

# DuneFront

Deliverable 4.3

September 2024



# Socio-economic/administrative boundaries Deliverable 4.3

(D4.3)

## Deliverable information

Title	Socio-economic/administrative boundaries
Deliverable number	D4.3
WP number	4
Author(s)	Oliver Lojek(TUBS), Constantin Schweiger (TUBS), Paulo Rosa Santos (UPORTO)
Lead beneficiary	
Contributors	Oliver Lojek, Constantin Schweiger, Paulo Rosa Santos
Type	Report
Dissemination level	Public
How to cite	Lojek O., Schweiger C., Santos P.R. (2024). Compilation of freely existing socio-economic/administrative boundaries, Version 1.0, DuneFront Project Deliverable 4.3, Technische Universität Braunschweig.

## Versioning and contribution history

Version	Date	Authors (Institution)	Notes
Version 0.1	27/09/2024	Oliver Lojek(TUBS), Constantin Schweiger (TUBS), Paulo Rosa Santos	Version to be checked and approved by DuneFront consortium
Version 1.0	01/10/2024	Oliver Lojek(TUBS), Constantin Schweiger (TUBS), Paulo Rosa Santos	Final version approved by all Beneficiaries

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.



**Funded by  
the European Union**

## Cover page

This report is the first deliverable of work package 4 Boundary conditions (D4.3 Socio-economic/administrative boundaries) in the DuneFront project. DuneFront focuses on better understanding dune-dike hybrid Nature-based Solutions (DD-hybrid NbS) to create sustainable, inclusive, and visually appealing coastal management infrastructure. These innovative solutions aim to integrate biodiversity while addressing significant socio-economic challenges along Europe's densely populated coasts. By studying existing hybrid NbS, this report lays the groundwork for better understanding the design aspects of these systems.

The primary objective of this report is to research and compile existing and freely available geo-information across European coastlines pertaining to flood protection levels and flood risk/inundation maps. Furthermore, marine sediment extraction sites are researched and compiled based on available information to visualize potential source areas for hybrid coastal defense structure built-up. Additionally, potentially impacted citizen numbers and estimated flood related losses are researched and compiled. Finally, contact information regarding responsible national agencies for flood protection, water level monitoring and early warning systems are compiled in list.

This compilation aims at researching and cataloguing coastal boundary information and will be complemented by deliverables D4.1 contributing physical boundary conditions and D4.2 compiling distributions of important species.

The DuneFront project considers 12 Demonstrators across six countries—Portugal, France, Belgium, the Netherlands, Germany, and Sweden—with diverse functionalities and environmental conditions. The compiled geo-information serves for contextualizing demonstrator sites investigated within DuneFront and facilitates the identification of coastal areas for potential upscaling at a later stage of the project.

In general, this report provides an overview of readily available geo-information data regarding coastal protection levels, flood inundation water levels and extent, affected populations and responsible coastal/riverine flood protection agencies.

## Table of Content

1.	Introduction .....	8
1.1	Overview of work package 4 (WP4 – Boundary conditions).....	8
1.1.1	Tasks of work package 4 .....	8
1.1.2	Milestones and Deliverables of work package 4.....	8
1.2	Aims and objectives of this report .....	8
2.	Flood protection.....	9
3.	Flood maps.....	10
3.1	River/Coastal flood maps .....	10
3.2	Coastal flood maps.....	12
4.	Marine sediments .....	15
5.	Agencies .....	16
6.	Conclusions .....	22
7.	Publication bibliography.....	23

## List of Figures

Figure 1: Flood protection values for the European Union showing protection against return intervals for certain flood type events. ....	9
Figure 2: Flood inundation depth in meters and extend for simulated flood scenarios with a 1:100-year return interval. Left pane: Northern Europe, Belgium, The Netherlands, Germany; Right pane: Southern France.....	11
Figure 3: Figure 4: Flood associated damage estimate in €uro for simulated flood scenarios with a 1:100-year return interval. Left pane: Northern Europe, Belgium, The Netherlands, Germany; Right pane: Southern France.....	12
Figure 5: Flood associated affected population estimate for simulated flood scenarios with a 1:100-year return interval. Left pane: Northern Europe, Belgium, The Netherlands, Germany; Right pane: Southern France.....	12
Figure 6: Simulated inundation depth according to the ECFAS flood impact catalogue for a 50-year return interval storm surge event lasting 36 hrs. Left pane: Belgium and the Netherlands; Right pane: Germany. ....	14
Figure 7: Marine seabed sediments according the harmonised Folk V classification. Data is obtained from the EMODnet data base.....	15
Figure 8: Established and authorized marine sediment extraction zones in European coastal waters. ....	16

