

DuneFront

Deliverable 16.2

Stakeholder Engagement Strategy

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Stakeholder Engagement Strategy

D16.2

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Author(s)	Coco Koedooder; Ine Moulaert; Dries Bonte
Lead beneficiary	VLIZ
Contributors	With significant contributions from Nicolas Robin, Bruno Castelle, Marie-Helene Ruz, Paolo Rosas Santos, and Oliver Lojek.
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Executive Summary

This deliverable contains the **stakeholder engagement strategy (D16.2)** for the Horizon Europe Research and Innovation project of DuneFront. DuneFront is a multi-disciplinary and multi-national project which aims to demonstrate that **Dune-Dike hybrid Nature-based Solutions** (DD-hybrid NbS) can efficiently integrate dikes with dunes as a sustainable, inclusive, and aesthetic solution to coastal protection while ensuring coastal safety under climate change. DuneFront will do this by collecting data from 12 pilots (Demonstrator sites) spread across 4 vulnerable coastal areas in Europe. To realize the objectives of the different tasks, deliverable, and milestones, DuneFront partners must contact and interact with several local, regional and global stakeholders throughout the project. A stakeholder is hereby defined as “any group or individual that is affected by or can affect the project’s objectives and/or achievements”. Stakeholder engagement is further defined as “any uni- or bi-directional interaction with a stakeholder or stakeholder group”. The stakeholder engagement strategy hereby acts as an overview of how DuneFront plans to coordinate and engage with these stakeholders during its project lifetime.

In addition to its mandatory requirement in all Horizon Europe Research and Innovation projects, a key objective of the strategy is to facilitate communication between and amongst DuneFront partners and relevant stakeholders in a clear, and systematic manner. The strategy further aims to help coordinate engagement activities in a manner that avoids stakeholder fatigue, a common obstacle where stakeholders lose interest, trust, or motivation to engage with the project team, resulting in reduced feedback, support, and/or collaboration. The stakeholder engagement strategy in DuneFront is therefore a systematic approach designed to identify, understand, and manage the perspectives, interests, and concerns of various stakeholders. It begins with a Stakeholder Assessment, where stakeholders are identified and grouped into stakeholder clusters. Their relevance to each of the different tasks, deliverables and milestones is determined in order to construct a tailored Stakeholder Engagement Plan that is monitored and evaluated as the project progresses.

The stakeholder engagement strategy is outlined across several chapters. In Chapter **1** details of the aim and objectives of DuneFront regarding stakeholder engagement are outlined. Chapter **2** introduces the theory and terminology underpinning the engagement strategy. Chapter **3** provides a country-specific overview of coastal safety management, including legislation, responsibilities, perspectives, and challenges related to each of the 12 Demonstrator sites. Chapter **4** compiles best practices and lessons learned on stakeholder engagement from DD-hybrid NbS assessment reports. Chapter **5** identifies the relevant stakeholders and groups present at the Demonstrator site in order to begin constructing the engagement plan. Chapter **6** offers a timeline of planned engagement activities aligned with project milestones; and Chapter **7** emphasizes the ongoing monitoring and flexibility of the strategy to adapt as needed.

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List of abbreviations

Abbreviation	Explanation
DD-hybrid NbS	Dune-Dike hybrid Nature Based Solutions
WPs	Work packages
NbS	Nature-based Solution
PDT	Predictive Digital Twin
DSS	Decision-Support System
R&D	Research and Development
PDEC	Plan for Dissemination and exploitation, including Communication activities
DMP	Data Management Plan
RRI	Responsible Research and Innovation
GDPR	General Data Protection Regulation

1. Introduction

1.1 DuneFront and the objective of Task 16.3 (D16.2)

Historically, coastal protection is typically achieved through engineering-based solutions, where dikes represent a traditional and conventional coastal defense infrastructure but one that is costly to construct at large scales. Natural dunes provide a cheaper and more sustainable alternative, but their effectiveness due to their dynamic behavior, is not well characterized. The project **DuneFront** aims to demonstrate that **Dune-Dike hybrid Nature-based Solutions (DD-hybrid NbS)** can efficiently integrate dikes (e.g. static hard infrastructure) with dunes (e.g. dynamic aeolian and vegetated sediments) as a sustainable, inclusive, and aesthetic solution to coastal protection while ensuring coastal safety under climate change. In this manner, DD-hybrid NbS help promote biodiversity and the restoration of nature while safeguarding human assets and blue economic activities. DuneFront’s 19 work packages (**WPs**) are grouped into five components (**Figure 1**) that include management (WP1-WP3), research and innovation (WP4-WP12), actions (WP13-WP15), communication (WP16-WP18) and ethics (WP19).

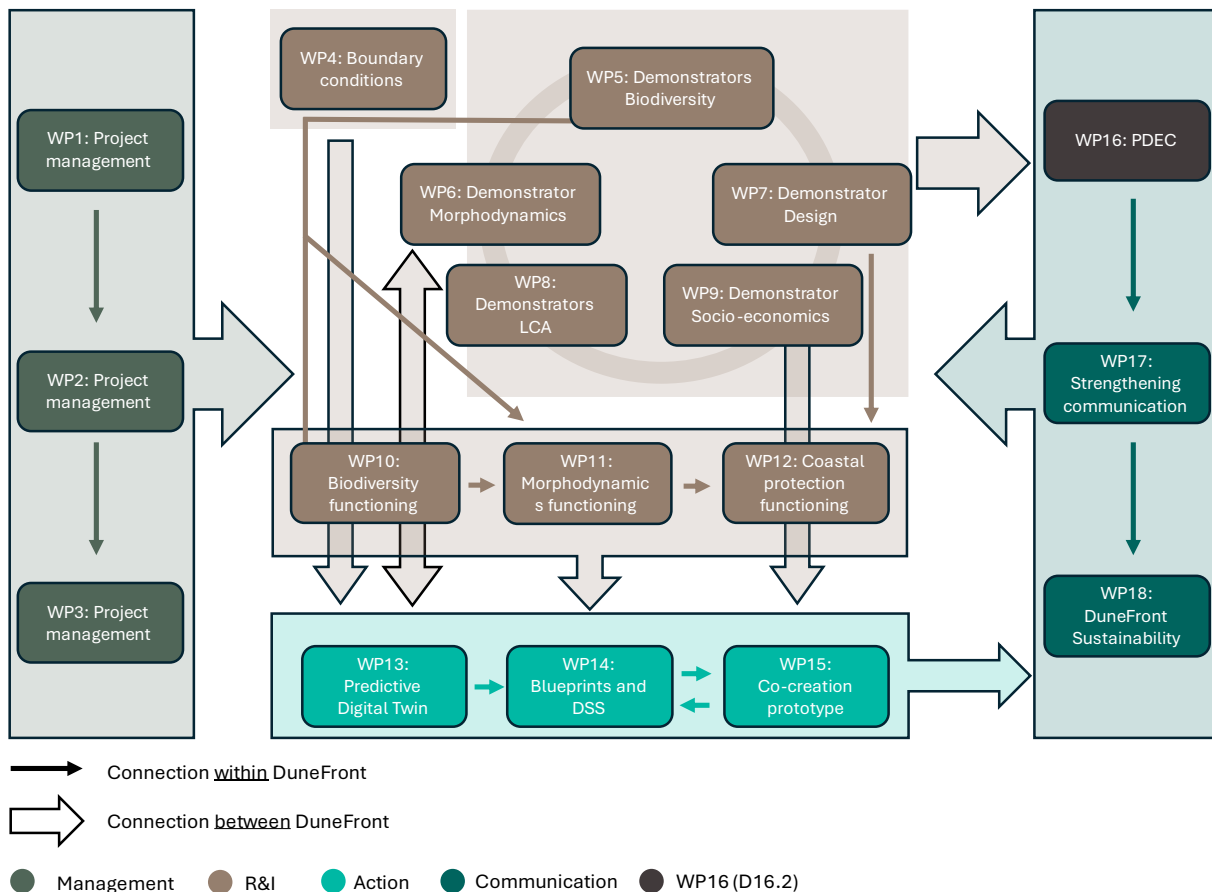


Figure 1. Structural overview of the work packages (WPs) in DuneFront.

DuneFront will achieve its objective by identifying key biological, physical, and socio-economic boundary conditions (**WP4**), translating evidence on biodiversity, morphodynamics and design from twelve DD-hybrid NbS Demonstrator Sites (see **Figure 6**) across Europe (**WP5-WP9**) and pinpoint the multi-functional role these NbS can play along vulnerable European coasts (**WP10, WP11, WP12**). The integration of this multidisciplinary knowledge into a predictive digital twin (PDT) that models and visualizes DD-hybrid NbS under different storm simulations and climate change scenarios (**WP13**) will pilot the development of a Decision-Support-System (DSS), create coastal and marine infrastructure Blueprints (**WP14**), and help advise the installation of a new prototype (**WP15**) along one of the most recreated coasts of Belgium (De Panne) through a co-creation process. The developed end-user tools will provide a wide range of stakeholders with design, installation, and market-ripe business plans to continue to promote and upscale DD-hybrid NbS. In addition to research and development, the success of DuneFront lies in structural changes in governance and policy and an increased awareness in DD-hybrid NbS from society at large. Through its Demonstrator-site-based approach and international partners spread across 4 vulnerable coastal areas in Europe, DuneFront must take into consideration and interact with a diverse and wide range of global, regional, and local stakeholders. These stakeholders will need to be connected and engaged with in a coordinated and constructive manner. A Plan for Dissemination and exploitation, including Communication activities (**PDEC**) and a stakeholder engagement strategy was hereby developed (**WP16**) and will be implemented and monitored throughout the lifetime of the DuneFront project (**WP17**) and beyond (**WP18**).

WP16.3 concerns the development of a **stakeholder engagement strategy** for DuneFront (**D16.2**). It acts as a framework of the stakeholders that DuneFront plans to engage with in a coordinated and systematic manner. A key objective of the strategy is to facilitate communication between and amongst partners and stakeholders in a clear, and transparent manner while avoiding stakeholder fatigue. Following an assessment of the stakeholder engagement culture at the local, regional, and EU level, stakeholders are identified in connection to the different work packages and the 12 Demonstrator sites. From there, a selection of stakeholders will be made (**M16.2**) that will be engaged with throughout the project's lifespan. The stakeholder engagement strategy, presented here, will include the following sections (**Figure 5**):

1. **Stakeholder Theory** – including the definitions used in the project as well as the theoretical basis of this stakeholder engagement plan
2. **Stakeholder Engagement Culture** – at the national and EU-level for the 12 different Demonstrator sites.
3. **Stakeholder Assessment** – of the stakeholders involved in the different tasks, deliverables and milestones of DuneFront
4. **Stakeholder Engagement Plan** – outlining the activities planned in DuneFront.
5. **Monitoring and Evaluation** – of the stakeholder engagement procedure within DuneFront.

1.2 Importance of a Stakeholder Engagement Strategy in DuneFront

The importance of a stakeholder engagement strategy is highlighted by three main reasons.

(1) In a pragmatic sense, the implementation of a stakeholder engagement strategy helps a multi-disciplinary and multi-national project such as DuneFront run more smoothly by keeping track and streamlining moments of engagement while reducing **stakeholder fatigue**. Stakeholder fatigue is often identified as a major obstacle during stakeholder engagement¹ and occurs when stakeholders lose interest, trust, or motivation to engage with the project team, resulting in reduced feedback, support, or collaboration.

(2) Evaluations of Horizon 2020, the predecessor of Horizon Europe, resulted in a Responsible Research and Innovation (RRI) framework for Research and Innovation Horizon Europe projects which includes the submission of a stakeholder engagement plan².

(3) The stakeholder analysis helps generate information about the relevant actors present in a project, assesses their attitude, interests, agendas, and potential influence on decision-making processes³. Stakeholder engagement initiatives can hereby be implemented to highlight and clarify potential misperceptions surrounding DD-hybrid NbS amongst different stakeholder groups.

1.3 Connection to other work packages

The stakeholder engagement strategy (D16.2) represents an overview of the manner in which stakeholders are involved in DuneFront. In the majority of work packages contact with external stakeholders will be undertaken. Work packages where stakeholder engagement is a key component within their respective tasks include those related to data management (T1.3), communication (T16.1, T16.4, T16.5), socio-demographic analyses (WP9), the upscaling of DD-hybrid NbS (WP14) and the co-creation process of a DD-hybrid NbS in De Panne (WP15). While information regarding the planned stakeholder engagement activities is summarized for each work package in Chapter 5, more specific details around stakeholder engagement will be found in the deliverables and milestones of these respective work packages.

1.4 Ethics in Stakeholder Engagement

Several stakeholder communication and engagement activities contain ethical aspects related to human and personal data, and the environment. Activities include (1) the involvement of external participants in interviews/surveys and workshops, (2) the collection and processing of personal data and the use of secondary data for socio-economic analyses, and (3) the involvement of non-EU partners. The European Commission has hereby prescribed ethical principles and a practical informed consent procedure. DuneFront has hereby appointed an external and independent ethics advisor and consultant that will provide an **ethics report** for three planned reporting periods. Leads of the tasks deliverables and milestones requiring and organizing engagement activities with external stakeholders are

responsible for consulting and adhering to the Ethics Advisor Guiding Document. The ethical issues, guidelines and actions related to stakeholder engagement activities are summarized in **Table 1**. Therefore, any Stakeholder Engagement activities in the DuneFront project will be subject to informed consent and relevant ethics approvals that will be obtained, and personal data processing will be in compliance with data protection laws, including the GDPR⁴.

Table 1. Ethical guidelines related to stakeholder engagement activities.

Human Participation		
Human participation in research/interviews through Stakeholder surveys/interviews/participation/ Expert surveys/interviews.	<ul style="list-style-type: none"> Human participation should be voluntary, based on informed consent and right to withdraw at any time. All participating project partners should request and obtain ethics approvals for human participation by relevant bodies (e.g. institutional or regional Research Ethics Committees), in accordance with national laws, prior to the start of the relevant activities involving human participation. 	<ul style="list-style-type: none"> All external parties that are contacted and involved in the project will be informed through the informed consent sheet prior to participating in an activity. All partners involved in these activities will obtain approval through their institutional or regional Research Ethics Committee.
Personal Data		
Personal data collection and processing from surveys, interviews and workshops. Socio-economic factors will be analyzed, which may include sensitive data. Secondary use of data may be used for the socio-economic analysis. Certain raised issues may be politically or professionally sensitive for the respondents.	<ul style="list-style-type: none"> A Data Management Plan (DMP) needs to be in place for the personal data to be processed within the project and the sensitive information which may be generated from the project. To demonstrate compliance with the General Data Regulation (GDPR) (EU) 2016/679⁴ the DMP should describe the procedures and the technical/security/organizational measures that will be in place to protect personal data. The DMP should also describe in detail the anonymization/pseudonymization procedures to be used for protecting particularly sensitive information e.g. (political/professional). A Data Protection Officer (DPO) must be appointed, and their contact details should be made available to all research participants through the informed consent/information sheet. 	<ul style="list-style-type: none"> The revised DMP (D2.1) for the project will include the procedures that are in place to protect personal and sensitive data A Data Protection Officer will be appointed and will be indicated on the informed consent sheet and included in the revised DMP.

1.5 Reading Guidelines

The stakeholder engagement strategy is presented across several chapters that can be read as stand-alone documents as they convey relevant information for internal and external stakeholders. Background information and theory concerning the process of stakeholder engagement can be found in Chapter 2. Preparatory steps of the stakeholder engagement

process in DuneFront include the state of play and best practices and lessons learned from 12 DD-hybrid NbS Demonstrator sites that are presented in Chapter **3** and Chapter **4**, respectively. The process of stakeholder identification and mapping and a list of relevant stakeholders is presented in Chapter **5**. Chapter **6** highlights a timeline of the stakeholder engagement activities followed by a description of the different engagements that are expected to take place. Lastly, Chapter **7** highlights the monitoring and evaluation periods planned for DuneFront. It is important to note, that while the stakeholder engagement strategy represents an overview of planned engagements, a full stakeholder assessment conducted for each of the individual objectives of each work package task, is beyond the scope of the stakeholder engagement plan.

2. Stakeholder theory and terminology

To ensure clarity and transparency of the stakeholder engagement strategy proposed in DuneFront, several terms and concepts must first be defined and described. The theoretical outline presented here will act as the backbone of the stakeholder engagement strategy.

Briefly, the **Stakeholder Engagement Strategy** is a framework to effectively interact and collaborate with stakeholders who have an interest or are in any way impacted by the activities and outcomes of a project or initiative. The strategy will outline how different stakeholders will be involved within different aspects of the project. Importantly, it's a systematic method to list, understand, and manage the different perspectives, interests, expectations and concerns of different stakeholders. It typically starts with a **Stakeholder Assessment** which involves **Stakeholder Identification**, clustering them into stakeholder groups, followed by a **Stakeholder Mapping** to estimate their potential relevance to a project. An overview of the different components in a typical stakeholder assessment can be found in **Figure 2**, and is modified from a flowchart presented by Blue Balance¹. This process helps to prioritize stakeholders and tailor engagement approaches accordingly within the final **Stakeholder Engagement Plan**. This plan is subsequently monitored and evaluated as the project progresses. In theory, the assessment can be conducted for each aim and objective of the different work package deliverables and milestones in DuneFront (e.g. the co-creation, communication, and dissemination objectives in DuneFront), however its execution is beyond the scope of this deliverable. The different components of a stakeholder assessment are further described in more detail below.

