	Large	2018, implemented
27	Tweed Sand Bypass	Australia	Coastal adaptation, sand nourishment	Large	2000, implemented
28	PPP for a flood-proof district in Bilbao	Spain	Watershed management, Stormwater management	Large	2016, implemented
29	Regional hybrid flood management, the Norfolk Broadlands	United Kingdom	Watershed management, Stormwater management	Large	2001, implemented
30	Mikoko Pamoja	Kenya	Coastal Adaptation, coastal ecosystem restoration (Mangroves)	Small	2012, implemented
31	Vlinder Myanmar Blue Carbon	Myanmar	Coastal Adaptation, coastal ecosystem restoration (Mangroves)	Large	2020, implemented
32	Markets and Mangroves Project	Vietnam	Coastal Adaptation, coastal ecosystem restoration (Mangroves)	Large	2012, implemented
33	Blue Forests Madagascar	Madagascar	Coastal Adaptation, coastal ecosystem conservation (Mangroves)	Large	2016, implemented
34	Yokohama Blue Carbon Project	Japan	Coastal Adaptation, coastal ecosystem restoration (Seagrass)	Medium	2015, implemented
35	Fukuoka Blue Carbon Project	Japan	Coastal Adaptation, coastal ecosystem restoration (Seagrass)	Medium	2019, implemented
36	J-Blue Project	Japan	Coastal Adaptation, coastal ecosystem restoration (Seagrass)	Medium	2021, implemented

37	Forested Wetland Assimilation in the Mississippi Delta	Luisiana, USA	Coastal adaptation, coastal ecosystem restoration (Wetlands)	Large	2012, withdrawn
38	Blue carbon Project gulf of Morrosquillo (Vida Manglar)	Colombia	Coastal Adaptation, coastal ecosystem restoration (Mangroves)	Large	2021, implemented
39	Miro Forestry	Ghana and Sierra Leone	Reforestation	Large	2020, implemented
40	India Sundarbans Mangrove Restoration Project	India/Bangladesh	Coastal Adaptation, coastal ecosystem restoration (Mangroves)	Large	2010, implemented
41	Selva Shrimp Kalimantan	Indonesia	Coastal Adaptation, coastal ecosystem restoration and conservation (Mangroves)	Large	2013, implemented
42	Galapagos National Park User Fees	Ecuador	Marine ecosystem conservation	Medium	1998, implemented
43	Bonaire Marine Park scuba diving fee	Bonaire (Netherlands)	Marine ecosystem conservation	Small	1992, implemented
44	International Visitor Conservation and Tourism Levy	New Zealand	Ecosystem conservation	Medium	2019, implemented
45	Environmental preservation fee in Bombinhas, Santa Catarina	Brazil	Coastal adaptation, coastal ecosystem conservation	Small	2013, implemented
46	Beach nourishments in North Carolina	North Carolina, USA	Coastal adaptation, sand nourishment	Medium/Large	2005, implemented
47	Measures against coastal erosion in Sirolo and Numana	Italy	Coastal adaptation, sand nourishment	Large	2020, implemented
48	The "Carnes del Pastizal" label	Argentina and Brazil	Ecosystem conservation	Small	2010, implemented

Table S2: Case study database, section 2

	Innovative financial measure
No.	

	Green Bond	EIB	Aggregation	Smart contract	Tokenisation	Carbon Credits	Eco-labels	Ecotourism user fee	LVC	PPP	Blended finance	Offsets
1	x		x									
2	x		x								x	
3	x		x									
4	x		x				x					
5		x										
6		x										
7		x										
8		x	x									
9		x										
10		x	x								x	
11		x										
12		x										
13		x										
14			x								x	x
15	x		x								x	
16			x				x				x	
17			x									
18					x	x						
19				x	x							
20			x	x								
21	x		x	x		x						
22			x		x	x						
23			x		x							x
24			x		x							
25										x		
26										x		
27										x		
28			x							x		
29			x							x		
30						x		x				x
31			x			x						x
32							x					
33						x						x
34						x						x
35						x		x				x