## List of Tables

Table 1: List of agencies tasked with monitoring (coastal) water bodies, maintaining, planning and constructing hydraulic flood protection works and warning of impending storm surge events. .... 17

## List of abbreviations

Abbreviation	Explanation
DD	Dune-Dike
DD-Hybrid	Dune Dike-Hybrid
NbS	Nature based Solution
GIS	Geo-Information-System
WP	Work Package
RBMPs	River Basin Management Plans
WFD	Water Framework Directive
PoM	Programs of Management
KTM	key types of measures
NUTS	nomenclature of territorial units for statistics
APSFrs	Assessment of potential significant flood risk
RBD	river basin districts
PRFA	preliminary flood risk assessment
EFAS	European Flood Awareness System
EMODnet	European Marine Observation and Data Network
TWL	total water level
ECFAS	European Coastal Flood Awareness System
RI	Return interval

# 1. Introduction

## 1.1 Overview of work package 4 (WP4 – Boundary conditions)

The overarching goal of work package 4 “Boundary conditions” consists of researching and compiling spatial data for Europe pertaining to physical, biological and socio-economic boundary conditions, which are expected to have an impact on the functioning of investigated Dune-Dike-hybrid (DD-hybrid) Nature-based Solutions (NbS). Spatial data is researched using the internet as well as available data-bases and compiled for Europe using geo-information systems (GIS).

### 1.1.1 Tasks of work package 4

The objective of the first task (Task 4.1) in this work package, consists in researching and compiling physical boundary conditions (water levels, wave conditions etc.) for European coasts.

The objectives for the second task (Task 4.2) within the work package focus on researching and compiling information for the distribution of important species (species, spatial extend etc.).

The objectives of the third task (Task 4.3) and thus the objectives of this report, is to collect and catalogue freely available spatial information regarding flood protection levels, flood risk/inundation maps, affected population and damage loss estimates, marine sediment extraction site information. This task involves researching and cataloguing spatial information.

Overall WP4 aims at collecting and using spatial information to be used within DuneFront for numerical modelling approaches (WP5-6, WP11), physical experimental campaigns (WP10, WP13) and data driven assessment of upscaling efforts (WP14, WP18).

This work package also includes a second task (Task 7.2), which focuses on collecting extreme storm boundary conditions, including various climate change scenarios, for use in physical modelling.

### 1.1.2 Milestones and Deliverables of work package 4

The key milestone (M4.1) involves the compilation of all boundary conditions for transfer to other WPs.

The deliverables include:

- **Deliverable D4.1:** Catalogue/List/Database of physical coastal boundary conditions for subsequent numerical/physical investigations.
- **Deliverable D4.2:** Catalogue/List/Database of the distribution of important species, providing essential data for data driven analysis and subsequent modelling.
- **Deliverable D4.3 (this report):** Catalogue/List/Database of socio-economic and administrative boundaries for subsequent data driven analysis and upscaling analysis.

This report focuses on Deliverable D4.3, describing and showcasing collected spatial information.

## 1.2 Aims and objectives of this report

The main objective of this report is to present the compilation of researched spatial information regarding socio-economic and administrative boundaries important for ensuing work packages within the DuneFront project.

## 2. Flood protection

Flood protection against coastal and riverine floods can be achieved through man-made hydraulic protection works, which can be classified as conventional hard (grey) structures for example sea walls and dikes as well as soft (green) measures such as beach nourishments, dunes and salt marshes. Generally, European states have a history of developing and building conventional coastal and riverine flood protection measures, as these appear to be financially more viable due to the striking absence of information regarding cost-benefits and performance of NbS (Vousdoukas et al. 2020).