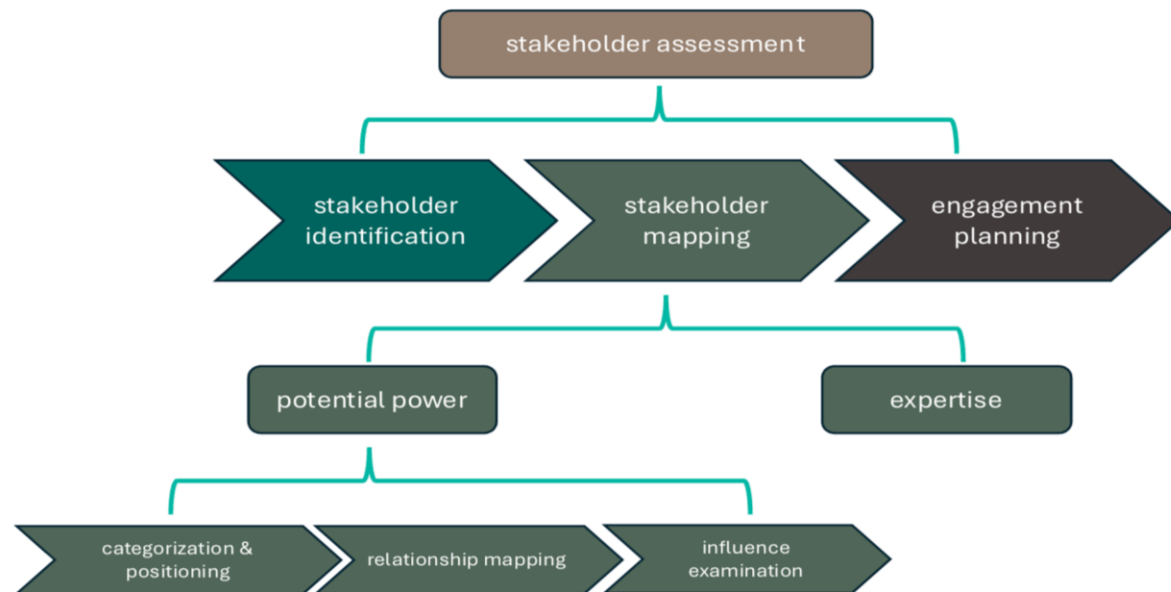


Figure 2. Overview of the stakeholder assessment.

2.1 Stakeholder Identification and Stakeholder Groups

The first step in a stakeholder assessment involves the identification of stakeholders to a project and placing them into different stakeholder groups. Despite the large number of projects involving stakeholders and scientific studies on stakeholder engagement, the definition of a “**stakeholder**” is not formally defined⁵. Its definition largely differs based on the selected range of actors one wishes to include as stakeholders. A well-accepted definition of a stakeholder has been proposed by R. Edward Freeman⁶ in 1984 who defines it as:

“Any group or individual who is affected by or can affect the achievement of an organization’s objectives”

There are several reasons⁷ why a broad definition is chosen within a stakeholder engagement strategy^{*1}. Typically, it will encompass a larger list of actors that may be associated to a project and is implemented to limit and reduce stakeholder identification bias that inevitably occurs. By obtaining a larger list of stakeholders, in comparison to the one obtained when utilizing a stricter definition, one can aim to reduce the exclusion of certain groups, identify actors fulfilling multiple roles within a stakeholder engagement framework, or whose engagement changes as the project progresses.

^{*1} Although it has also been argued that effective communication is hindered by the lack of consensus and conceptual ambiguity around the term ‘stakeholder’⁸

After stakeholders have been identified, several of their characteristics are gathered including potential perspectives towards the project, working field, possible connections, or their support/opposition in relation to the project or initiative. This data is collected to determine their overall influence and expertise towards the outcome of a project and the varying roles they may play in achieving the aims and objectives of DuneFront (e.g. see *later Chapter 2.2 stakeholder mapping*).

Based on the described characteristics, stakeholders are categorized into **stakeholder groups**. Typically, the categorization is done according to the “**Quadruple Helix Innovation Model**”⁹. Stakeholders are hereby grouped according to the following four categories: **(1)** academia, **(2)** industry, **(3)** government, and **(4)** the public/ civil society. The model is an extension of the “Triple Helix of knowledge”^{*2} that was first proposed in a study of innovation in science and technology by Etzkowitz and Leydesdorff¹¹ which excluded the fourth category. The latter was later included to acknowledge the influence of media and culture on the public and its impact on the final outcome and success of a project.

In DuneFront, the four groups of the Quadruple Helix Innovation Model were further defined to include the following components:

1. **Research and innovation** – academic bodies, researchers, scientists, university professors and students in relevant scientific fields. In DuneFront, project partners include researchers and experts in engineering and geosciences, ecology, connecting and co-creating, and construction.
2. **Industry impacting and impacted by coastal management infrastructure** – companies affiliated to the blue economy including representatives of the dredging and construction industry, environmental engineering, manufacturers of material, and the recreational and tourism industry.
3. **Policy makers, authorities responsible for coastal management, certification authorities** – at a local, regional, national, and European scale, including government agencies and environmental regulatory bodies overseeing compliance with environmental laws and regulations.
4. **General public, NGO, local coastal communities** – local, national, and European community members living near or visiting or (for recreational

^{*2} Recently, the “**Quintuple Helix Innovation Model**”¹⁰ proposed that the environment should be considered as a 5th stakeholder category. The environment is directly impacted by the implementation and achievement of a project such as DuneFront. Its inclusion would consider coastal ecosystems that provide natural protection against erosion and storm surges (e.g. dune habitats), endangered or protected species that inhabit coastal areas (e.g. marram grass), and climate and weather patterns affecting coastal dynamics (e.g. storms and sea level rise). While relevant, the addition of a 5th category adds complexity that hinders its pragmatic inclusion and is beyond the scope and the aim of the stakeholder engagement objectives for DuneFront.

purposes) making use of (vulnerable) coastal areas who are directly affected by coastal erosion, flooding, and storm surges, non-governmental organizations (NGOs) focused on environmental conservation, coastal resilience, and community engagement. Environmental activists advocating for sustainable coastal development and nature-based solutions.

2.2 Stakeholder Mapping

After stakeholders have been identified they can be grouped and mapped according to several characteristics in a “**stakeholder mapping**” exercise. Several methods and brainstorming activities have been developed to investigate the relationships that exists between stakeholders¹². Visual representations can help identify key stakeholders to engage with depending on relevant attributes such as their influence or interest in a project such as DuneFront. Another key benefit is the possibility of finding patterns and gaps in the selection of stakeholders that a project plans to engage with. Two common stakeholder mapping exercises are described in further detail below.

The relationship between stakeholders can be mapped using a **social network analysis**. A graphic illustration of a social network map visualizing the relationships existing between and amongst stakeholder groups can be found in **Figure 3**, which was modified from a figure depicted in Blue Balance¹. The higher the number of connections a stakeholder has the higher its potential influence within a project. The exercise can be used to help identify stakeholders with a high potential influence, where the more connections a stakeholder has to other stakeholders, the stronger the influence it can exert within a project.

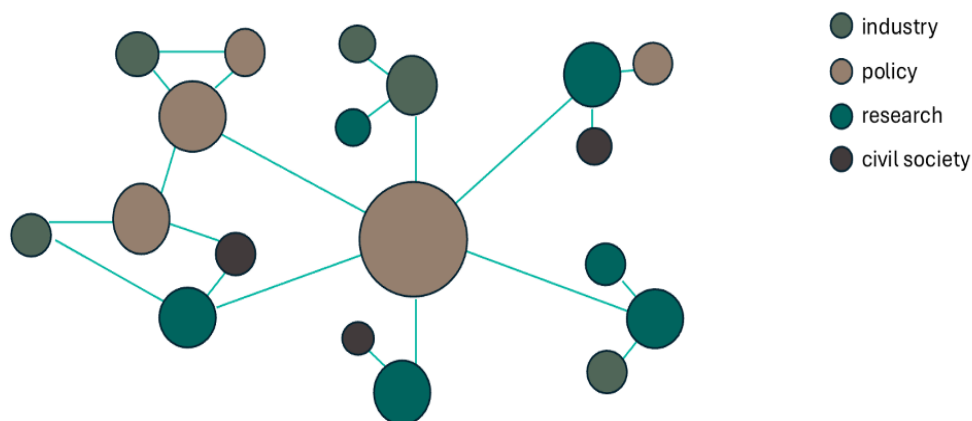


Figure 3. Graphic illustration of a social network analysis.

The influence of stakeholders, together with other relevant traits can further be visualized by plotting them in a multi-dimensional **stakeholder matrix**¹³ (**Figure 4**), also known as Mendelow’s Matrix. To avoid over-complexity this stakeholder mapping exercise is typically two-dimensional, but in certain cases visualization of stakeholders within a three-dimensional matrix can be more preferable. In a stakeholder matrix, the influence (e.g. sometimes referred to as “power”) is typically chosen as one of the two dimensions visualized in the matrix, while

the second dimension plotted is often dependent on the aim of the stakeholder engagement strategy^{12,14,15}. In DuneFront, the categories “influence” and “expertise” are the two key categories one will most likely consider when selecting stakeholders. The expertise and influence of a stakeholder can vary and change depending on the objective of the analyses. In general, public stakeholders can typically be characterized by having a low influence that increases when considering organized communities and organizations and varying degrees of expertise. Research stakeholders are typically characterized by having a high level of expertise but a lower degree of influence. Government stakeholders are characterized by having a relatively high level of influence but with varying levels of expertise. Lastly, Industry stakeholders contain varying degrees of influence and expertise. The influence of a stakeholder is typically considered a key trait to identify amongst the stakeholders of a project and when finetuning the stakeholder engagement for a particular task. In DuneFront, it is also important to consider the connection between local, regional and global stakeholders.

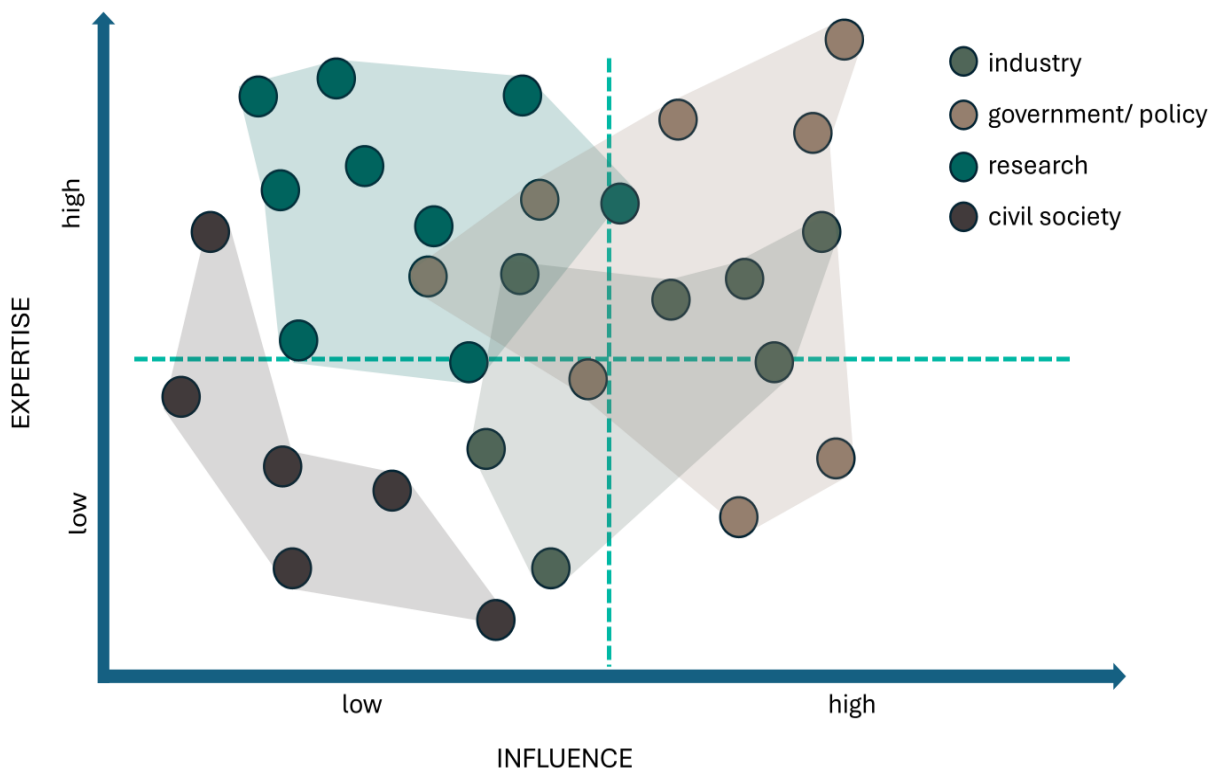


Figure 4. Illustration of a stakeholder matrix according to influence and expertise.

Finally, depending on the objective of a task, deliverable, or milestone, the following dimensions (traits) can also be relevant when mapping stakeholders DuneFront plans to engage with:

1. **Level of Influence (Power):** the extent to which a stakeholder can influence the decisions, actions, or outcomes of a project or initiative. Stakeholders with high

influence or power may include government regulators, major investors, key clients, or influential community leaders. For DuneFront this would include stakeholders that can influence its key objectives involving the promotion, upscaling, and acceptance of DD-hybrid NbS as an alternative coastal protection strategy for vulnerable coasts.

2. **Level of Expertise:** the stakeholders' knowledge, skills, and expertise related to the project or initiative. Stakeholders with high levels of expertise may possess specialized knowledge or technical skills that are relevant or may become relevant as the project progresses. They include scientists, engineers, consultants, regulatory authorities or government agencies, local community members or organizations. For DuneFront this includes stakeholders that need to be consulted with to obtain information that can further influence the design, implementation, and maintenance of a DD-hybrid NbS.
3. **Level of Interest/ Concern:** the interest, involvement, or concern regarding the implementation or outcome of the project or initiative. Stakeholders with high interest or concern may include affected communities, advocacy groups, or individuals with vested interests in the organization's operations. For DuneFront these stakeholders are relevant in the design-process of a DD-hybrid NbS and highlights groups to inform regarding DD-hybrid NbS and to address its acceptance in society.
4. **Level of Support/ Opposition:** the attitudes and behavior towards a particular project or initiative, ranging from strong support to active opposition. Stakeholders may vary in their degree of alignment with the organization's goals, values, or initiatives. While it holds similarities to the level of interest a stakeholder can have it, this category lays emphasis on whether the image of the project is positive or negatives towards the different stakeholder groups.
5. **Proximity/ Geographic range:** the physical proximity to the organization's operations or project sites. Stakeholders located in close proximity to the DD-hybrid NbS may have a more immediate and direct impact on or be more affected by the project or initiative. For DuneFront, a distinction between local, regional, EU, or global geographic range is hereby relevant in the stakeholder analysis process. The 12 Demonstrator sites of DuneFront aims to involve several coastal communities, provinces, and districts as well as more general administrative entities to promote DD-hybrid NbS. As the co-design process of a DD-hybrid NbS in DuneFront occurs in De Panne, the association stakeholders have to this specific geographical region will be of particular importance.
6. **Level of Dependency:** The reliance of a stakeholder for the resources, services, or outcomes of a particular project or initiative. Stakeholders with high dependency may include suppliers, employees, or local businesses that rely on the project due to their livelihood or for its economic support. For DuneFront

this includes stakeholders to consider in the design, implementation, and maintenance of a DD-hybrid NbS.

2.3 Stakeholder Engagement

After the stakeholder mapping and selection of stakeholders has been determined the most effective approach to engage with them is determined. While the term 'stakeholder engagement' is interpreted differently across disciplines and areas of research, it typically describes the ways that individuals, or groups can be involved in the design, conduct, and dissemination of a project. In DuneFront, "**stakeholder engagement**" is hereby defined as:

"Any interaction, be it uni- or bi-directional, with a stakeholder or stakeholder group"

According to Nelimarkka et al.¹⁶ the different types of stakeholder engagement can be classified into five levels of increasing participation:

1. **Inform:** selected stakeholder groups are provided with information to understand the scope of the project, potential opportunities, solutions, problems, and/or alternatives. Stakeholders typically have a low level of influence and hold a low level of expertise.
2. **Consult:** selected stakeholder groups are asked for feedback on analysis, alternatives, and/or decisions within a project. Stakeholders typically have a low level of influence and a high level of expertise (e.g. research institutes and industry).
3. **Involve:** the project works directly with stakeholder groups to ensure concerns and aspirations are consistently understood and considered. Stakeholders typically have a high level of influence but a low level of expertise.
4. **Collaborate:** project partners and stakeholder groups interact in each aspect of the decision including the development of alternatives and the identification of a preferred or optimal solution. Stakeholders typically have a high level of influence and a low level of expertise.
5. **Co-create:** the project is realized with the active involvement of stakeholders where the final decisions made are in the hands of the stakeholders. Typically, stakeholders have a high level of influence and a high level of expertise.

Engagement with selected stakeholders occurs through various **stakeholder engagement tools** and methods. It includes, but is not limited to, the provision of information in the form of flyers, a website or social media, the filling out of surveys or the conducting of interviews, site visits, and the organization of interactive workshops and trainings. While "informing", would be a **uni-directional interaction** to provide information to a particular stakeholder group (e.g. through a website or social media), "consultation", "involve", "collaboration" and "co-creation" are **bi-directional interactions** where the input of a particular stakeholder is obtained (e.g. through surveys and workshops) and implemented. The added value of a "co-creation" process is the active involvement of a diverse team of stakeholders throughout the

project, which considers different perspectives, expertise, and resources when taking decisions in a project. This process is expected to foster a shared responsibility amongst stakeholders towards the outcome of a project and can lead to more sustainable and impactful results. A key objective in DuneFront is to design, implement and maintain a DD-hybrid NbS in De Panne through the process of co-creation (D15.3). In WP15, stakeholder engagement meetings will be set up in a manner to ensure a well-functioning process that addresses potential conflicts and constraints that may arise, by identifying stakeholder values, interests, and knowledge throughout the process.

2.4 Stakeholder Engagement Approach in DuneFront

Based on the theory presented above, the process of the stakeholder engagement plan for DuneFront is further outlined below. The framework is derived from the Stakeholder Engagement Blueprint presented by Blue Balance¹ (**Figure 5**) and consists of 7 steppingstones that are grouped into a preparatory stage, a stakeholder assessment and an execution phase. The 7-step process is expected to be dynamic and evolving. Its implementation is hereby iterative where changes and modifications can be made throughout lifespan of the project. To successfully implement a flexible stakeholder engagement plan, consistent monitoring and evaluation is required and will feed back into the engagement process as the project progresses.

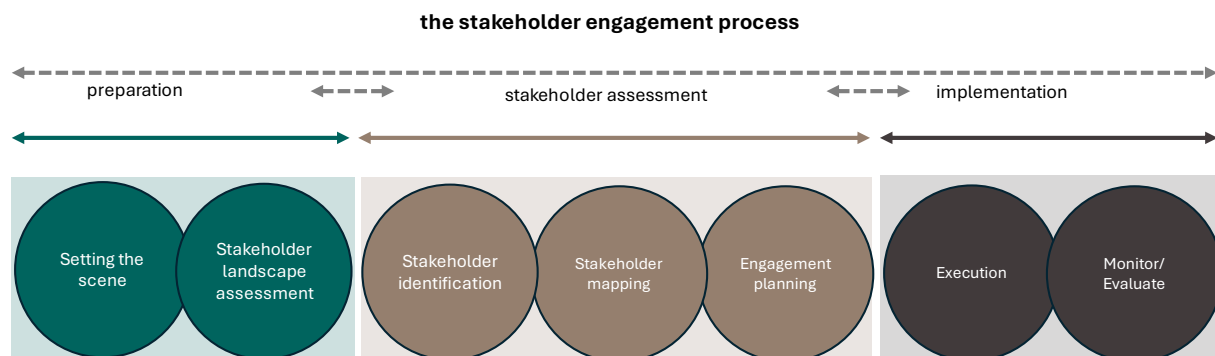


Figure 5. The stakeholder engagement process presented in DuneFront.