36						x				x		x
37						x						x
38						x		x				x
39						x	x					
40			x			x						x
41			x				x					
42								x				
43								x				
44								x				
45								x				
46									x			
47									x			
48							x					

Table S3: Case study database, section 3

No.	Barrier addressed						
	High Performance risks	Low measurability	Site specificity	Long lead time	Insufficient project size	Jointness	Low excludability
1	x	x			x		
2	x	x					
3	x						
4	x	x			x		
5	x						
6	x						
7	x						
8	x	x					
9	x	x					
10	x	x		x			
11	x						
12	x						
13	x						
14	x				x		
15	x				x		
16	x				x		
17	x				x		
18			x		x		

19		x			x		
20		x	x		x		
21	x	x					
22					x		x
23					x		x
24					x		
25	x					x	
26							
27	x					x	
28					x	x	
29	x				x	x	
30							x
31							
32							x
33							x
34						x	x
35						x	x
36							x
37							x
38							x
39							x
40	x				x		x
41							
42		x					x
43							x
44							x
45							x
46							x
47							x
48							x

Table S4: Case study database, section 4

No.	Enabling conditions of applicability	Hindering conditions of applicability	Financial service providers and financial intermediaries	Public/Philanthropy sector support	Sources
1	High credit rating; Pipeline of investment-ready eligible projects; Procurement criteria prioritising NBS	Low credit ratings; Insufficient project size	Certification, credit rating, verification	None	Marsters et al., 2021
2	Alignment with government policy agenda Pipeline of investment-ready eligible projects	Low credit rating; need for clear economic benefits; Coordination of multiple parties, high transaction costs	Transaction structuring, credit rating, verification	Credit enhancement	Iyer et al. 2018; Tirumala and Tiwari 2022
3	Not mentioned	Complex product with limited direct replicability	Transaction structuring, credit rating, verification	Not mentioned	Tirumala and Tiwari 2022; NIB 2019
4	High creditworthiness; Credible certifications	Not mentioned	Certification, third-party verification, credit rating	Granting	Marsters et al. 2021
5	Alignment with government policy agenda	Lack of track record	Transaction structuring, financial advisory, third-party verification, performance measurement	Enabling legislation, granting	Brand et al. 2021, Goldman Sachs (n.a.)
6	High credit rating; regulatory incentives	Lack of pipeline of investment-ready projects; Insufficient project size	Transaction structuring, financial advisory, third-party verification, performance measurement	Granting, regulatory incentives	Quantified Ventures 2023; CBF 2023a, b.
7	Alignment with government policy agenda	Not mentioned	Transaction structuring, financial advisory, third-party verification, performance	Granting	Quantified Ventures 2023

			measurement		
8	Single proxy metric (Volume of stormwater storage) across the different projects	High uncertainty and transaction costs due to lack of track record	Transaction structuring, financial advisory, third-party verification, performance measurement	Granting	Quantified Ventures 2023, Brand et al. 2021
9	"Polluter pays" funds available through the deepwater horizon oil spill fund	Changes in political preferences resulted in the interruption of the project	Transaction structuring, financial advisory, third-party verification, performance measurement	Granting	EDF 2018
10	Repayment structure matches the time horizon of benefit generation; Focus on measuring ESS with clear economic benefits	Lack of track record; Plurality of paying beneficiaries increase complexity and transaction costs; Trade off between precise measurement and ESS price.	Transaction structuring, financial advisory, third-party verification, performance measurement	Credit enhancement, granting	BFC 2017
11	Community involvement and relationship-buildi ng	Misalignment between financing cycle and restoration benefits; Difficulties in stakeholders coordination and standardisation complex systems	Transaction structuring, third-party verification, performance measurement, certification	Granting	Arjaliès, 2021
12	Use of proxy metrics	Difficulty in tracking number of individuals varies from species to species	Transaction structuring, performance measurement, third-party verification	Granting	The Green Finance Institute 2023c
13	Not mentioned	Arrangement complexity is a source of structural risk (risk mitigation and revenue	Investment intermediary, transaction structuring, performance	Granting	Hall et al., 2017 Hall and Lindsay 2018