Flood protection values for European member states are available, with differentiations discernible between policy and design (European Commission, Joint Research Centre 2022; Scussolini et al. 2016). Policy related information is based protection values defined in protection laws; design values are the actual developed protection heights designed to protect against (coastal) flooding from events with defined return intervals (RI, i.e., 1 in 100 years). Collected information for coastal protection levels within the European Union is compiled in Figure 1 for the NUTS (nomenclature of territorial units for statistics) level 2 (EUROSTAT 2024).

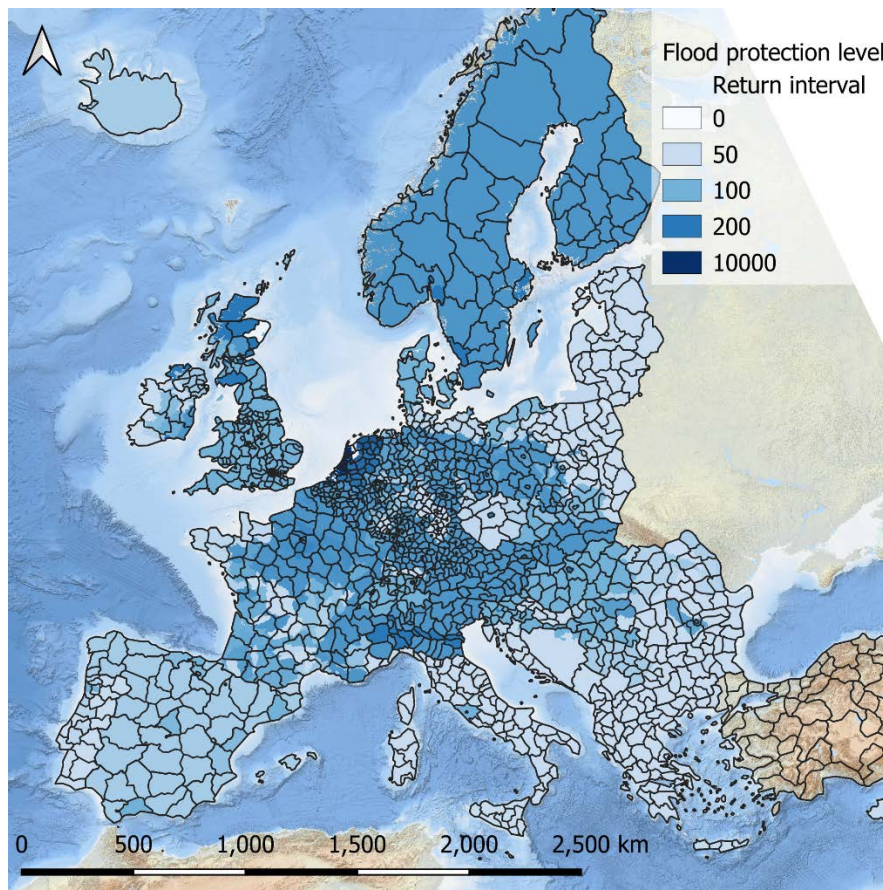


Figure 1: Flood protection values for the European Union showing protection against return intervals for certain flood type events.

## 3. Flood maps

### 3.1 River/Coastal flood maps

The level of flood protection shown in Figure 1 represents the design value associated to a return interval for a flood event a given flood defence can protect against. Flooding is caused by any flood event above the protection level, overtopping or breaching the defences (Dottori et al. 2021).

The 6<sup>th</sup> implementation report of the EU Flood Directive (European Union 2007) focuses on River Basin Management Plans (RBMPs) under the Water Framework Directive (WFD) to develop and implement programs of measure (PoMs). PoMs are typically built around “key types of measures” (KTMs), resembling measures taken to reduce river related pressures by removing obstacles, increasing flood discharge capacities and upgrading waste water treatment plants as well as phasing out priority substances. Across all 27 EU member states KTMs have been identified and PoMs have been developed. Some progress has been reported, but in a lot of situations obstacles pertaining to governance, delays or insufficient funding hinder the implementation to reduce the overall flood risk throughout the river basin districts (RBD).