3. State of play: perspectives and challenges

This chapter on the “state of play” gives an overview of coastal management, including the current legislation, the division of responsibilities, the perspectives different people may have, and the resulting challenges currently hampering the implementation and/or acceptance of DD-hybrid NbS. It will focus on the various perspectives towards DD-hybrid NbS at the EU-level, and the different Demonstrator sites (**Figure 6**). The cultural and historical plurality within the EU influences the considerations that have been taken in different coastal regions regarding flood risks and coastal safety¹⁷. The experience of a disaster event, for example, can act as a major catalyst for adaptation and often plays an essential role in the decision making in flood risk management¹⁷. While this section is in line with the preparatory steps required for a stakeholder assessment, it is also particularly relevant as input for different work packages within DuneFront including the multi-functional use (WP9), co-creation process (WP15), policy (WP17, WP18), life cycle assessment (WP8), blueprints and DSS (WP14) of DD-hybrid NbS.

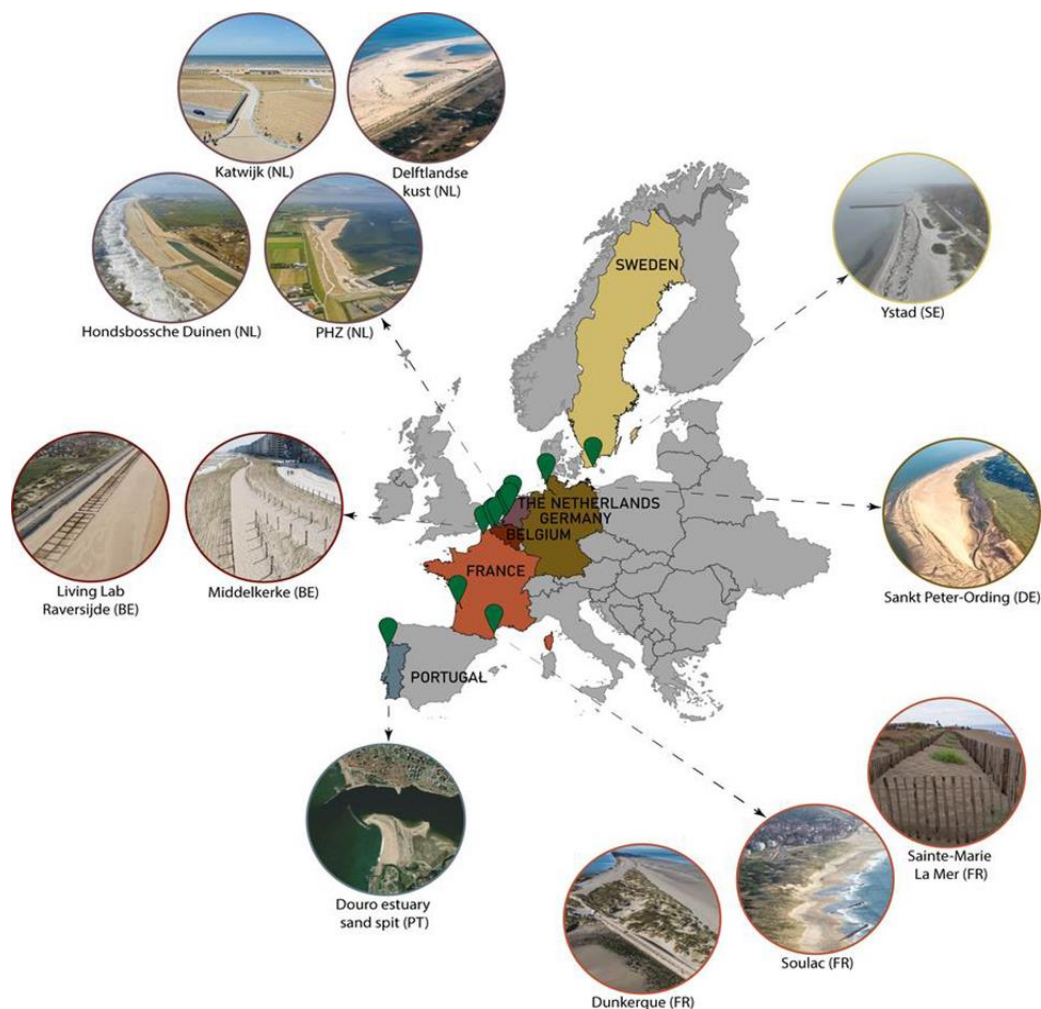


Figure 6. Overview of the 12 Demonstrator sites of DD-hybrid NbS in DuneFront.

3.1 DuneFront in the context of Horizon Europe

The adaptation to climate change and disaster risk reduction is recognized as a global priority, as exemplified by global frameworks such as the Paris Agreement¹⁸. According to the Intergovernmental Panel on Climate Change (IPCC)¹⁹, the total sea level rise on earth increased by 0.2 m between 1901 and 2018. The global average is currently 3.7 mm per year (2006–2018) and is accelerating, despite the presence of regional variations, and not being globally uniform. The rising sea level is expected to influence the re-occurrence of storms, floods, and storm surges along vulnerable coasts and it is currently estimated that around 1.81 billion (23% of the world population) worldwide are exposed to an inundation depth*³ of over 0.15 meters²⁰. For the European coasts, one of the most densely populated coastlines in the world, the expected annual number of people exposed to coastal flooding is expected to rise from 102,000 to 1.52–3.65 million by the end of the century²¹. In the absence of further investments in coastal adaptation, the annual damage from coastal flooding in Europe is estimated to be €1.2 billion and is projected to increase by two to three orders of magnitude by the end of the century²¹. In particular, the coastal zones of the North Sea in Belgium, the Netherlands and Germany, are particularly prone to floods due to storms or rising sea levels²². Acknowledging the growing concern of the impact of climate change on coastal safety, the European Parliament published the Floods Directive²³ that serves as a guideline to all European coasts and inland waterways regarding the assessment and management of flood risks.

Historically, coastal protection is often achieved through engineering-based solutions. Conventional coastal defense infrastructures include the construction of artificial hard-substrate dikes, seawalls, and groynes to protect against erosion and flooding. In recent decades, there has been a growing recognition of the limitations and negative impact of traditional coastal defense infrastructure. This has led to an increased interest in **nature-based solutions***⁴ (NbS) as an alternative and more sustainable way to protect and maintain vulnerable coasts. As researchers and practitioners continue to explore the potential of NbS, evidence for their functional role in coastal protection and overall acceptance is still lacking and there has been a shift towards hybrid approaches that combine both natural and engineered elements. The integration of artificial dikes with natural dunes for coastal protection are typically referred to as Dune-Dike hybrid Nature-based Solution (**DD-hybrid NbS**)²⁶. This approach recognizes the strengths of both natural and engineered elements to

*³ **Inundation depth** is the water level as a result of the storm tide, and is expressed in terms of height of water, in metres, above ground level. It provides the clearest and most commonly understood method for communicating storm surge-driven coastal flooding.

*⁴The term **Nature-based Solutions** (NbS) can be seen as an umbrella term that encompasses a wide range of conservation and sustainability measures that started to gain traction in 2007²⁴. While the exact definition of what exactly can be considered as a NbS can vary, the European Commission currently defines it as: ‘Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social, and economic benefits and help build resilience.’²⁵

enhance coastal resilience in the face of climate change and sea-level rise. While there are several types of DD-hybrid NbS, it typically involves a combination of beach nourishments and a strengthening of the dike itself²⁷. While DD-hybrid NbS are developed in European sandy coast along several urbanized areas, these systems are currently being implemented at small scales.

Funded under Horizon Europe², EU's research and innovation funding program until 2027, the promotion and optimization of DD-hybrid NbS in DuneFront corresponds well to the European Green Deal²⁸ and the New European Bauhaus²⁹ initiatives. The European Green Deal, approved in 2020, is a set of policy initiatives by the European Commission with the overarching aim of making the European Union (EU) climate neutral in 2050, under the Paris Agreement¹⁸. The EU mission 'Restore Our Oceans & Waters' was created to achieve the marine and freshwater objectives of the European Green Deal. It entails a wide range of policy and measures to address climate change, biodiversity loss, pollution, and other environmental challenges while also ensuring a just transition for all citizens and regions. The Green Deal includes the EU Biodiversity Strategy for 2030³⁰ aimed to protect and restore biodiversity. In July 2023, the European parliament adopted the Nature Restoration Law³¹, in the form of legally binding targets, aimed to restore 20% of nature on both land and sea of the EU by 2030. The Birds Directive³² and Habitat Directive³³ form two important components of the biodiversity policy of the EU that is directly relevant to DuneFront. Lastly, New European Bauhaus, supports creative and cultural initiatives that translate the European Green Deal into a tangible manner to the public. The physical experience of DD-hybrid NbS serves as an example of sustainable and innovative design which aligns well with the overall objectives of the New European Bauhaus initiative. The integration of technical, aesthetic, and ecological elements in the design of DD-hybrid NbS not only contributes to climate resilience and biodiversity restoration but enhances the experience of the coastal environment.

3.2 National Level

DuneFront will gather and translate evidence from 12 DD-hybrid NbS Demonstrator sites on biodiversity, morphodynamics and coastal safety*⁵. All Demonstrator sites are located at vulnerable European coastal regions of the North Sea, the Atlantic, the Baltic and the Mediterranean Sea. To better characterize the 'state of play' at different national levels for DD-hybrid NbS, DuneFront partners were contacted with the following open-ended questions:

- Please provide a general description of the coastline.

*⁵ A comprehensive overview of the design of each of the 12 DD-hybrid NbS Demonstrator sites can be found in D7.1.

- Who are the responsible authorities for the construction and maintenance of coastal protection (including DD-hybrid NbS)?
- How were DD-hybrid NbS introduced to the country? Any relevant documents used when discussing DD-hybrid NbS (e.g. agreements, reports, legislation)?
- What is the general public perception (e.g. concerns) regarding coastal protective measures including DD-hybrid NbS?

Responses were coupled with a literature search and compiled per country into the following sections below. The deliverable of WP7 (D7.1) which summarizes the Demonstrator design reports was also used to obtain additional information about the DD-hybrid NbS Demonstrator sites. A brief summary is given for the coasts of Belgium, the Netherlands, Germany, France, Sweden and Portugal. For larger coastlines the state of play focused largely on the location of the DD-hybrid NbS Demonstrator site(s).

3.2.1 Belgium

The Belgian coast, characterized by natural dunes and sandy beaches, is a small (65km) but relevant economic hub and one of the most developed coastal regions in Europe. The Flemish coast along the North Sea is below the level of an annual storm surge (+5.5 m TAW) and is hereby vulnerable to coastal flooding. The historic belt of dunes that naturally protected the hinterland have since been replaced by apartment buildings facing the sea, with only a third of the original dune belt still recognizable as such. Today, the Flemish coast is densely urbanized and populated where eleven coastal municipalities are protected by a sandy beach in combination with a hard sea wall or promenade. The fine sand beaches stretching the entire coastline are popular with both domestic and foreign tourists, with 30% of apartments ($\pm 97,000$) estimated to be utilized as secondary vacation homes³⁴. In addition to tourism, the industrial seaports of Zeebrugge and Ostend, offshore wind energy parks, the marinas of Nieuwpoort and Blankenberge, Ostend airport, and the agricultural sector in the hinterland represent other major economic interests along this coastal area.

Similar to other countries along the North Sea, risk-based safety standards and a precautionary attitude is dominant in Flanders¹⁷. In Belgium, coastal protection from storms and floods is primarily managed at the regional level by the Flemish Government. Involvement from the federal government is more limited and primarily focuses on broader environmental policies and international obligations. The regional Flemish Agency for Maritime Services and the Coast (MDK) is responsible for protecting the coast against storm surges and flooding from the sea³⁵. While investment and construction of coastal safety measures falls with MDK, the maintenance is the responsibility of the local government who, in turn, can shape the coastal protection measures provided they are within the framework of the Masterplan for Coastal Safety³⁶. Approved in 2011, the Masterplan for Coastal Safety³⁷ highlighted measures to be implemented by 2050 to protect the coast while considering a sea level rise of 30 cm.

The measures would consider the entire coastline and where possible, 'hard' measures (e.g. dikes) would be complemented with 'soft' measures (e.g. dunes). In this context, DD-hybrid NbS (e.g. dune in dike or dike in dune) were introduced as an alternative to the more classical solutions of hard dikes and storm walls. In 2024, the Flemish government approved the draft of Coastal Vision, a strategic policy plan that builds on the Coastal Safety Master Plan and lays down the framework to protect the Belgian coast for up to 3m sea level rise. In this plan, the Flemish government proposes to move up the coastline. This would allow the Belgian beaches to remain as wide as possible for recreative functions while providing sufficient space to implement the necessary coastal protective measures. Recently, pilot projects have been set up along the Belgian coastline. The Grass Dike project in Middelkerke represents a collaboration between the Flemish Government and the city. The site considers a 1000-year returning storm with a target water level elevation of 10.5 meters³⁸. Additional DD-hybrid NbS were installed in Raversijde, Oostende and in Knokke Heist. They act as pilots for dune construction on the beach in front of a sea dike that acts as an intervention to limit sand erosion and the nuisance aeolian sand has on the coastal road, tram line, and sea dike.

Change to the Belgian coastline is often met with resistance for fear of losing what is familiar³⁶. For the residents at the Belgian coast and the people visiting the coast an important aspect is the accustomed view of the sea and its accessibility. In the past, dune growth was typically prevented to improve the appearance of the beach for recreational use, increase ease of access, or maintain the view of the sea³⁹. The implementation of dunes and the expansion of the beach will hinder these familiarities and can create opposition from the general public towards the idea of wider beaches and higher dunes. New initiatives and pilot projects such as the implementation of the Grass Dike in Middelkerke, and the Living Lab Raversijde, however, are changing this perception by gradually allowing the perception of new benefits (e.g. the wider dike and walking path through the dune enables people to walk in the sun instead of in the shade created by the tall flanking apartment buildings).

3.2.2 The Netherlands

The Netherlands is a country where approximately 26% of the land is below sea level with a history that is strongly intertwined with the sea. The entire Dutch coastline has a length of 523 km that borders the North Sea (353 km), the Wadden Sea and the Western Scheldt. Currently, half of the coast (± 254 km) consists of dunes, dikes and flood defenses that protect the country from coastal flooding. In comparison to the more urbanized Belgian coast, the urbanization of the sandy beaches in the Netherlands is scattered with densely urbanized areas interspersed with more natural and open agricultural zones. Some areas of the coast are less protected, including ports, harbor areas and coastal towns that are partially seaward of the protective dikes or dunes.

Since 1814, coastal protection from storms and floods in the Netherlands has been a national responsibility executed by the Rijkswaterstaat, a government agency overseeing primary

flood defenses, such as dikes, dams, and storm surge barriers. Maintenance of the infrastructure is the responsibility of the Regional Water Boards. Currently, the state works together with the 21 water boards in the National Water Program (2022–27) to lay out the responsibilities and requirements of flood risk management operations to be completed by 2050. Several historical floods have influenced the legislation and perception of coastal protection in the Netherlands. In the 1953 North Sea Flood, water levels reached 5.6m above the mean sea level, resulting in widespread destruction and the recorded deaths of 1,836 people. Realizing the re-occurrence of such events, the national and regional water boards setup the Delta Works Commission to better protect the Netherlands and its citizens from future flooding and contribute to climate-resilient spatial planning, resulting in the Delta Plan to protect the southwestern part of the Netherlands⁴⁰. In 2008, building on the historic Delta Plan, the Delta Program was introduced to address long-term water safety and climate resilience against future storms and floods across the Netherlands. The commission drafted a report to plan for a rise in the North Sea up to 1.3 m by 2100 and prepare for a 2–4 m rise by 2200 through measures including the strengthening of dikes and broadening of coastal dunes⁴¹. According to the Delta Decision on Water Safety⁴², the probability of death from flooding for everyone behind the dikes should not exceed 1 in 100,000 per year by 2050. In 2011, the plan further outlined that sand nourishment can be used effectively as a natural and flexible means of coastal protection and pushed the principle ‘soft where possible, hard where necessary’. This decision aligns with the implementation of DD-hybrid NbS in the Netherlands, such as the Hondsbossche and Pettemer Sea Defense project, where an old sea dike was transformed into a natural dune landscape that was completed in 2015.

In slight contrast to Belgium, the Netherlands has a longer history of implementing large-scale coastal engineering projects, such as the Delta Works⁴⁰, which have shaped public perception and acceptance of coastal management strategies⁴³. There is a stronger public recognition of the importance of these measures in enhancing coastal resilience and protecting against sea-level rise. This is emphasized when comparing coastal safety plans in the Netherlands which prepare for a 10,000-re-occurring storm as opposed to a 1000-year storm in Belgium¹⁷. Sand replenishments typically contribute to local and regional goals for an economically strong and attractive coast. Similar to Belgium, however, the perception of DD-hybrid NbS in the Netherlands is increasingly positive but countered with a similar sentiment to preserve the familiar coastline and its aesthetics. The Dutch coastline, however, is larger and less populated compared to Belgium, with the presence of more dunes and tourism playing a less significant role in coastal management decisions. The implementation of DD-hybrid NbS in the Netherlands has done with extensive stakeholder engagement and public outreach within its design to a positive effect (e.g. the Prins Hendrik Zanddijk in Texel).

3.2.3 Germany: Sankt-Peter Ording

Germany has a coastline that stretches along the North Sea (538 km) and the Baltic Sea (1851 km). Coastal protection from floods and storms in Germany is managed at different levels of

government, including the federal, state, and local municipalities whose responsibilities are outlined in the overarching "Küsten- und Hochwasserschutz" framework for both the North Sea and Baltic coasts. The federal government sets overarching policies, standards, and regulations related to coastal protection through various ministries, such as the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU). Coastal protection policies and measures are subsequently implemented and managed at the state level by coastal states while the local municipalities and districts are responsible for the maintenance and operation of coastal protection infrastructure, such as dikes, flood barriers, and drainage systems. Similar to the Netherlands and France, its relevance took shape in response to a devastating storm, in this case the North Sea flood of 1962, which highlighted the vulnerability of coastal areas to storm surges.