		generation tradeoff)	measurement, third party verification		
14	Track record of social and environmental projects; Program diversification; Expertise in innovative finance mechanisms with private sector engagement	Trade-off between private corporate objectives and the non-profit interests; Building relations and policy change requires long time frames that are incompatible with some investors	Project aggregation, certification, transaction structuring, financial advisory	Granting, credit enhancement	Bath et al., 2020
15	Strong link between conservation and economic development	Country risks; Limited beneficiary payment capacity; Bureaucratic processes distancing stakeholders from project managers	Investment intermediary, transaction structuring, project aggregation	Granting	Gibbon 2017; Michaelowa et al. 2021
16	Not mentioned	Lack of track record; Projects are often early-stage and involve complex, multi-level systems of stakeholders	Project aggregation, transaction structuring	Credit enhancement	Green Finance Institute 2023b
17	Not mentioned	Lack of track record	Project aggregation, transaction structuring, financial advisory, certification.	Granting, credit enhancement	Green Finance Institute 2023a USAID 2021
18	Not mentioned	Not mentioned	Not mentioned	None	Booman et al. 2021
19	Data-rich transactions; Plurality of monitoring instruments (Satellites, drones, cameras, field monitoring) results in both auditable and high	An accurate combination and integration of data requires additional kinds of technology such as artificial intelligence, machine learning and Internet of Things.	Third-party verification	None	GainForest 2023, Kotsialou et al. 2021

	resolution data.				
20	Smart contract structure is easily tailored to specific project needs	Regulatory gaps; Monitoring and information verification delay rewards. Low stakeholders' digital literacy; long-term incentives and more comprehensive forest conservation could not be included through smart contracts.	Third-party verification	Granting	Mulley 2021, 2022
21	Not mentioned	Regulatory and policy gaps, lack of market maturity.	Third-party verification	None	BIS 2022
22	Prepaid forward model, whereby payments for carbon credits are made in advance and delivery is guaranteed. Integration of indigenous knowledge.	Not mentioned	Standard setting, third-party verification	Granting	Solid World, 2023
23	Governmental development offset framework	Not mentioned	Transaction structuring	Regulatory incentive, granting	CommBank 2019
24	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Czura 2022
25	Operating costs represent a significant share of the overall costs.	Contracting and tendering was time consuming and a learning process for all parties due to lack of experience in PPP.	Not mentioned	Project specification and supervision	Bisaro and Hinkel 2018 Tanis and Vergeer 2008
26	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Baroni et al. 2019 Brisbane City, 2018

27	Specific enabling legislation enacted; Uncertain technology	Risks related to the large variability in coastal processes	Financial advisory	Enabling legislation	Ware and Banhalmi-Zakar 2017
28	The relocation and compensation of companies operating on the site was managed with ample preparation time; Broad stakeholders involvement.	The great number of stakeholders involved delayed the realisation of the project. Initial lack of trust in the commitment of private partners to pursue wider co-benefits	Not mentioned	Granting	Climate Adapt 2016, Baroni et al. 2019
29	Broad, periodic and digital public consultations; Integration of wider benefits within the financial limits of the project.	Partial social resistance to restoration	Not mentioned	Project specification and supervision	Climate Adapt 2020b
30	Long-term research and community engagement background; Community-based model integrating education, employment and training for long-term sustainability	Wider-scale co-benefits are not captured yet; Unstable carbon credit prices; Insufficient project size to achieve economies of scale and global carbon credit markets; Lack of inclusion of soil carbon leaves a major part of carbon sequestration untapped; Sea level rise not accounted for.	Standard setting, transaction structuring, third-party verification, financial intermediary	Granting	UNDP 2020, Wylie et al. 2016
31	Community-based model integrating education, employment and training for	Not mentioned	Standard setting, transaction structuring, third-party verification	None	Vanniarachchy 2020