The Wadden Sea represents a unique coastal entity within the North Sea. In 1986, the Wadden Sea's ecological significance and unique ecosystem was recognized as a UNESCO World Heritage Site. It encompasses diverse ecosystems, including tidal flats, salt marshes, and mudflats, which support a rich variety of flora and fauna leading to an increased focus on conservation and sustainable management resulting in the establishment of the Wadden Sea National Park by 2010 in the Netherlands, Denmark, and Germany. The German portion of the Wadden Sea National Park has a coastline spanning 240km extending along the northern coast of Germany, encompassing areas in the states of Lower Saxony and Schleswig-Holstein⁴⁴. The first DD-hybrid NbS in Germany occurred along the Wadden Sea to enhance coastal protection while promoting natural habitat formation and biodiversity. The DD-hybrid NbS at Sankt Peter Ording, is part of the Natura 2000 network of protected areas within the EU. It is therefore managed by both the National Park Authorities and the Coastal and Flood Protection agency. The dunes of St. Peter-Ording, are located on the inland dike and are strongly dissected by buildings and roads as well as by the reforested forest areas (historically to prevent natural dune movement) and have hereby lost their naturalness in many places. Recently, the coastal dune area of St. Peter-Ording has been included in the "Strategy for the Conservation of Biodiversity in Schleswig-Holstein". While an emphasis on conservation is a defining feature for this region, flood risk management to some extent overrules nature protection in Germany. The perception around coastal protection measures differs between stakeholders. Those associated with coastal protection tend to advocate for the effectiveness of more conventional measures to safeguard people and material assets from flooding. In contrast, nature conservation agencies such as the national park authority value the ecological benefits of NbS⁴⁵.

Sankt Peter-Ording is a popular seaside resort located on the North Frisian coast of Schleswig-Holstein, attracting visitors with its wide sandy beaches, dunes, and vibrant beach culture⁴⁴. The region's economy relies heavily on tourism, with Sankt Peter-Ording serving as a major tourist destination for both domestic and international travelers. Nature is a key attraction point to visitors and in 2021 alone, 364,000 overnight guests and more than

580,000 day-visitors visited the municipality on the Wadden Sea (St. Peter-Ording Tourist Office, 2022). The long-term preservation of the area is hereby an important point of view to the general public. While a managed retreat was seen as a viable approach towards coastal protection it likely faces significant resistance from local residents⁴⁵. This opposition is rooted in the local community's traditions, arising from a long-standing history intertwined with the North Sea. There therefore appears to be a general consensus from the public around the desire to preserve the Wadden Sea's ecological and cultural significance to local residents and visitors⁴⁵. In addition to tourism, the Wadden Sea coast is home to important economic activities such as offshore wind energy production, maritime industries, and agricultural activities in the hinterland, making it a significant economic hub for the region.

3.2.4 Sweden: Ystad

In Sweden, the majority of sandy beaches are situated along the Baltic coast of Scania County and Halland, in the most southern part of the country. Ystad is situated on the Baltic Sea coast and experiences different coastal processes compared to the North Sea coasts. Beach erosion in Scania has led to damage in infrastructure, nature and the cultural value of the landscape and is further aggravated by a net increase in the mean sea level⁴⁶. The Baltic Sea is characterized by lower tidal ranges and generally less severe storm events compared to the North Sea, which influences the type and scale of coastal protection measures required and includes the implementation of groynes and revetments as opposed to more extensive engineering infrastructure (e.g. storm surge barriers and dikes).

Unlike the Belgian, Dutch and German coasts, coastal protection in Sweden is the responsibility of the local municipalities and landowners and not at a regional or national level. Climate change adaptation is allocated to the regional County Administrative Boards. In 2003, the Swedish Geotechnical Institute (SGI) was assigned the role of coordinating knowledge about coastal and river erosion at the national level but remains only an informing body. Ystad hereby represents a case study where the local municipality has shifted its coastal management system from traditional hard solutions (e.g. rock and concrete constructions of breakwaters, revetments, groynes) to soft (e.g. sand and vegetation supplementation) solutions⁴⁶. The previous hard measures have created long-term complications that are increasingly being criticized by the general public⁴⁷. For example, the implementation of a small private revetment can transfer the erosion downstream, compelling a neighboring landowner to build a revetment as well. Similarly, groynes have disturbed the natural sand transport from west to east. These negative effects have resulted in a gradual shift towards the implementation of more 'soft' coastal defense techniques. In Sweden, there is an ongoing debate about the responsibility for coastal erosion. At the regional and national level, however, there is still a limited understanding on coastal erosion that is attributed, in part, to the geographical and political distance between regional and national government bodies.

3.2.5 France : Dunkirk, Soulac, and Sainte-Marie-la-Mer

The shoreline in mainland France is about 5500 km long (excluding overseas regions and territories), of which 25% is affected by erosion and exposing 850,000 inhabitants and 570,000 properties to shoreline retreat in low-lying areas⁴⁸. In 1986, the Coastal Law (Loi Littoral) was introduced to guide urban planning and development in coastal areas, ensuring that environmental concerns are balanced with economic and social needs. France has a national adaptation plan to climate change for its French territories, including those overseas, which involves concrete actions to be taken by 2050. The “Gestion des Milieux Aquatiques et Prévention des Inondations” (GEMAPI) mandate is a national framework in France, that decentralized and assigns specific responsibilities to local authorities for managing aquatic environments and the prevention of floods. Concretely, it means that in coastal cities, local authorities oversee the construction of dikes and other defense structures against the sea. The EU Floods Directive²³ is implemented under this framework by the “Direction Régionale de l’Environnement, de l’Aménagement et du Logement” (DREAL). It provides technical expertise and oversees land use planning and environmental issues while the “Direction Départementale des Territoires et de la Mer” (DDTM) is responsible for the reduction of risk and its further implementation. Local authorities are hereby responsible for the actual implementation and management of these policies, while national authorities provide tools and financial support. After the Xynthia storm in 2010, where more than 50 people died, there was an increased awareness of the need to improve French coastal risk management policies⁴⁹. It included a need to manage shoreline risks whilst limiting urbanization and resulted in the development of the “Plan de Submersion Rapides” (PSR). While the Plan de Prévention des Risques Littoraux (PPRL) was already implemented in 1997, the national strategy for integrated coastline management was subsequently revised after the Xynthia storm⁵⁰.

As mainland France has a much longer coastline to protect, in comparison to the Belgian and Dutch coastline, for cost-efficiency reasons its coastal protection policy is largely in support of an avoidance strategy⁵¹. In addition, the current strategy promotes a softer and more ecosystem-based approach (e.g. NbS) in comparison to past coastal-management strategies that largely involved an engineering-based approach⁵². Considerations hereby include land use planning, the prevention of further urbanization in low-lying coastal areas or the anticipatory relocation of vulnerable inhabitants^{*6}. In general, the actual implementation of the national adaptation plan has taken the form of experiments at local scales, suggesting that stakeholders are still in the process of legitimizing relocation as a coastal adaptation strategy. DD-hybrid NbS are therefore not common in France and only a few experiments are

*6The cost-benefit analysis methods currently imposed by French authorities do not favour relocation, arguing that the benefit of relocation does not outweigh the more immediate, high costs involved, such as the need to buy new land or properties in comparison to traditional policies of protection or beach nourishment⁵³.

known. In general, the involvement of residents in the design and planning of such policies remains limited. New guidelines at the national level to further involve the populations followed by a similar requirement at the regional level should however result in a change of practice at the local level. Similar to Sweden, there hereby appears to be a disconnect between the national objectives and local coastal development on the ground⁵³.

The three French Demonstrator sites lie along three coastlines including the North Sea (Dunkirk), the Atlantic (Soulac), and the Mediterranean (Sainte-Marie le Bain). All three sites are located in areas of France that are particularly prone to coastal flooding⁵². Nonetheless, the coastal safety in each of these sites can be characterized by different processes and life histories that are briefly described below.

The North Sea: Dunkirk

The North Sea coastline of France spans 55 km of almost continuous wide, gently sloping sandy beaches backed by coastal dunes. The coastline has been massively transformed by urban and port development and the only stretch of preserved dune barrier, less than 8km long, is located east of the port of Dunkirk. Similar to the coastal area of Belgium, the densely populated coast of northern France consists largely of reclaimed lands (polders) that are below the mean high tide, making them particularly exposed to coastal risks including flooding during storm surges. Coastal communities in the area consist of local residents, second homeowners and tourists. Here coastal dunes and dikes serve as the only form of protection to the area. In particular, the Demonstrator site at Dunkerque Beach is adjacent to the seaside resort of Malo-les-Bains and focuses on three key locations, the western and eastern sections of the dike 'Digue des Alliés', and along the dike 'Digue du Break'. Digue des Alliés was constructed in 1876 but was breached during storms in 1949 and in 1953. Following the Xynthia storm, in 2010, the Port of Dunkirk was commissioned by the French government to reinforce the dike. To protect the dike from wave impacts and prevent marine flooding during storms, a massive beach nourishment project was implemented in 2014. Dunes were hereby erected at Malo les Bains in 2015 to mitigate sand invasion on the seawall promenade and were reshaped in 2021. In 2020, additional dunes were established on the dike to protect the low-lying and vulnerable districts of Dunkirk. The efforts were coordinated by the Grand Port Maritime de Dunkerque (GPMD) until 2018 and thereafter by the "Communaute' Urbaine de Dunkerque" (CUD).

In the French part of the North Sea, while a vast majority of inhabitants are aware of the coastal risks, the felt threat of exposure to coastal floods is spatially influenced and is strongly influenced by the location of their house and its distance to the shoreline⁵⁴. Preference for different strategies (e.g. adaptation, protection or relocation), or the use of hard or soft coastal protection measures however, did not appear to be spatially controlled⁵⁴. The implementation of coastal risk prevention plans can hereby cause social conflicts, which in some cases has led to national government ministers to intervene. Making areas unavailable to build on, can clash with the development plans of local authorities. On the other hand, relocation can be

met with strong resistance from residents. While agreement amongst stakeholders could be found on the main objective of the PPRL regarding land use planning, different sensitivities raised amongst groups regarding its purpose, particularly in the case of areas protected by protection structures, against marine submersion or the retreat of the coastline. Misunderstandings were also reported due to a discrepancy in the degree of technical understanding between different actors⁴⁹. In Dunkerque for example, it took more than 10 years to implement the PPRL as local stakeholders contested the extent of the area where the construction of new buildings was restricted. At Malo-les-Bains, a dune was developed and erected in front of the seawall promenade in 2015, prior to the construction of a four stars hotel. To preserve the view of the sea, the dune was subsequently levelled and almost destroyed in 2020.

The Atlantic Sea: Soulac

The Atlantic coast of France covers more than 1500 km of coastline from Brittany in the north to the Spanish border in the south and comprises approximately 50% of sandy beaches. The coastline encompasses long west-facing beach-dune systems in the south, which are interrupted by tidal inlets and estuaries of various scales. Further north, rocky shores are dominated by islands and coastal embayments resulting in a wealth of coastal settings, including a limited number of dune systems. Given the large proportion of low-lying coasts, tidal range and wave climate, the Atlantic coast of France is exposed to serious erosion and submersion hazards, with dramatic spatial variability. In the framework of DuneFront, the focus lies in the nearly 250 km of beach dune systems along the southwest coast of France. Over the last century the average erosion trend is over 1 m per year but contains a large spatial variability. The local maximum erosion is approximately 11 m per year, and the maximum local accretion is approximately 6 m per year⁵⁵. The Soulac Demonstrator site is located within the North Médoc coast, adjacent to the large Gironde estuary. Over the last centuries, this coastline has locally suffered from periods of severe erosion that threatens coastal infrastructures and requires the progressive implementation of coastal structures and local beach nourishments⁵⁶. Such measures have only locally or temporally buffered erosion. A notable exception is the central beach of Soulac, where a groyne has been accreting and rising over the last decades. Today, the beach is nearly 250 meters wide, and the sand level almost reaches the top of the former dike, that is subsequently buried under the sand. At this location, the wind blows sand into the coastal resort during winter storms and is a major hazard that requires the implementation of a dune in front of the dike to prevent further erosion. The primary objective of Soulac is hereby to restore its biodiversity to the seafront and reduce the transport of windblown sand into the coastal resort during winter storms.

The Soulac area has a long history of coastal erosion and, surprisingly, there is a strong lack of understanding from the general public about the causes of coastal erosion. A renowned example is the case of residential building Le Signal, located just a few hundred meters to the south of the Demonstrator site, and rapidly became a symbol of coastal erosion. Built

between 1965 and 1970, the sea was still 200m away but now the Atlantic Sea has gained ground at a rate of 4–8m per year. In 2014, the owners were evicted from the building and was followed by a long legal–administrative battle of six years to obtain compensation from the government. Given that such compensation is unique and will not be repeated in the future and given the strong erosion rates in many areas of this coastline, the public and inhabitants are really concerned about the threat of other coastal buildings. In addition, the general belief by the public is that only hard structures are efficient in tackling erosion. In contrast to other sectors in the southwest of France, soft engineering techniques or NbS are therefore deemed an inappropriate solution by the general public. The Soulac Demonstrator site, overseen by the “Communauté de Communes Médoc Atlantic” (CCMA) and managed by the Soulac Council and the “Office National des Forêts” (ONF), aims to restore the natural state of the Soulac seafront and reduce the transport of aeolian sand into the coastal resort during winter storms by building a dune in front of the dike. It is therefore expected that such renaturation will not receive much attention. In contrast, stakeholders are concerned about locals and tourist walking on the new dune field of this coastal resorts, which attracts a lot of tourists each summer, and can hinder the establishment of the vegetation.

The Mediterranean Sea: Sainte-Marie-la-Mer

The Gulf of Lions along the southeastern Mediterranean coast, stretches over 200 km and is comprised of narrow sand barriers isolating several lagoons. The coastal dunes are low, with a height of around 2–3 m and the beach is often narrow (a few tens of meters). Since the 1960s, the coast has been transformed and included the construction of 12 seaside and yachting resorts, from scratch and carried out under the state–driven development initiative Mission Racine⁵⁷. Mission Racine operated from 1963 to 1983 and was accompanied by the development of mass tourism that targeted the working–class population. It resulted in a dramatic increase in the number of visitors to the area from 30,000 in the 1960s to 5 million in 1990 which subsequently increased the areas net income, job creation and inward migration. Today the area contains a large percentage of secondary homeowners and seasonal tourists⁵⁸. The decision to focus on tourism was partially related to the economy of Languedoc–Roussillon that was, at the time, largely based and dependent on viticulture (e.g. winegrowing). The plan importantly resulted in large–scale landscape and ecological transformations. The Languedoc–Roussillon coast was an area of brackish lagoons and sand dunes with a very unstable and changeable geomorphology, and therefore required extensive intervention to achieve the stabilization needed for permanent settlements⁵⁷. The tourist–led urbanization has resulted in chronic erosion in the area. Since the 1940’s, the beach of Sainte–Marie–la–Mer is located downstream of 6 breakwaters. Today, more than 30% of the coastline is equipped with hard coastal defense structures to protect from disturbance by longshore drift and erosion introduced by the construction of a harbor jetty in the 1970’s. Riprap (e.g. boulder aggregations) placements have been undertaken all along the coast since the 1980’s and 1990’s, and sand beach nourishment has also been implemented. While the area has low significant wave heights and a low tidal range, the water can reach 4m high during winter

storms and strong onshore winds. The establishment of the Conservatoire du Littoral in 1975, is frequently seen as representative of the environmental turn of public policies in France⁵⁷. An ecological restoration program took place in November 2021 and involved the installation of sand trapping fences along the 2.3 km coastline to protect the embryo dune. The construction of groins between the port and the dune dike system maintains and accelerates erosion on this part of the coastline.

The population and tourists attach little importance to dune restoration regarding erosion in this part of the coast because they, similar to the entities that manage it, are mostly familiar with the historical practices of installing permanent hard structures to mitigate the effect of erosion and avoid the risk of submersion⁵⁹. In general, there appears to be a poor awareness of coastal flood risk amongst surveyed populations within Languedoc-Roussillon^{59,60}. However, a paradigm shift is slowly taking place with the example of the dune restoration plan established in 2021 in front of the walking dike in Sainte-Marie-la-Mer. In addition, following strong erosion in 2024 and the destruction of part of the dune-dike system present, the municipality plans to move this structure landwards.

3.2.6 Portugal: Douro Sandspit

Portugal has a coastal zone that stretches over 1800km to the North Atlantic with over 75% of its population living on the coast, of which 14% are within 2km of the coastline at high tide⁶¹. The sandy shores of the Atlantic coast in Portugal hereby faces a key set of challenges related to coastal erosion caused by high-energy waves and the human modification of river networks, principally by the construction of dams, which has drastically reduced sediment supply to these coastal regions. These challenges are further exacerbated by both anthropogenic pressures from population growth and urbanization, and the threats of climate change including the rise in the mean sea level, and the increase in the intensity and frequency of extreme events.

In 2014, Portugal expanded its administrative boundaries from three to four levels, adding intermunicipal governance alongside national, regional, and municipal levels⁶². This decentralization has helped to increase the influence of local actors, allowing regulations to better address the specific needs of coastal zones. Importantly, it is seen as an effective way to build political trust from the local public, whilst fostering social commitment with coastal management. However, the number of actors focused on landscape planning has decreased, with the Directorate-General for the Territory now being the primary landscape actor, despite lacking a comprehensive landscape strategy or vision for the coastal zone area. The governance of Portugal's coastal areas suffers from fragmentation, with coastal, spatial, marine, and environmental planning being managed as separate components by various institutions with conflicting priorities. This fragmentation has impeded effective policy integration and coordination. Despite the growing influence of local authorities, the central government retains significant control and lacks consistent political support, complicating efforts to develop a cohesive framework for coastal and landscape management^{62,63}. The

separation of responsibilities between land and sea, combined with a complex mix of actors and interests, further exacerbates the challenges of coastal governance in Portugal⁶³.

The Douro River is one of the major rivers of the Iberian Peninsula. Fifteen dams have been built along it, 5 of which are within Portugal, to regulate the water flow, generate hydroelectric power, and allow navigation through a system of locks. Its water eventually flows into the Atlantic Ocean through a narrow and highly dynamic funnel-shaped estuary at the margins of two cities, Porto and Vila Nova de Gaia. Freshwater inflow is partially controlled by the Crestuma-Lever dam that was built in 1985 and experiences interannual variability, with large differences between dry and rainy years resulting in strong currents, seasonal floods and fine sediment depositions. Collectively, these factors are responsible for the presence of the Douro Sandspit⁶⁴ containing a micro-ecosystem of significant biological interest⁶⁵. The Douro River dam system, however, has reduced the main supply of fine sediments to the estuary and along with it the total amount of continental sediments reaching the coastal region. While the estuary and its associated coastal hybrid structures play an important role in coastal safety, reducing storm impacts and supporting local ecological and economic interests, the area faces ongoing challenges related to coastal erosion and needs effective management and protective measures. The Douro sandspit is a key geomorphic feature that protects the Douro estuary banks, the surrounding inland areas and harbors from wave action, especially during storm events⁶⁶. Breakwaters were constructed between 2004 and 2008 to address the diminished protective function of the sandspit due to erosion and retreat into the estuary. In addition to coastal protection, the breakwaters were also built to help restore ecosystem services including the nursing and refuge of the saltmarsh wetland. The Local Natural Reserve of Douro Estuary (RNLED), established in 2008, is a protected area including several important biotopes, such as marine sandy shores, sand dunes, small salt marshes, and intertidal mud/sand areas. In particular, the intertidal zone, covering approximately 27 hectares, is recognized under the EU Habitats Directive³³ as a crucial habitat type that requires protection⁶⁴.

In the 1992, the UN Rio de Janeiro Earth Summit required nations to sustainably develop coastal areas and implement Integrated Coastal Zone Management (ICZM) strategies⁶⁷. While public participation was seen as a vital cornerstone in the ICZM, a study of a population-based survey in Portugal⁶⁸, indicated that the large majority of participants (93%) felt that there is a significant lack of information available to the public about coastal risks assessment and management. In particular, participants of the survey viewed human activities, such as interventions at river basins and coastal engineering, as the primary causes of shoreline retreat rather than natural factors like sea level rise, storms, and wave action. They also viewed that altering the landscape due to pressures from real estate and tourism development on coastal zones compromises environmental sustainability and increases the vulnerability of local communities. Subsequently, the public's perception of coastal management, particularly regarding nature-based solutions versus grey infrastructure, revealed a preference for



nature-based approaches. Nearly half of the participants view natural approaches as highly effective for managing coastal risks. These methods are seen as innovative and beneficial for coastal resilience and enhancing marine life. Conversely, only about 10% consider grey infrastructure, such as jetties and groins, very effective. These structures are criticized for exacerbating erosion, disrupting sediment supply, and being costly to maintain. More than 30% of participants identified coastal hazards, particularly erosion, and issuing risks as significant challenges.

4. Best Practices and Lessons Learned

This chapter provides some best practices and lessons learned regarding stakeholder engagement towards the use of DD-hybrid NbS and coastal safety, based on available literature, including publications and project reports, and specific Demonstrator site input from the respective Demonstrator site leads.

4.1 General lessons learned from other EU projects.

As a starting point, general recommendations were obtained from EU funded projects in the marine coastal environment regarding stakeholder engagement. In particular, the EU funded project ULTFARMS^{*7}, and the VLAIO funded project BlueBalance^{*8} were consulted and form the basis of this list. The findings from these studies can be summarized into 6 messages detailed further below:

(1) Maintain a clear objective. DuneFront involves a dynamic group of partners and stakeholders spanning multiple countries with varying engagement cultures for a duration of several years. The stakeholder engagement strategy will hereby include an overview of the stakeholder engagement activities currently planned for DuneFront, with the objective of each engagement, and the targeted stakeholders outlined (Chapter 6).

(2) Have a plan. A predefined stakeholder engagement plan can help maintain an overview of the project to help streamline the interactions between project partners and stakeholders and enable opportunities for synergies within the project and between projects (Chapter 6). The possibility to combine events, questionnaires, and other stakeholder activities may help to avoid excessive and repetitive interactions with relevant stakeholders and potentially limit resources and associated costs. DuneFront aims to coordinate the acquisition of data from the 12 Demonstrator sites and plans to consult, connect and coordinate with similar ongoing EU projects.

(3) Utilize a targeted approach. DuneFront involves a dynamic group of partners and stakeholders spanning multiple countries with varying engagement cultures for a duration of several years. Stakeholder engagement can starkly differ between countries and according to the specific tasks and work packages. It is hereby essential to understand the needs and preferences of different stakeholders, and the context in which they operate in. In addition to a stakeholder assessment (Chapter 5), information on the “state of play” and public

^{*7} **ULTFARMS** – Built around 6 European pilots on Low Trophic Aquaculture developments within wind farm multi-use zones to demonstrate the benefits of co-location of different combinations of marine activities (i.e. renewable energy, aquaculture, bio-resources, environmental restoration, maritime transport, and tourism services) in the same marine space.

^{*8} **BlueBalance** – The general objective of the BLUE BALANCE project is increasing public involvement and participation in the sustainable transition of the Flemish coastal area and, in so doing, the development of a societal ‘license to operate’ for sustainable (economic) activities.

perceptions were gathered at the EU and national level (Chapter 3) and best practices and lessons learned were obtained from the different Demonstrator sites (Chapter 4.2). The gathered information can further help inform the co-creation process of De Panne (WP15), the future upscaling of DD-hybrid NbS related projects (WP14), and the socio-demographic analyses (WP9).

(4) Think of timing and remain flexible. Ideally, stakeholders should be engaged, informed, and consulted prior to the design and implementation of a project. Maintaining flexibility and adaptability within an engagement plan is important as the interest of stakeholders and their needs for information and/or engagement can change as a project progresses. The engagement strategy should include a pipeline to collect feedback from stakeholders and be implemented so that this feedback can be incorporated into the plan. The stakeholder engagement strategy in DuneFront is therefore presented relatively early within the project's lifetime (M8) and is designed to stay somewhat flexible by including several monitoring and evaluation periods to allow for the implementation of relevant changes and updates to the plan by relevant partners and stakeholders (Chapter 7).

(5) Choose the right tools. Different tools are more effective to engage with different stakeholder groups, depending on the objective. In addition, tools can help in the capacity building of a project where stakeholders are not merely informed and consulted but are also capable of actively shaping its outcome and influencing decisions. The development and dissemination of such tools can help lead to a more inclusive, transparent, and sustainable decision-making process regarding DD-hybrid NbS. DuneFront plans to engage with stakeholders and communicate results in several different manners involving both virtual and physical forms of interactions to take place.

The objectives, outcomes, and results of DuneFront will further be disseminated to different stakeholder groups through multiple channels described in more detail in the Communication Plan (WP16.2). The establishment of a website and 'digital identity' helps distribute general information to a large audience in a uniform manner while more detailed, in-depth information, in the form of thematic webinars, workshops, and training sessions can help target stakeholders on a more personal level. Several visits to a select number of DD-hybrid NbS are also planned to translate knowledge about DuneFront and DD-hybrid NbS in a more visual and tangible manner. Publications, seminars, and conferences will further help disseminate research findings to the wider scientific community.

(6) Create added value and disseminate results. Establishing interest and continuous commitment from stakeholders (and avoiding stakeholder fatigue) can be achieved by adding value to stakeholders towards the project's outcome. This can be achieved, for example, by including industrial sectors in the construction of blueprints that in turn can be implemented at selected sites from the portfolios of those industrial partners (WP14). Added value also includes the provision of relevant knowledge and information around the objectives, results

and impacts of a project to different stakeholder groups. DuneFront, for example, aims to inform key government and industrial enablers by providing critical insights into how DD-hybrid NbS are adopted and presented in different countries through the dissemination of results in the form of LCAs, PDTs, DSS, blueprints, and policy briefs (WP8, WP13, WP14, WP17, WP18). The value can further increase when the results of DD-hybrid NbS obtained by DuneFront are included within the co-creation process (WP15). Collectively, they help maximize the acceptance, and up-take of DD-hybrid NbS to stakeholders both within Europe and worldwide.

4.2 Stakeholder engagement at Demonstrator sites

Best practices and lessons learned regarding stakeholder engagement during the design and implementation of several DD-hybrid NbS were collected from the project partners through several open-ended questions:

- Which stakeholders were involved during its design or construction?
- Any lessons learned from the stakeholder engagement process (positive and negative)
- Any reports on participatory trajectories or engagement processes?
- Any (ongoing) citizen engagement projects?

Overall, the lessons-learned compiled from Demonstrator sites could be summarized into 10 best practices towards stakeholder engagement of DD-hybrid NbS for DuneFront that are described in more detail in the sections below.

9 Best Practices towards Stakeholder Engagement of DD-hybrid NbS

1. Perform a thorough stakeholder identification and assessment.
2. Gather the overall perception of stakeholders around coastal safety and DD-hybrid NbS within the area.
3. Consider differences between local, regional, national, and global perceptions regarding DD-hybrid NbS.
4. Identify and involve stakeholders associated to multiple pilot (Demonstrator sites) to improve legitimacy and credibility when promoting DD-hybrid NbS at larger scales.
5. Be aware that different benefits and drawbacks of DD-hybrid NbS are relevant to different stakeholders.
6. Apply a strong and iterative communication effort.
7. Utilize appropriate and understandable terminology attuned to different stakeholder groups.
8. Present a clear overview of DD-hybrid NbS (implementation, construction, and maintenance) and clarify responsibilities amongst stakeholders.
9. Assess whether the planned level of engagement aligns with the level stakeholders themselves wish to participate in (e.g. inform, consult, involve, collaborate, co-create).
10. Plan for gradual changes in the overall attitude and acceptance of DD-hybrid NbS.

4.2.1 The Belgian Coast

Best practices and lessons learned regarding stakeholder engagement along the Belgian coast were obtained from the Sustainability and Resilient Coastal Cities (SARCC) project report³⁶. The report included information about the stakeholder assessment and participation trajectory from the 2 Demonstrator sites in Belgium. The Grass Dike in Middelkerke and represents a fully planted dune-in-front-of-a-dike constructed in 2020. The Living Lab in Raversijde is a 1.5 ha and 120x20 m² experimental dune-in-front-of-a-dike constructed in 2020.

Prior to the start of the design process and its eventual implementation, it is important to **gather the overall perception of stakeholders around coastal safety and DD-hybrid NbS within the area**. An active questionnaire in Raversijde helped obtain the general perception of DD-hybrid NbS. It showed that the majority of functional users of the coast thought more positively about the implementation of a DD-hybrid NbS but were not necessarily vocal about it. Contrastingly, negative reactions were more outspoken, but only represented a minor fraction of the general public opinion. Contextualizing these responses was therefore relevant prior to making changes in the design process.

While the investment and construction of a DD-hybrid NbS in Belgium is the responsibility of the regional government, their maintenance is the responsibility of the local municipality³⁶. As agreements between the Flemish and local governments must be made, government stakeholders valued clarity in the communication of cost distribution towards the construction and maintenance of a DD-hybrid NbS. Within the engagement process it is therefore important to communicate and **present a clear overview of DD-hybrid NbS (implementation, construction, and maintenance) and the expected responsibilities amongst stakeholders**. For the responsible authorities, the benefits must outweigh the cost of implementation and maintenance in comparison to the implementation of the traditional hard-substrate solution (e.g. dikes). The ability of a DD-hybrid NbS to lower overall maintenance costs, such as a reduction in sand clearing activities due to decreased sand erosion through the plantation of marram grass are hereby relevant arguments to be made when promoting DD-hybrid NbS to government stakeholders.

Change to the Belgian coastline is often met with resistance for fear of losing what is familiar (e.g. the accustomed view of the sea and accessibility). In the past, dune growth was typically prevented in many locations through beach cleaning operations and the mechanical degrading of dunes to improve the appearance of the beach for recreational use, increase ease of access, or maintain views of the sea from shorefront residences³⁹. From local administrations, there is a willingness to rethink the Belgian coastline in favor of DD-hybrid NbS if there is sufficient integration with the needs of current functional users of the coast including stakeholders related to primary and secondary homes, transport, hikers, beach cabins, surf clubs and catering establishments³⁶. The promotion of DD-hybrid NbS should

therefore focus primarily on the benefits that are visible and can be experienced tangibly (e.g. enhanced recreational space, greenery, biodiversity) and not purely focus on coastal safety and the preparation for T1000 storm surges. Unclear communication results in the wrong impression that the alternative to the implementation of a DD-hybrid NbS is to keep the coastline unchanged as opposed to the construction of hard-substrate dike or storm wall. Functional users of the coast therefore need to be given time to adapt to visible change. **Stakeholder engagement must therefore plan for gradual changes in the overall attitude and acceptance of DD-hybrid NbS.** The slow and stepwise implementation of a DD-hybrid NbS can therefore enable coastal users to slowly get used to a changing coastline and improve overall acceptance. In this manner, facilitating dune growth through the plantation of marram grass or stimulating dune expansion using natural processes can be met with less resistance in comparison to a large and sudden sand supplementation activity.

4.2.2 The Dutch Coast

Best practices and lessons learned regarding stakeholder engagement from DD-hybrid NbS along the Dutch coast were gathered from the following projects^{36,43,69,70}. These reports included information about the stakeholder assessment and participation trajectory of the different Demonstrator sites. The Demonstrator site at the Delflandse kust, the Sandmotor, is an existing dune-in-front-of-dike constructed in 2008–2009 close to Ter Heijde in South Holland and connected to the Spaniards Dune. The Prins Hendrik Zanddijk, in Texel is a dune-in-front-of-dike and dike-in-dune completed in 2019. Lastly, the Hondsbossche Duinen is a dune-in-front-of dike close to Petten in North Holland that was constructed in 2015.

The successful implementation of co-creation in the design process of several DD-hybrid NbS in the Netherlands is an important component that influenced their successful implementation⁷⁰. Residents along the flood defense, farmers, nature organizations, recreational users, fisheries, and port companies are among the stakeholders involved. In preparation, extensive outreach efforts, monitoring and data collection were conducted to inform ongoing management and reach out to stakeholders. Strategies were adapted and put in place to ensure the project's success in meeting its dual objectives of flood protection and ecological enhancement. Similar to the Belgian DD-hybrid NbS, the design process in the Netherlands emphasized the importance of communicating potential changes in activities and functional usage to the area. In the past a higher priority was given to flood safety in comparison to socio-environmental concerns which influenced the public endorsement of DD-hybrid NbS and subsequently its implementation⁶⁹. A limited evaluation of the values stakeholders give to the landscape can lead to expectations not being met after construction. Therefore, it was important to consider that **different benefits and drawbacks to coastal safety solutions are relevant to different stakeholder groups.** Gathering information about the primary motivations, recreational activities, likes and dislikes of stakeholders when visiting a DD-hybrid NbS that sets it apart from the neighboring coast can be valuable in the design process. It is recommended to incorporate the opinions of residents and beach users through

methods dedicated to these stakeholder groups (e.g. surveys, workshops, online platforms) to enable dialogue and discussion early in the project. In the Sand Motor, the presence of a lagoon could uniquely be utilized by kitesurfers and further attracted wind- and wave-surfers, hikers, bathers, artist, amateur archaeologists, and paleontologists to the area leading to the appearance of spontaneously organized cultural activities. While this positively promoted DD-hybrid NbS, the slow but natural siltation of the lagoon by sand, also meant that its functional use for such activities is expected to decrease over time. The currents present at the Sand Motor created a slight enhanced risk of swimmer safety which may become relevant if the implementation of a DD-hybrid NbS is expected to increase the number of bathers to the area. On the other hand, access to the DD-hybrid NbS by cars and hikers (with dogs) had a substantially negative impact on the development of nature (especially for breeding birds). While the growth of vegetation over time ultimately reduced this disturbance by making parts of the dune less accessible, it may therefore be necessary to implement upfront agreements regarding recreational activities in the design process of the DD-hybrid NbS.

A **strong and iterative communication effort** prior and during the design phase of a DD-hybrid NbS was considered to be a crucial important step in gaining public trust and creating general acceptance of the project. The involvement of multiple stakeholders through regular workshops and presentations during the design process of the Hondbossche Duinen helped build mutual trust amongst stakeholders through regular contact opportunities and was implemented in other DD-hybrid NbS in the Netherlands (e.g. Prins Hendrik Zanddijk in Texel). The campaign targeted multiple stakeholders enabled modifications to the design to address the concerns local communities had towards the recreational and tangible experience of the DD-hybrid NbS (e.g. creating viewpoints to stay in connection with the sea). In this manner, the effort helped promote and gain approval towards the construction of the DD-hybrid NbS.

In addition, there is real value in **performing a thorough stakeholder identification and assessment**. Going beyond the usual suspects may sometimes be necessary in order to not exclude important stakeholders. A clear example was shown when stakeholders from the regional water authority were forgotten and not included in discussions around the maintenance of the DD-hybrid NbS. This ultimately led to a non-optimal construction of the DD-hybrid NbS. The analyses of stakeholders who were not included during a project is hereby relevant in order to evaluate the inclusivity of a project and its influence on the final outcome of that initiative and its objective⁷¹ and in this case became a valuable lesson learnt for future projects.

4.2.3 The German Coast

Best practices and lessons learned regarding stakeholder engagement from DD-hybrid NbS along the German coast were obtained for Sankt Peter Ording a dune-in-front-of-dike within the Wadden Sea National Park^{44,45}.

In Germany, the DD-hybrid NbS at Sankt Peter Ording is managed by the National Park authorities and Federal coastal protection agency. The design had to integrate several of the needs and desires from different parties that prioritized different aspects of a DD-hybrid NbS. The coastal defense agency, put emphasis on a design focused on coastal protection (e.g. a dike) and wanted a reliable, pragmatic, and monetarily calculatable design that worked. Nature conservation and park authorities, on the other hand, valued designs stressing the importance of a minimal invasive approach (e.g. a dune) that included the absence of foreign materials, noise pollution, impacted water seepage and percolation, or changes in redox potentials. Tourist agencies were interested in an added value to the marketing system while citizens were mainly concerned about the visual aspects and safety of the design. It was important to be **aware that different benefits and drawbacks of DD-hybrid Nbs were relevant to different stakeholders.**

When communicating about DD-hybrid NbS it was important to ensure concepts and results are explained and understood to different stakeholders. The communication of results from the DD-hybrid NbS was conducted by researchers with an engineering background. Results involved numbers, forces and physical parameters that are solution oriented, which was not always easy to communicate clearly and in an approachable manner. For example, scaled physical modelling was a relatively novel method to the majority of stakeholders and had to be explained accordingly. The limits of such approaches and model realizations regarding vegetation coverage, chemical reactions, physical impacts, sediment scaling and wave flume limits (2D vs real beaches) had to be communicated in a clear and coordinated manner. **When engaging with stakeholders it was important to utilize appropriate and understandable terminology that was attuned to the different stakeholder groups.**

4.2.4 The Swedish Coast

Best practices and lessons learned regarding stakeholder engagement from DD-hybrid NbS along the Swedish coast were obtained for the Ystad municipality^{46,47}. Ystad experiences some of the most serious beach erosion along the Swedish coast. The city has a dune-in-front-of-dike following beach nourishments carried out from 2011–2021 in Sandskog National Reserve and Löderup Strandbad.