	long-term sustainability				
32	Proven direct economic benefits of certifications. Broad stakeholders involvement	UN-REDD application for carbon credits dropped due to lengthy bureaucracy.	Standard setting, third-party verification	Not mentioned	Wylie et al. 2016
33	Not mentioned	Incoherent policy framework.	Standard setting, third-party verification	Enabling legislation	Wylie et al. 2016
34	Development of ad hoc carbon crediting scheme for local offsetting; Alignment with government policy goals; Local social acceptance and support; Broad stakeholders participation.	Not mentioned	Not mentioned	Granting	Kuwae et al. 2022; Suehiro et al. 2020
35	Local social acceptance and support; Broad stakeholders participation.	Not mentioned	Not mentioned	Granting	Kuwae et al. 2022
36	Dynamic carbon credit pricing (based on relative co-benefits) and flexible scheme for methodologies. Local social acceptance and support; Broad stakeholders participation.	Not mentioned	Transaction structuring, third-party verification	Granting	Kuwae et al. 2022
37	Inclusion of soil carbon sequestration	The project was withdrawn due to large uncertainties in GHG sequestration estimates	Standard setting, transaction structuring, third-party verification	Granting	Mack et al. 2022, Sapkota and White 2020

38	Community-based model integrating education, employment and training for long-term sustainability	Limited local capacity in environmental governance	Standard setting, transaction structuring, third-party verification	Granting	VERRA 2021, Conservation International 2022
39	Clear revenue streams (forestry sector)	Not mentioned	Certification, standard setting, transaction structuring, third-party verification	None	GPC 2021, MIRO 2022
40	Cheap labour costs. Inclusion of soil carbon sequestration.	Several climate and anthropogenic pressures on restored areas. Sea level rise was not accounted for.	Standard setting, transaction structuring, third/party verification	None	Wylie et al. 2016
41	Investment in marketing of the Selva Shrimp label. Supportive role of Government passing new regulation for certified aquaculture and payments for ecosystem services	Uncertain landscape-level impact. Restoration is measured through proxy which is not descriptive of ecosystem health, and there is no horizontal collaboration among farmers to manage area-level risks.	Certification, third-party verification, financial advisory, financial intermediary	Granting, supervision, enabling legislation	Bottema 2019
42	Part of the revenues from the park are used to reduce pressures on the ecosystems in the long term; Presence of Charismatic species of fauna; Tourism is the main economic sector in the	Illegal fishing, poaching and resource extraction create pressures on the ecosystems. Fees are not based on real recreational value to the users, nor to the cost of the park.	None	Granting, enabling legislation	Benitez et al. 2001

	island. Price discriminating fees				
43	High willingness to pay	Scuba diving industry opposing the increase of fees to optimal level	None	Granting	Brenes Vega 2004
44	High willingness to pay; Growing tourism sector	Not mentioned	Not mentioned	Enabling legislation	Ministry of Business, innovation and employment 2023
45	High willingness to pay; growing tourism sector.	Not mentioned	Not mentioned	Enabling legislation	Prefeita Municipal de Bombinhas, 2013
46	Clear, yet unequally distributed, recreational and risk mitigation values of restoration.	Instances of public resistance to increased taxation for coastal management.	None	Enabling legislation	Mullin et al. 2018
47	Strong public information, stakeholder consultation and cooperation with local communities; Cost-benefit analysis demonstrated tourism revenues as co-benefits.	Tension between future budget uncertainties and need to repeat beach nourishment periodically.	None	Enabling legislation, granting	Climate Adapt 2020a
48	Proof of increase of profit from the sale of certified products (market demand)	Market conditions limiting the promotion of sustainable ecosystem management. Possible trade-offs with other productive activities carried out within the certified farm.	Certification, third-party verification	Granting	Altmann and Berger Filho 2020

Table S5: Case study database, References

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