It was important to construct a clear overview on the implementation, construction, and maintenance process of a DD-hybrid NbS that is well understood amongst the different stakeholders. The needs and interests had to be considered by different stakeholders including those from sectors related to the environment, tourism, business, and education. Researchers further served as consultants and actively participated in the design and impact assessment of the sand nourishment projects. The decision-making on implementing the DD-hybrid NbS at Ystad was a rather difficult process. As it was the first large scale sand supplementation project, leading to multiple uncertainties amongst different stakeholders that were not clearly communicated and resolved. This is predicted to be the underlying

cause of significant delays in the permitting process⁴⁷. While a permit for the actual nourishment was given in 2001, the permit for offshore sand extraction was rejected several times. In 2011, after a delay of almost 10 years, it finally became possible to implement the project. In 2013, request for additional beach nourishments at Ystad were swiftly approved. **It was therefore important to present a clear overview of DD-hybrid NbS (implementation, construction, and maintenance) and clarify different responsibilities amongst stakeholders.**

It is important to **consider differences between local, regional, national, and global perceptions regarding DD-hybrid NbS**. Within the political stream in Sweden, there is an ongoing discussion about the responsibility for coastal erosion. In this manner, a potential disconnect is perceived between policy at the national, regional, and local level regarding coastal protection. The sand nourishment project at Ystad was eventually seen as a successful alternative method for coastal protection by the local municipality. The local stakeholders from the Scanian coastal region subsequently aim to place the coastal erosion issue on the regional and national agenda. They hereby seek national policy changes that promote financial and approval measures for their implementation. At the regional and national level, however, there is a more limited understanding on coastal erosion in Scania which is attributed, in part, to the geographical and political distance between Scania and Stockholm. At these levels, doubts remained regarding the impact of sand nourishments to counter coastal erosion in Ystad. To successfully upscale DD-hybrid NbS in Sweden, more information is needed regarding policy windows around coastal erosion and climate change adaptation and the actors that can influence them.

4.2.5 The French Coast

Stakeholder engagement reports were not yet available for the French Demonstrator sites, so best practices and lessons learned regarding stakeholder engagement were obtained from a report analyzing coastal management along the coast of France^{48,72,73}. The report largely focused on the strategy of anticipatory relocation, but the recommendations put forward remain relevant to DuneFront and to DD-hybrid NbS.

In particular, the report highlighted the importance of the national pilot studies to help reinforce the legitimacy and credibility of relocation strategies across France^{48,50}. The Ministry for Ecology launched a call to local authorities to implement policy experiments and pilot studies to test coastal management solutions that could be considered as “incubators” to help conceive and test new ideas⁵⁰. In this manner, local authorities were involved, and legal and regulatory hindrances could be identified. Several stakeholders were involved in multiple pilot projects and were actively participating in debates and discussions at the local and national level. These stakeholders gained a higher influence in comparison to stakeholders associated to a single pilot site. They can hereby act as an influential bridging organization between different sectors⁴⁸ and engaging with them can hereby improve the legitimacy and

credibility of a project. For DuneFront, it is hereby important to **identify and involve stakeholders associated to multiple demonstrator (pilot) sites to improve legitimacy and credibility when promoting DD-hybrid NbS at larger scales.**

In France, efforts were made to **gather the overall perception of stakeholders around coastal safety and DD-hybrid NbS within the area.** National seminars were organized to facilitate the diffusion of collected experiences and concerns regarding the upscaling and mainstreaming of the resented solutions regarding coastal safety. Within, or alongside, several of these pilot projects, multiple surveys were conducted regarding the public perception of coastal safety measures in France. This policy-making process provoked lively debates about the feasibility, institutional constraints, funding and more generally the acceptability of coastal safety measures⁷². Results indicated that perceptions varied according to the population type (e.g. primary and secondary homeowners, tourists, and recreational beach users) but was also heterogenous, due to psychological and socio-economic constraints. In addition to a person's degree of risk exposure and their awareness of being in an area at risk⁷², their acceptance was largely reflective of their perceived attachment towards a place.

4.2.6 The Portuguese Coast

Best practices and lessons learned regarding stakeholder engagement were obtained from a public engagement report that assessed the public perception and preferences for coastal risk management in Portugal⁶⁸.

The report highlighted that the surveyed individuals demonstrated a proactive disposition to engage in coastal management and that a participatory coastal management strategy is favored by participants. Citizens found engagement practices meant to inform or consult to be unsatisfactory in meeting their needs and expectations. Instead, individuals expressed a preference for a higher degree of interaction as a result of a more collaborative engagement where citizens could participate to determine the actions to be taken. In Portugal, public participation in coastal management is not institutionalized, in contrast to other countries (e.g. the Netherlands). Instead, participatory approaches in Portugal tend to largely rely on public consultation mechanisms, upon which the population appears to be unaware of and seems to erode trust by the public to the public authorities⁶³. This was further reflected in the survey where 20% of participants reported their distrust in governmental and public authorities. Despite the public's expressed willingness to participate in coastal management, the exact type and degree of participation that was preferred was not determined from the study. Nonetheless, the report highlighted the importance in determining *a priori* **whether the planned level of engagement is in alignment with the level stakeholders themselves wish to participate in (e.g. inform, consult, involve, collaborate, co-create).**

5. Stakeholder Assessment

Identification of the stakeholders and stakeholder groups involved in a project is an essential step in the process of constructing an efficient engagement plan. DuneFront is designed as a multidisciplinary project that unites 10 universities, 3 non-academic research institutes, 2 partners from industry and 1 governmental agency, for a project spanning the scientific disciplines of ecology, sediment dynamics, socioeconomics and coastal processes/safety engineering. In addition to the partners of the project, a large number of stakeholders are relevant to the successful implementation of DuneFront and extend it beyond its lifetime of 4 years. According to the different tasks and objectives of work packages, the stakeholders to engage with in DuneFront can be separated into several components:

- Stakeholders contacted by work package leads to obtain data from each of the 12 Demonstrator Sites (WP4-WP9). This includes stakeholders that must be contacted to obtain permission for sampling and field work.
- Stakeholders to communicate the objectives and results of DuneFront. This includes visits by stakeholders to observe the demonstrator sites, the physical twin set-ups in Belgium, German, and the Netherlands (WP12), the connection of DuneFront with citizen science projects (WP16.4), and other European and international projects (WP16.5).
- Stakeholders engaged with to co-develop the tools and guidelines, as part of WP13 and WP14, in a fit-for-purpose and user-friendly manner and stakeholders that will use the tools and guidelines beyond the timeline of the project
- Stakeholders contacted for the co-creation process in De Panne (WP15). This includes stakeholders involved in the design, construction, and maintenance of a DD-hybrid NbS as well as the stakeholders needed to obtain the necessary permits.

Stakeholders already connected to the DuneFront demonstrator sites were identified within the proposal and were grouped into four categories according to the quadruple helix innovation model (see Chapter 2). The description of the state of play of different countries (Chapter 3), best practices and lessons learned from the DD-hybrid NbS (Chapter 4) further help to fine-tune and consider additional stakeholders from the different respective Demonstrator sites. As mentioned previously, the involvement of stakeholders in DuneFront is dynamic rather than stagnant and can therefore change as the project progresses through its milestones and deliverables. A stakeholder long list will be formed and updated as the project progresses (M16.2). It helps act as an overview and baseline of the various stakeholders targeted by the different engagement activities planned for DuneFront. This list can be consulted when planning a stakeholder engagement activity and to help pinpoint potential gaps that are missing. It is important to note that the clustering of stakeholders into

groups should also not be seen as a rigid procedure because a stakeholder can be placed into one or more groups, depending on their role within a project or task. It is also important to highlight that the stakeholders included in for this DuneFront Stakeholder engagement strategy do not necessarily represent the stakeholders that would be required to include in every DD-Hybrid NbS project within every country*⁹.

DuneFront partners and demonstrator site leads were asked to provide additional information about the stakeholders they will need to contact and included based on the following criteria:

1. Any stakeholders to engage with to meet the deliverables and milestones of a work package (e.g. the collection of data from demonstrator sites)?
2. Any stakeholders relevant to the Demonstrator site at the local, regional, or national level?
3. Any other stakeholders relevant at the local, national, EU or global level?

An overview of the different stakeholder groups associated to the 12 different DD-hybrid Demonstrator sites can be seen in **Table 2**. A summary of the stakeholder groups involved in DuneFront are discussed in more detail below.

Table 2. Overview of the stakeholder groups associated to the 12 Demonstrator sites.

DD-hybrid NbS	Country	(1) Research and Innovation	(2) Government and Policy	(3) Industry	(4) General Public, communities NGOs
Demonstrator sites					
Partners are indicated in brown and in bold, responsible authorities are highlighted with an asterisk (*), stakeholders that have already been contacted are highlighted in bold. Please note that certain stakeholders can be placed in different or multiple groups depending on the defined objectives of a stakeholder assessment.					
Douro estuary sandspit	Portugal	UPORTO	Municipality of Porto, Municipality of Vila Nova de Gaia , Directorate General for Territory	Port of Leixões, Port of Viana do Castelo , (*) Port Authority of the Douro, Leixões and Viana do Castelo (APDL), Recreational Tourism	Agência Portuguesa do Ambiente, Instituto para a Conservação da Natureza e das Florestas , Local Natural Reserve of Douro Estuary (RNLED), Residents of Porto, Residents of Vila Nova de Gaia, recreational users
Soulac	France	UBx, Observatoire de la Côte Nouvelle-Aquitaine ,	Soulac Concil, Office National des Forêts (ONF) , (*) Communauté de	Recreational Tourism	Residents of Soulac-sur-Mer, secondary homeowners, recreational users, Centre Permanent d'Initiation à

*⁹ A guideline for co-creation of DD-Hybrid NbS in WP14 will present a blueprint for stakeholders that includes stakeholder identification and engagement activities.

		Bureau de Recherches Géologiques et Minières (BRGM)	Communes Médoc Atlantic (CCMA)		l'Environnement (CPIE)
Dunkirk	France	ULCO, Géodunes	(*) Communauté Urbaine de Dunkerque (CUD), Pole Métropolitain Côte d'Opale (PMCO), Office National des forêts (ONF), (*) Grand Port Maritime de Dunkerque (GPMD), Région Hauts de France, Institution Départementale des Wateringues	Grand Port Maritime of Dunkerque, Recreational Tourism (e.g. restaurants, beach cabin renters, surf clubs),	CoastSnap users, Residents of Dunkirk and Malo les Bain, recreational users (fishermen, beach cabin users, tourists, secondary homeowners, hikers, board sports), Centre Permanent d'Initiation à l'Environnement (CPIE), coastal heritage (shipwrecks), bird protection agencies
Sainte-Marie La Mer	France	UPVD, Observatoire de la Côte Catalane (OBSCAT), EID-Med	(*) Perpignan Metropole Méditerranée (PMM), Office National des forêts (ONF), National authority (DREAL), Region Occitane	Recreational Tourism	Residents of Saint-Marie La Mer, secondary homeowners, recreational users, Centre Permanent d'Initiation à l'Environnement (CPIE)
Living Lab Raversijde	Belgium	UGent, KULeuven, EVFH, VLIZ, ARCADIS, INBO	(*) Municipality of Oostende, (*) MDK, Institute voor Natuur en Bos (INBO), Province of West Flanders,	Jan de Nul, DEME (civil and marine Contractors), De Lijn (tramline), Tourisme Vlaanderen (recreational tourism)	CoastSnap users, 4Sea, Wind & Watersport Vlaanderen (WWSV) Residents of Oostende, secondary homeowners, recreational users, Natuurpunt, coastal heritage
Middelkerke grass dike	Belgium	UGent, KULeuven, EVFH, ARCADIS, INBO, VLIZ	(*) MDK, (*) Municipality of Middelkerke, Institute voor Natuur en Bos (INBO), Province West-Vlaanderen	Civil and marine Contractors (Jan de Nul, DEME), Tourisme Vlaanderen (recreational tourism), De Lijn (tramline), landscape architects (MOP, UrbanDesign and Clusterlandscape),	4Sea, Wind & Watersport Vlaanderen (WWSV) , residents of Middelkerke, secondary homeowners, recreational users, Natuurpunt, CoastSnap users, coastal heritage

				engineering companies (Plantec and SBE)	
Delflandse kust (Sand Motor)	Netherlands	UU, TU Delft, DELTARES, Ecoshape	(*) Waterboard of Delfland, Rijkswaterstaat, Province of South Holland, Municipality of Westland, Municipality of Den Hague, Municipality of Rotterdam, Ministry of Infrastructure and Environment,	(*) Boskalis and Van Oord (civil and marine contractor), Port of Rotterdam, Dunea (drinking water company), recreational Tourism	Federation of Nature and Environment South Holland, World Wildlife Fund (WWF), Residents of Westland, Den Hague and Rotterdam, Recreational users (kite-, wind-, wave- surfers, hikers, bathers), National Park Hollandse Duinen
Hondsbossche Duinen	Netherlands	UU, TU Delft, DELTARES, Ecoshape	(*) Waterboard of Hollands Noorderkwartier (HHNK), (*) Rijkswaterstaat, Province of North Holland	(*) Contractors Boskalis and Van Oord, Recreational Tourism (e.g. beach restaurants, holiday housing providers)	CoastSnap users, Residents of Petten and Groet, Recreational users, Federation of Nature and Environment North Holland (MNH)
Katwijk	Netherlands	UU, TU Delft, DELTARES, Ecoshape	(*) Waterboard of Rijnland, (*) Municipality of Katwijk, Rijkswaterstaat, Province of South Holland	Recreational Tourism, Buried parking garage integrated within the dune	Residents of Katwijk, Recreational users, Natuur en Milieufederatie Noord-Holland (MNH),
Texel, Prins Hendrik Zanddijk	Netherlands	UU, TU Delft, DELTARES, Ecoshape	(*) Waterboard of Hollands Noorderkwartier (HHNK), Rijkswaterstaat, Province of North Holland, Municipality of Texel	(*) Jan de Nul, Recreational Tourism (e.g. camping sites), Ferry company TESO, Fisheries, Farmers	CoastSnap users, Residents of Texel, Recreational users, CoastSnap NL (UU), Federation of Nature and Environment North Holland (MNH), UNESCO World Heritage Site Wadden Sea area
Sankt Peter Ording	Germany	TUB, University of Berlin	(*) National Park and Marine Conservation Schleswig-Holstein (LKN.SH), (*) Deich- und Hauptsielverband Eiderstedt, Landesbetrieb für Küstenschutz (DHSV Eiderstedt), Municipality of	Recreational Tourism (e.g. beach bars, watersport, kitebuggy school)	Nationalpark Schleswig-Holsteinisches Wattenmeer, (*) National Park Wattenmeer (NLPV), Residents of Sankt-Peter Ording, Wadden Sea tourism, UNESCO World Heritage Site Wadden Sea, WWF Germany,

			Sankt Peter-Ording		
Ystad	Sweden	Lund University	(*) Municipality of Ystad	Port of Ystad, Spa Hotels, SWECO (UK), Recreational Tourism	Residents of Ystad, environmental tourism, recreational users (cycling and walking path), CoastSnap users , Naturskolan
Others		TAMU, University of Plymouth	European Commission, Municipality of De Panne, Municipality of Knokke, Danish Coastal Authority	SWECO (UK)	World Wildlife Fund (EU)

1. Research and Innovation Stakeholders – Partners of DuneFront are largely composed of universities and research institutes associated to the 12 DD-hybrid NbS (e.g. UGent, KULeuven, Bordeaux, UPORTO, UBx, UPVD, TU Delft, UU, TUB, LU, TUBERLIN, TAMU, DELTARES). In addition, DuneFront is connected with several other Research and Innovation stakeholders related to the monitoring (e.g. Observatoire de la Côte Nouvelle-Aquitaine, Observatoire de la Côte Catalane, Géodunes engineering office), the evaluation of biodiversity (INBO), consultancy of the co-design and construction of DD-hybrid NbS (e.g. EcoShape, ARCADIS, SWECO), and expertise in the research of dune formation and erosion related processes (University Plymouth). These research and innovation stakeholders typically have a high level of expertise, are interested and involved in the results and outcome of DuneFront but contain a low level of influence concerning the promotion of DD-hybrid NbS as an alternative to hard-substrate alternatives for coastal protection. Stakeholders here are primarily consulted and collaborated with.

2. Government and Policy Stakeholders – DuneFront is connected to several government institutes and municipalities associated to the 12 Demonstrator sites. As mentioned in Chapter 2, in most European countries the construction and maintenance of a DD-hybrid NbS is typically the responsibility of the regional government and local municipality. Unique to Germany, both the National Park (e.g., National Park and Marine Conservation Schleswig-Holstein LKN.SH) and the federal coastal protection agency (e.g., State Agency for Coastal Protection) are relevant authorities for the DD-hybrid NbS. These stakeholders represent an important group for DuneFront to connect with due to the high level of influence and power they exert regarding the certification (permission), promotion, construction, maintenance, and acceptance of DD-hybrid NbS. In particular, the DuneFront partner representing the Flemish government, MDK, together with the local municipality of De Panne are key stakeholders involved in the realization of the co-creation process in WP15 where a DD-hybrid NbS will be designed, applied for, and constructed in De Panne.

3. Industrial Stakeholders impacted by coastal management infrastructure have a more varying level of influence, expertise, interest, and support towards the outcome of DuneFront. DuneFront partners Jan de Nul and DEME, but also the industrial stakeholders Boskalis and Van Oord represent dredging, offshore wind and marine contracting companies typically involved in the construction of coastal protection infrastructure including several of the Demonstrator sites. In DuneFront, these industrial stakeholders contain a high level of commercial expertise in blue-grey infrastructure and to some degree a level of influence that is necessary to upscale DD-hybrid NbS and bring them to the market as a viable alternative to more traditional hard-substrate coastal protection measures. Other industrial/commercial stakeholders impacted by coastal management infrastructure include the recreational and tourist industry along the coast (e.g. Tourism Flanders, Spa and Seaside Hotels, surf and beach sport clubs) and port authorities. These stakeholders may have concerns towards the outcome and conclusion of the project in relation to how the implementation of a DD-hybrid NbS can influence their economic prosperity. For example, the port authorities in Portugal (e.g. Port of Leixões, Port of Viana do Castelo), France (Grand Port Maritime of Dunkerque), and the Netherlands (Port of Rotterdam) are in close connection with their municipalities regarding the management of coastal protection infrastructure. Ports and harbors typically have a large economic value yet are particularly vulnerable to flooding or outside a flood defense system as they require openings within a coastal protection system for its functioning (e.g. access points to roads or rail).

4. General Public – In DuneFront, the general public includes local coastal communities, recreational and functional users of the beach, but also NGO's advocating on behalf of citizens and nature (e.g., Portuguese Agency of the Environment, Institute of Nature and Forest Conservation, 4Sea, Environmental Federation of South Holland, World Wildlife Fund). The general public typically reflect stakeholders with a low level of influence and expertise but are highly impacted by the implemented coastal protection measures. Different stakeholders in this group can have varying levels of concern, or approval of the project and DuneFront can actively inform stakeholders with balanced and objective information to assist them in understanding the nature and objectives of an NBS project. Interested members of the public can obtain further information about the project and DD-hybrid NbS on the DuneFront website and sign up to its periodic newsletter (for more information see D16.1). In comparison to an individual, larger organizations generally have a stronger voice and therefore a higher level of influence. In Belgium, this stakeholder group can further be empowered through the dissemination of results and the active involvement in the co-creation process in De Panne where relevant concerns can be addressed in the design of the DD-hybrid NbS. In particular, DuneFront plans to connect with CoastSnap users to disseminate information about the project and DD-hybrid NbS.

6. Stakeholder Engagement Overview

DuneFront plans to engage with a broad range of stakeholder groups at different moments throughout the project. The main objective of the stakeholder engagement strategy is to present an overview of the activities taking place and coordinate events in such a way that maximizes efficiency while minimalizing stakeholder fatigue. Where possible efforts are made to streamline tasks by coordinating and combining stakeholder engagement moments.

The stakeholder engagement plan follows a stepwise approach to obtain a fit-for-purpose strategy that is structured around the framework presented in Blue Balance¹. A review of best practices was described in Chapter 2 and Chapter 3 and a stakeholder analysis was performed in Chapter 4, respectively. In this chapter, the stakeholder engagement activities in DuneFront are presented. Information on stakeholder engagement activities planned within the different work package deliverables and milestones were collected from the proposal and from work package leads. For each task/ deliverable/ milestone, partners were asked details around their stakeholder engagement activities were obtained through the following questions:

1. What information do you need to obtain from stakeholders?
2. Who are the targeted stakeholders and stakeholder groups?
3. How will they be engaged with? (please be as specific as possible)
4. Provide any details about the planned engagement.
5. When is this engagement planned?

Where information was lacking, partners were contacted individually for further clarification. The list of activities and responses was compiled into a chronological list of planned stakeholder engagement activities per year and where possible details of the engagement are listed. Below we present the stakeholder engagement for each year.

6.1 Year 1 (M1-M12)

An overview of stakeholder engagement activities in Year 1 (M1-M12) is summarized in **Table 3**. If known, the targeted stakeholder groups are listed for each task/ deliverable/ milestone. Details of the stakeholder engagement can be found in the text below.

Table 3. Summary of engagement activities currently outlined in Year 1 (M1-M12).

Work package	Work package lead	Task/Deliverable/ Milestone	Due month	Engagement objectives	Stakeholder Engagement	Targeted Stakeholder Groups
Year 1						
WP4-WPIO	(multiple)	WP4-WPIO	see Annex 1	Data collection from the 12 Demonstrator sites as input for different tasks	Individual contacts, bilateral meetings and emails	Data owners and providers from the 12 Demonstrator sites

				(see Annex 1 for more details).		
WP16	UPORTO, UGent, VLIZ	M16.4: Identification of connecting initiatives and projects	M11	EU and global projects associated to DuneFront are identified, contacted and engaged with for	Bilateral meetings, emails and conferences	EU and global projects (e.g. Network Nature Plus, MANABAS, TRANSEATION, BlueMissionBanos, ULTFARMS, SUSANA)
WP16	VLIZ	M16.3: Incorporate information links at the existing Demonstrator CoastSnap stations	M12	Dissemination of DuneFront and DD-hybrid NbS to the public through CoastSnap info channels.	Links on panels of CoastSnap stations to disseminate information, Kustportaal website, and emails	CoastSnap users of the Belgian coasts, (and possibly CoastSnap members from other countries with Demonstrator sites)
WP8	UGent	M8.1 Selection of existing rating systems	M15	Propose a new conceptual framework for rating of blue infrastructure	Bilateral meetings to interact and discuss with experts	Internal and external expert contributors (e.g. partners of TRANSEATION)
WP15	MDK	D15.3: Co-creation – first outreach to local stakeholders	M24	First outreach to local stakeholders	3 virtual interactive stakeholder workshops (M7, M9, M12)	Relevant stakeholders of de Panne (see Table 6)

6.1.1 Coordination of data needs and requirements in work packages

Within the first year of DuneFront (M1–M12), the majority of the stakeholder engagement concerns the collection of data from the 12 different demonstrator sites (WP4–WP9). The gathered data from these work packages will further be relevant for the downstream analyses in other work packages leading to the construction of Life Cycle Assessments, Predicted Digital Twins (PDT), a Decision-Support System (DSS), and Blueprints.

To increase the efficiency of data collection, a Demonstrator Lead was appointed for each of the twelve Demonstrator Sites at the start of the project. The chosen demonstrator leads coordinated the collection of data from the relevant stakeholders. Typically, the leads were chosen because they already had data collections from a Demonstrator Site in their possession, knew of its availability online, or were in contact with relevant stakeholders of a Demonstrator Site from previous projects. When data was not available online, WP Leads coordinated questionnaires about their data requirements to send to Demonstrator leads. This was also an opportunity for WP Leads to reach out to relevant stakeholders and communicate about the Demonstrator site’s role in DuneFront. To enable this, informative flyers of the different Demonstrator Sites were prepared for distribution to stakeholders.

Streamlining the request for data amongst work packages was important to limit repeated contact of relevant stakeholders for the same data. To gather an overview of data requirements needed by work packages, WP Leads were asked to submit the data needed to

complete an individual task (**Annex 1**). From this compilation, an overview of data overlaps could be highlighted (**Table 6**). In this manner, possible areas of coordination could be identified. For example, socio-economic data was required from Demonstrator Sites by WP4, WP8, and WP9 which was compiled by WP8.

Table 4. Overview of data requirements by work packages for the different Demonstrator sites.

Data requirements (DD-hybrid NbS)							
Colored boxes (brown) indicate where work package leads have clarified, they would oversee and coordinate the data collection and share with other work packages							
	WPO4	WPO5	WPO6	WPO7	WPO8	WPO9	WPO10
Hydrodynamic data: wave (Hs, T), tidal			X	X			
Topographic data: DEM, DTM, XYZ files		X	X	X			
Meteorological data: wind (speed, direction)			X	X			
Climatological data			X	X			
Aerial imaging (UAV-orthophotos)		X	X	X			
Flood risk maps (e.g. T1000, T200, T100)	X						
Sediment depots	X						
Socio-Economic data	X				X	X	
Technical reports: Design, Safety, Maintenance				X	X	X	
Environmental Impact Assessment					X	X	
Costs (construction, operation, maintenance)					X		
Other technical reports (for infrastructure rating system)					X		
Sampling Permits (for field work)		X					X

6.1.2 Connecting projects

DuneFront aims to connect to other EU projects and initiatives to identify synergies, exchange good practices and jointly disseminate deliverables related to policy recommendations (policy briefs). In particular, DuneFront will seek to link with projects that support the development of policies, business models and market conditions to scale-up the implementation of DD-hybrid NbS. In the first year, projects are identified, contacted, and introduced to DuneFront partners through email and bilateral meetings (M16.4). Ongoing projects were identified through one or more overarching themes including:

- (a) dune-dike hybrid systems
- (b) blue-grey infrastructure
- (c) nature-based solutions
- (d) dune and coastal erosion monitoring
- (e) marine and coastal biodiversity and climate resilience
- (f) future flood risks
- (g) sustainability science promotion

From a list of EU projects, DuneFront will select projects to engage with. A final report on the interaction of DuneFront with interconnecting projects will be compiled and presented in the second year (D16.3). Several projects that have already been connected to DuneFront and interacted with can be seen in **Table 5**.

Table 5. EU projects DuneFront has currently already connected with.

Connecting Project	Relevance (A-G)	Date	Funding Call	DuneFront partners involved (if present)	Short description of the project	Link with DUNEFONT (e.g. input and outputs)
MANABAS COAST	ABCDEF	2022-2027	Interreg, EU	Flanders Hydraulics (EVFH)	NBS pilots in the North Sea	DD-hybrid NbS (demonstrator sites, erosion modelling, DSS, blueprints)
TRANSEATION	BC	2024-2027	HORIZON Europe		Marine and coastal hybrid blue-grey infrastructure including NBS	WP8 – LEEDS rating system of DD-hybrid NbS
NetworkNaturePLUS	G	2023-2027	HORIZON Europe		Promotion and upscaling of NBS in Europe, to stakeholders and the public	promotion of NbS, connection with similar projects, stakeholder engagement, citizen science
SUSANA	ABCDEF	2023-2025	VLAIO, Blue Cluster	UGENT, KULEUVEN, JAN DE NUL, DEME	DD-hybrid NbS	LCA and LCC analyses, dune modelling

DuneFront is in contact with **NetworkNaturePlus**, a Horizon Europe project that promotes projects involved in nature-based solutions and building with nature (e.g. New European Bauhaus initiatives). NetworkNaturePlus helps manage and promote collaboration between projects through several NbS Task Forces. DuneFront actively participates in several of these taskforces including Co-creation and Governance (VLIZ), NbS Communicators (VLIZ), Finance and Business Models for NbS (Jan de Nul), and Data and Knowledge Sharing (UGent). DuneFront will further utilise the Network Nature platform to help promote DD-hybrid NbS and disseminate results to relevant participants in the annual Network Nature Event (25th September 2024). The Network Nature Event can further help increase the network of interconnecting projects to DuneFront.

Several Demonstrator Sites (e.g. Living Lab Raversijde, Middelkerke, Zand Motor) are in association with other national or European projects that DuneFront plans to connect with (e.g. MANABAS COAST, SUSANA). The Interreg Europe project **MANABAS COAST** – which aims to mainstream NbS in the North Sea Region by developing and promoting an accessible framework, tools, and guidelines. **SUSANA** is a Belgian project funded through VLAIO and the Blue Cluster (e.g. Jan de Nul, DEME) that aims to develop a linked ecosystem services model to weigh the advantages and disadvantages of a dune-dike systems along the Belgian Coast and involve the Belgian Demonstrator sites (e.g. Middelkerke, Living Lab Raversijde).

Partners of WP8 in DuneFront have contacted and plan to collaborate with partners from its sister project **TRANSEATION** (Advancing Ecosystem-Based Management through Hybrid Blue-Grey Infrastructures in Marine and Coastal Areas), that is funded under the same Horizon Europe call. In WP8, a blue-infrastructure rating system is developed that builds on a life-cycle assessment (LCA) and a life cycle cost (LCC) analysis to quantify the environmental impacts and the costs of alternatives for coastal protection systems (D8.4). The design of its framework will be based on detailed literature research, targeted stakeholder involvement and expert contributions (M8.1). This rating system will then be applied on selected Demonstrator sites and after validation will be ready to use in the third year (M8.2) by stakeholders and integrated within the Decision Support Tool (DSS) in WP14 (M14.2). The rating system will act as a relevant resource to research, industrial, government and policy stakeholders for the development of tender evaluations and/or business cases with DD-hybrid NbS. Initial introductory meetings have already been conducted and follow-up meetings have been planned to further explore this collaboration through the sharing of updates and the validation and testing of joint-case studies.

6.1.3 Citizen science

DuneFront will interact with citizens using CoastSnap, a global citizen science project that engages citizens that have a smartphone to capture changing coastlines through repeated photos at the same location. These stations present an opportunity to disseminate information about the DuneFront project and the use of DD-hybrid NbS as a safeguard for coastal protection and biodiversity to interested members of the public. Several CoastSnap stations are located near the Demonstrator sites of the Netherlands (Hondbossche Duinen, Texel Prins Hendrikzanddijk), Sweden (Ystad) and France (Dunkerque). While not close to a Demonstrator site, other CoastSnap stations are also present in Belgium (Oostende), Portugal (Cascais), and Germany (Langwarder Groden).

Four CoastSnap stations along the Belgian coast will be equipped with DuneFront logos and links to obtain more information about the DuneFront initiative. Information about DuneFront will also be made available through various info channels (D16.3) or sent by email to active users of CoastSnap (M16.3). In this manner, CoastSnap users who are interested in dune-dike systems, nature-based solutions, coastal safety, and biodiversity can be informed about the results of DuneFront and DD-hybrid NbS.

To continue and discuss the promotion of DuneFront through citizen engagement, CoastSnap members that are involved in the organization of European CoastSnap stations (e.g. CoastSnap NL which is overseen by UU), will also be reached out to. In Sweden, Naturskolan represents another citizen science project that can potentially be utilized to promote DuneFront. Naturskolan provides teaching material about how students can use a scientific method to investigate the presence of birds, pollinators, insects, and plants. Reaching out to the managers of Naturskolan to discuss their engagement methods, and their best practices,

can be relevant to further promote DuneFront using citizen science. School visits to Demonstrator sites to explain to young children concepts affiliated to DuneFront including biodiversity, building with nature, nature-based solutions, and DD-hybrid NbS.

6.1.4 Co-creation: case study in De Panne

In WP15, design prototypes are made for the construction and maintenance of a DD-hybrid NbS in De Panne. The first outreach to local stakeholders by MDK is realized through a series of virtual co-creation workshops (D15.3). Three interactive workshops are planned (in M7, M9, and M11) and organized by ARCADIS (in conjunction with ReeLeaf), a Dutch design, engineering, and management consulting company. In the first workshop the project designs will be presented and introduced to a diverse set of local stakeholders. Stakeholders will provide feedback regarding the technical design, financial aspects, environmental assessments, demolition assessments, permitting process, monitoring, and maintenance of the DD-hybrid NbS. A summary of the stakeholders representing the four stakeholder groups can be found in **Table 6**. In the first meeting, results from project partners associated to the materials (D15.1) and the design (D15.2) of the dike will be presented to stakeholders. The design process will include the development of bio-receptive material and the aesthetics of the eco-dike design (D15.2). Based on the output from these meetings, a first design is prepared and presented in the second meeting to stakeholders. In the third meeting, the prototype technical design is agreed on. The final prototype will be presented to contractors in the tendering process. Permits and tender documents are applied for to the relevant authorities (M15.1). Finally, a co-creation handbook will be published combining the co-creation experience in De Panne with several stakeholder end-user tools developed in DuneFront (D14.5).

Table 6. Stakeholder groups within the co-creation process of the DD-hybrid NbS in De Panne (WP15).

Co-creation Stakeholders for De Panne					
Stakeholders that are also partners in DuneFront are highlighted in bold and in brown.					
Location	Country	(1) Research and Innovation	(2) Government and Policy	(3) Industry	(4) General Public, communities NGOs
De Panne	Belgium	UGent: Faculty of Engineering and Architecture, UGent: Faculty of Spatial Ecology and Evolution, VLIZ: Department of Innovation and Policy, ARCADIS, ReeLeaf, Instituut Natuur en Bos (INBO)	Maritime & Coastal Services (MDK), Municipality of De Panne, Vlaamse Landschap Maatschappij (VLM), Province West-Flanders, Flemish Government: Department of Mobility (MOW), Heritage, and Environment	Jan de Nul, DEME, Representing the tourist-sector in West Flanders (Westtoer), EuroMarina VYNieuwpoort	Wind & Watersport Flanders (WWSV), Royal Sand Yacht Club (RSYC)

6.2 Year 2 (M12–M24)

An overview of stakeholder engagement activities is summarized in **Table 7**. If known, the targeted stakeholder groups are listed for each task/ deliverable/ milestone. Details of the stakeholder engagement can be found in the text below.

Table 7. Summary of engagement activities planned in Year 2 (M12-M24).

WP	Partner	Task/Deliverable/ Milestone	Due month	Engagement Objectives	Stakeholder Engagement	Targeted Stakeholder Groups
Year 2						
WP12	TU Delft	D12.1: Physical Twin Dutch and physical model database	M18	Physically interact and communicate with stakeholders regarding the progress of DuneFront	Site visit of the physical twin in the Netherlands	Project partners, local research and innovation institutes, government and policy stakeholders
WP16	UPORTO	D16.3 Connecting to EU and Global projects	M18	Report on engagement with connected EU and global projects to identify synergies	Meetings and conferences	EU and global projects (e.g. Network Nature Plus, MANABAS, TRANSEATION, SUSANA)
WP9	LU	D9.2: Integration of multi-use potential in Demonstrators	M22	Identify multi-use opportunities and co-benefits of DD-hybrid NbS.	stakeholder questionnaires and field visits to selected Demonstrator sites in coordination with UGent, iinteractive workshop	Internal project partners and demonstrator leads
WP14	Jan de Nul	M14.1: Blueprints – key features and enablers	M22	Identification of key features and enablers to be included in the Blueprints	Interactive meetings	Internal industrial, academic, government and policy partners
WP17	VLIZ	M17.1: Video material of selected Demonstrators	M24	General stakeholder communication with the aim of creating awareness	3 videos made accessible online	Available to all stakeholder groups
WP17	UGENT	D17.1: First policy brief	M24	Marine Policy Brief	Bilateral meetings and feedback rounds with relevant stakeholders to	Local, national and EU-governmental organizations

6.2.1 Stakeholder-visits to the Dutch, German and Belgian Demonstrator sites.

In the Netherlands, TU Delft will use data from selected Demonstrator Sites to physically model and construct a Physical Digital Twin (PDT) focusing on wave–dike interactions (D12.1). The physical model will be realized through scaled wave flume experiments at TU Delft to

further study the coastal protection functioning of DD-hybrid NbS under extreme conditions and provide a database of hydrodynamic measurements. In year 3, physical twins will also be constructed in Germany (D12.2) and Belgium (D12.3). Collectively, they represent an opportunity for guided local stakeholder visits to showcase and discuss current results of DuneFront to partners but also relevant government and public stakeholder groups. In a wave flume experiment, TUB will model the influence of vegetation on dune erosion. In Belgium, dune-dike interactions will be modelled using a wave flume at Flanders Hydraulics (EVFH). The results of the physical models will be used for communication purposes to stakeholders as a resource for future research but also for public outreach and education on the value of NbS and biodiversity for coastal safety. The Demonstrator visits will disseminate current insights between project partners and targeted local stakeholders associated to the Demonstrator sites, including those associated to research, government, policy, and the general public. Visits will further help provide additional photo and video material of selected Demonstrator sites that can be compiled to disseminate DuneFront results and activities on its communication platforms including the website and newsletters (M17.1). WP9 plans to partially coordinate their field visits to selected Demonstrator sites to obtain information from stakeholders involved in the planning and implementation of DD-hybrid NbS regarding multi-use (D9.2). LU will inquire how, in addition to coastal protection, other benefits gained from DD-hybrid NbS are included and promoted (e.g. ecological, biodiversity, recreational functioning, property value). Two marine policy briefs will be written in year 2 (D17.1) and later in year 4 (D18.2) and disseminated to local, national and EU-policy and government organizations. These policy briefs will take advantage of the stakeholder engagement activities planned in these years (e.g. stakeholder demonstrator visits, workshops, seminars) to gather information about the results and presence of relevant gaps and needs from the different stakeholder groups regarding DD-hybrid NbS.

6.2.2 Blueprints

A blueprint is a detailed plan or framework outlining the steps and processes required to design, implement, monitor, and maintain DD-hybrid NbS effectively. Blueprints can inform research, industrial, and government stakeholders through worked out business cases and/or the use of political decision-making tools as well as create awareness to the general public and NGOs towards policy. As a first step interactive meetings with internal industrial and academic partners will be conducted to identify key features and enablers required for a successful site implementation of DD-hybrid NbS (M14.1). These meetings can further take advantage of the stakeholder long list (M16.2). Three different Blueprints and business plans will be developed for 2 new coastal and 1 marine DD-hybrid NbS that will be disseminated to relevant industrial and government, and policy stakeholders at the beginning of the third year (D14.1).

6.3 Year 3 (M24–M36)

An overview of stakeholder engagement activities is summarized in **Table 8**. If known, the targeted stakeholder groups are listed for each task/ deliverable/ milestone. Details of the stakeholder engagement can be found in the text below.

Table 8. Summary of engagement activities planned in Year 3 (M24–M36).

WP	Partner	Task/Deliverable / Milestone	Due month	Engagement Objectives	Stakeholder Engagement	Targeted Stakeholder Groups
Year 3						
WP14	Jan de Nul	D14.1 Blueprints	M25	Dissemination of Blueprints for 2 new coastal and 1 marine DD-hybrid NbS	Bilateral meetings and email contact to gather feedback from stakeholders to ensure blueprints are fit for purpose prior to external dissemination to promote DD-hybrid NbS to stakeholders	Industrial, government and policy stakeholders
WP12	TUB	D12.2: Physical Twin Germany	M27	Opportunity to physically interact and communicate with stakeholders regarding the progress of DuneFront providing opportunity to interact	Site visit of the physical twin in Germany	Project partners, local research and innovation institutes, government and policy stakeholders
WP15	MDK	M15.1 Co-creation – prototype nature inclusive design	M28	Prototype technical design is agreed on, and permits are applied for	application, public survey for feedback and bilateral meetings	Relevant authorities for permits at De Panne
WP15	MDK	D15.4 Co-creation – tendering advances	M28	Interaction and selection of contractors for the construction of a DD-hybrid NbS in De Panne	Tendering process for a DD-hybrid NbS in De Panne	Contractors
WP8	UGENT	M8.1 Rating system for blue infrastructure	M30	Design of the blue-infrastructure rating system is completed and ready to use	bilateral interactions with targeted stakeholders and experts	Expert contributors (e.g. partners of TRANSEATION)
WP12	EV FH	D12.3: Physical twin Belgian and physical model database	M33	Opportunity to physically interact and communicate with stakeholders regarding the progress of DuneFront	Site visit of the physical twin in Belgium	Project partners, local research and innovation institutes, government and policy stakeholders

WP5	Ubx	M5.1: Biodiversity & trait sampling strategy (M5.1)	M34	Promotion of transparent sampling practices and open access regarding data	Distribution of the sampling design and diversity report of Demonstrator sites to open science platforms.	Citizen science portals (iNaturalist), Nature Conservation Agencies and Nature Ministries from diverse countries
WP13	TU-Delft	M13.2 PDT application	M34	PDT will be show-cased internally to stakeholders and its visualization and user-friendliness will be evaluated	First feedback loops to fine-tune the PDT for later dissemination and inclusion in the DSS	Internal and selected stakeholders

6.3.1 Field work completed at Demonstrator sites.

After the necessary permits have been obtained from relevant stakeholders in the first year, field work will be conducted in both WP5 and WP10 along the 12 different demonstrator sites until the end of the third year (M36). In WP5, the vegetational composition of plots along replicated transects will be measured (UBx and UGENT) while in WP10, sand trapping measurements and individual plants of relevant species are collected to assess dune-impacted species traits and biodiversity functioning. The plants collected will also be used in wave-flume experiments studying the impact of vegetation on dune erosion (e.g. D12.2). The setup of the joint sampling design will be coordinated between work packages including the sampling permission needed from stakeholders of the different Demonstrator sites. This is particularly relevant to the German DD-hybrid NbS in Sankt Peter-Ording which is located within the Schleswig-Holstein Wadden Sea National Park. The biodiversity data with the associated sampling strategy from the different Demonstrators will be distributed to relevant stakeholders including Nature Conservation Agencies and Ministries of Nature from diverse countries (M5.1). To further promote transparency, the collected biodiversity data will be shared with citizen science portals (e.g., iNaturalist) to report back on local patterns across the Demonstrators. Where relevant, short informative articles will be produced for the general public. Collectively, the results from these sampling collections and experiments are relevant for the work packages WP6, WP10, and WP12.

6.3.2 Predictive Digital Twins

The data collected from the three physical twins constructed from the different wave-flume experiments coupled with data from previous work packages will come together to construct a predictive digital twin (M13.2). A **Predictive Digital Twin** is a virtual representation of different DD-hybrid NbS. Using simulations, machine learning and other decision-making technologies, digital twins can help predict the performance and behavior of different DD-hybrid NbS under various extreme weather events and climate change scenarios. The modules should be simple, yet practical and comprehensive. Through internal workshops with

selected industrial, government and policy stakeholders, the user-friendliness and visualization of the tool will be evaluated and improved upon. In year 4, the final PDT will be uploaded as a resource in a shared open platform (e.g. GitHub) that is then available to interested stakeholders for research purposes (D13.2). The PDT will also be relevant for later implementation into the DSS (M14.2).

6.4 Year 4 (M36–M48)

An overview of stakeholder engagement activities is summarized in **Table 9**. If known, the targeted stakeholder groups are listed for each task/ deliverable/ milestone. Details of the stakeholder engagement can be found in the text below.

Table 9. Summary of engagement activities planned in Year 4 (M36-M42).

WP	Partner	Task/Deliverable / Milestone	Due month	Engagement Objectives	Stakeholder Engagement	Targeted Stakeholder Groups
Year 4						
WP14	Jan de Nul	M14.2: Decision Support System	M40	Decision System Tool is market-ready and can be distributed to relevant stakeholders	Distribution of the Decision Support System	Marine planners, constructors, and policy makers
WP14	Jan de Nul	D14.5: Co-creation guideline handbook	M42	Develop co-creation guidelines	Bilateral meetings and feedback rounds with stakeholders to optimize the co-creation guideline	Marine planners, industrial constructors, government and policy makers
WP18	VLIZ	M18.1: Demo sessions and trainings to guide the use of the DuneFront instruments	M43	Coordination and organization of training sessions to disseminate stakeholder tools	Workshops, training sessions of stakeholder tools for end-users (DSS, co-creation guidelines, rating infrastructure, PDT, Blueprints),	Internal partners, industrial, local government authorities, and policy makers
WP18	VLIZ	D18.2 Second policy brief	M45	Marine Policy Brief	Bilateral meetings and feedback rounds with relevant stakeholders	Local, national and EU-policy and government organizations
WP18	VLIZ	M18.2: Organization of final event	M46	Disseminate key results of the project and set the stage for future projects and discussions on upscaling DD-hybrid NbS	Conference and meeting highlighting results, policy briefs and stakeholder tools	All partners, External experts, Stakeholders, end-users
WP13	TU Delft	D13.2: Predictive Digital Twin model	M48	Dissemination of the validated Open-Source PDT	PDT is uploaded to a shared environment (e.g. GitHub)	Research, policy and innovation stakeholders

WP14	Jan de Nul	D14.4 Business cases	M46	Secure further resources, financial means and operational market opportunities	Bilateral meetings	Industrial partners and financial stakeholders (e.g. NetworkNature)
WP14	Jan de Nul	D14.3: Exploration of potential sites for upscaling DD-hybrid NbS	M48	Valorization of results to potential international sites (priority areas)	Bilateral meetings	Industrial marine contractors

6.4.1 Training sessions for developed end-user tools (PDT, Blueprints, DSS)

Ultimately, the different R&I components such as the previously described DD-hybrid NbS rating system (D8.4), the PDT (M13.2), the developed blueprints (D14.1), and data from other work packages (e.g. technical design, biodiversity, coastal protection efficiency, social acceptance, and multi-functionality) will be translated into a **Decision Support System (DSS)** tool (M14.2). The DSS is a computer-based tool or framework designed to assist stakeholders in making informed and evidence-based decisions about the design, implementation, and management of NbS projects in comparison to the hard-substrate alternative. It will be based on the Predictive Digital Twin (PDT) and applied in the development of market-ready coastal and marine infrastructure blueprints and demonstrated through new operational dune-dike prototype in De Panne. Concretely, it acts as a key resource for the installation and design of future DD-hybrid NbS in EU and at a global scale. Workshops will help evaluate the visualization and user friendliness of the DSS to make it market ready prior to its distribution to relevant stakeholders. Industrial partners (e.g. DEME and Jan de Nul) will further use their expertise in business and commercialization, the developed tools (e.g. blueprints, PDT, and DSS), and their client portfolios to identify priority areas along EU and international coasts to explore potential sites for upscaling DD-hybrid NbS (D14.3). Using the Network Nature platform, industrial partners and financial stakeholders can be brought together to further connect with the finance world and secure further resources, financial means and operational market opportunities (D14.4).

UGENT will lead the development of a co-creation handbook for the implementation of DD-hybrid NbS to marine planners, constructors and policy makers (D14.5). The handbook will focus on the introduction of co-creation procedures into coastal zone management and bring together operational expertise and the experiences from industrial partners. Lessons learned and best practices regarding stakeholder engagement will feed into the co-creation handbook guideline for future projects. This will come from feedback of the co-creation process in WP15 as well as the monitoring of the stakeholder engagement plan in DuneFront in WP17 and WP18. Consequently, these guidelines will bring DuneFront NbS to a more effective site implementation level in the coastal zone management market.

WP18 will collaborate with partners that develop end-user tools (e.g. WP8, WP9, WP13 and WP14) to help organize necessary workshops and training sessions to allow relevant stakeholders to experience and test them (e.g., PDT, Blueprints, DSS) (M18.1). These tools are

relevant for further communication purposes both within the co-creation process, but also to promote the results of DuneFront to stakeholders associated to the general public or to connecting projects.

6.4.2 Final event

A final conference will be held, gathering all partners, external experts, stakeholders, end-users to present results and end-products of the project as well as set the stage for other projects and further discussions on the topic of blue-hybrid NbS safeguarding human infrastructure and biodiversity in coastal and marine environments (M18.2). Stakeholders include those from research, industry, government and policy. Best practices and lessons learned regarding stakeholder engagement will further be communicated to partners and stakeholders during final event.

7. Monitoring and evaluation

Measuring and evaluating the stakeholder engagement in DuneFront will be done continuously through a regular reviewing process. In line with the general lessons learned regarding stakeholder engagement, the engagement plan presented here for DuneFront is flexible and will be adapted if certain issues come to light.

A bilateral exploration round is used to identify and clarify stakeholder engagement activities planned by work package task leaders and Demonstrator site leaders within the DuneFront initiative. Their objectives, capabilities and resources will be discussed and incorporated within the stakeholder engagement framework.

Under the Project Management Handbook (D1.1), technical progress reports are filled in for each work package prior to each scientific board meetings (every 3 months). It entails a summary of the scientific work that has thus far been completed as well as a brief explanation of any deviations to the grant agreement. The reports are an internal document that helps monitor the project's scientific and technical progress per work package. The template of the technical progress report was updated to include a section on stakeholder engagement and communication. Regarding the stakeholder engagement, within the report the following questions are asked for each work package lead:

- Have stakeholders been contacted?
- Have any stakeholder engagement activities taken place or are currently planned?
- If so, please clarify which stakeholders, the engagement activity and when it has taken or will take place

Any changes or updates will be discussed during the SB meetings and will be incorporated into the stakeholder engagement follow up tasks of WP17 and WP18.

Participants of partner meetings, Demonstrator site-visits, planned end-user workshops and training sessions, will be asked to complete a feedback form after each engagement activity through digital surveys that will be sent to partners of DuneFront and critically evaluated. From these evaluations, the stakeholder engagement plan can be modified where needed. The annual consortium meetings (M12, M24, M32) and the final event (M46) that will be held at different locations across Europe, provide opportune moments to meet with local partners and stakeholders to receive feedback regarding engagement practices and needs in DuneFront (**Table 10**). After obtaining feedback from these consortium meetings, and where necessary, bilateral exploration rounds, will be held to further obtain a better overview of the overall perception of engagement practices in DuneFront by partners and stakeholders. The second consortium meeting will take place on the 30th-31st of October in Portugal in conjunction with a two-day symposium 'Building Coastal Resilience' (BCR24) on the 28th-29th of October. By combining the annual consortium meeting with a symposium, present further opportunities to reach out to local stakeholders and interconnect with projects and

demonstrator site visits. Best practices and lessons learned will be communicated to partners and stakeholders during the final event (M18.2).

Table 10. Summary of the four annual consortium meetings that will be organized for DuneFront.

Annual Consortium Meeting	Project month	Date	Location	Organizing Partner
Consortium Meeting 1	M1	16–18 January, 2024	Gent, Belgium	UGENT
Consortium Meeting 2	M12	30–31 October, 2024	Porto, Portugal	UPORTO
Consortium Meeting 3	M24	TBD	TBD	TBD
Consortium Meeting 4	M32	TBD	TBD	TBD
Final Event	M46	TBD	TBD	TBD

8. Annex

1. Date (31/08/2024): Data needs and Requirements.

Overview of the data required by different work packages (WP4-WP9) from the different Demonstrator sites. Where possible, referrals to the collection of data from other work packages, deliverables or milestones are also included. To streamline data collection, several work packages plan to coordinate the data exchange of similar data (see Table 4).

WP	Partner	Task	Task duration	Data required from Demonstrator sites	Due date for data to be obtained
Year 1					
WP4: Boundary conditions	Ubx-E	Task 4.1: Physical boundary conditions	M1-M15	Physical parameters (see WP6)	MO6-MO8
	UGent-B	Task 4.2: Distribution of important species	M1-M15	Physical parameters (see WP6)	Preliminary data MO6 (complete M10-M12)
	TUB	Task 4.3: Socio-economic/administrative boundaries	M1-M15	Socio-economic and administrative data (planning, construction, maintenance costs, building costs), sediment depots , and flood risk maps (T1000, T200, T100)	M10
WP5: Demonstrator Biodiversity	Ubx-B	Task 5.1 Mapping Annex 1 habitat evolution	M6-M20	Aerial images (UAV-orthophotos) and DEM (from WP6) for quantitative analyses of habitat type and evolution	Winter 2024-2025
	Ubx-B	Task 5.2 Biodiversity patterns	M6-M36	Permits for field work, species list , GPS measurements of vegetation plots	MO6-MO9 (depending on the demonstrator site)
	UGent-B	Task 5.3. Biodiversity connectivity	M6-M36	Data from tasks 5.1 and 5.2, 6.1 and 6.2	M12
WP6: Demonstrator morphodynamics	UPVD/Ubx/ULCO	Task 6.1 Morphodynamic patterns	M1-M12	Physical parameters: topographic, hydrodynamic, climatological data (wave, tide, shoreline trend) to construct DTM data (M6.1) and obtain erosion/ sedimentation budgets (DEM) (D6.1)	MO8
	KULeuven/TUB-E	Task 6.2 Vegetation-sediment interactions	M6-M15	vegetation coverage (D5.2), DEM (D6.1), physical parameters to improve XBeach root mapping (D6.2).	M12
	TUB-E	Task 6.3 Environmental influences	M1-M18	Boundary conditions (WP5), morphodynamic patterns (D6.1), vegetation coverage (D6.2)	

WP7: Demonstrator design	UGENT-E	Task 7.1. Comprehensive investigation of existing designs of the DuneFront Demonstrators	M1-M6	Available design, safety and maintenance reports (D7.1; M7.1)	M03-M04
	TU Delft	Task 7.2 Boundary conditions for the physical modelling of extreme storms	M7-M12	Physical parameters (Task 6.1), sand profile, vegetation characteristics (D6.1, D6.2) from WPO6 (D7.2)	M03-M09
WP8: Demonstrator LCA	UGENT-M	Task 8.1. Design of a rating system for blue infrastructure	M1-M15	Technical reports (design, environmental impact assessment, permits, materials, machinery, transportation logs, energy usage, emissions, construction schedule etc) needed for rating system of blue infrastructure	M06
	UGENT-M	Task 8.2. Translate parameters of DD-hybrid NbS into input for the different impact categories	M12-M24	Design reports (Task 7.1), socio-economic data (Task 4.3), environmental impact assessment (Task 8.1)	M06-M10
	UGENT-M	Task 8.3. Produce full life cycle inventories (LCI)	M12-M30	Technical reports (Task 8.1)	M06
	UGENT-M	Task 8.4. Perform a life cycle assessment and life cycle cost analysis and validate the blue infrastructure rating system on the selected Demonstrators and new prototype	M18-M44	Data on costs of construction, operation, and maintenance	M12
WP9: Demonstrator Socio-economics	LU	Task 9.2 Integration of multi-use potential in Demonstrators	M10-M22	Socio-economic data for multi-use and semi-structured questionnaires about multi-use potential coupled with observations through visits at Demonstrator sites (M9.1).	M12

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