Largest individual pressure on water bodies are hydromorphological alterations (p.14, 6<sup>th</sup> implementation report European Commission 2021) addressing dams, weirs, groundwater table alterations and natural state of flow. Overreaching target is to achieve 25'000 km of free-flowing rivers in Europe through re-naturalization of river beds, re-connecting oxbow lakes and laterally as well as longitudinally giving the river beds more space to arrive at connected and integrated ecosystems.

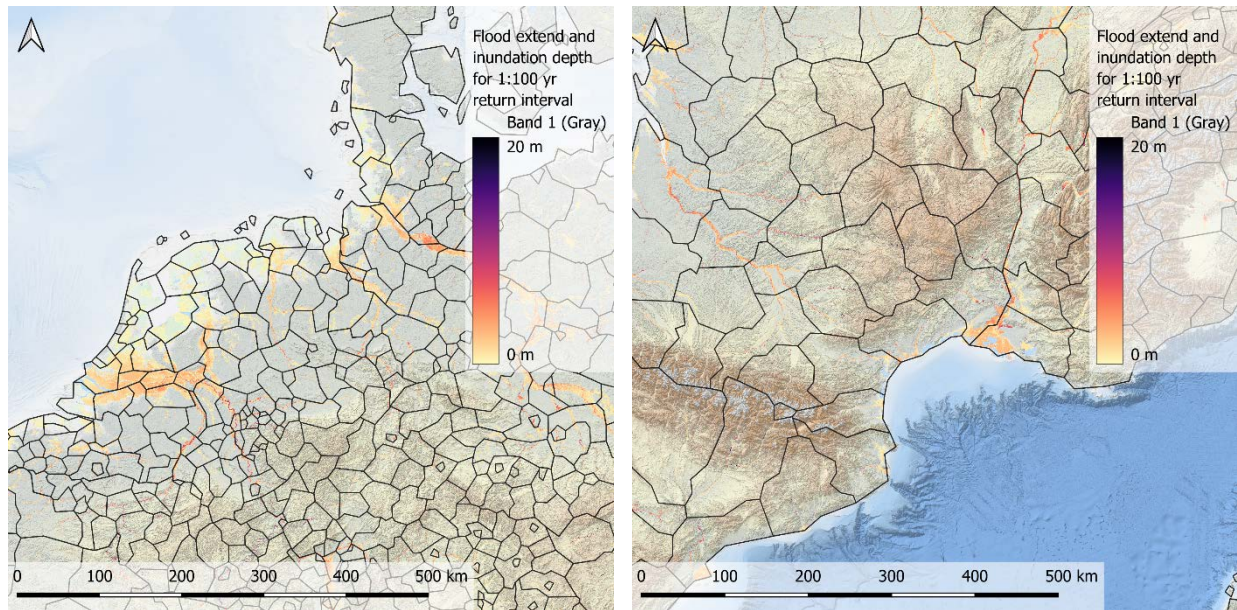
Progress from the 5<sup>th</sup> to 6<sup>th</sup> report was marginal related to hydromorphology, since member states have to develop their own flow objectives for their respective RBDs and develop PoMs to implement in order to reach a “good status” and correlating KTMs to track the progress. Overall, 7 EU member states reported 2018 that ecological flow objectives were developed for at least some water bodies, which is identical to reports from 2016. Furthermore, 20 of 27 member states reported on surface water bodies, lacking information for 7 states and only 5 out of 27 reported on ground water. Due to insufficient data hydromorphological status assessments are not feasible at the moment.

A preliminary flood risk assessment (PRFA) was the initial step mandated by the European Flood Directive (European Union 2007). Within this first step identification of areas of potential significant flood risks (APsFRs) was conducted, which is primarily based on available information from past floods and in part on forecasts of potential future flood events.

Within the European Union, 2/3 of floods reported/registered are inland or river floods, whilst coastal flood risk is gaining importance with sea level rise augmenting the risk especially for densely populated coastal areas. However, despite the progress in assessment and reporting methodologies in 12 member states, 60% of the EU river basins lack information on flood damages sustained, rendering impact assessment difficult. Implementation of all currently planned PoMs to reach the KTMs defined is estimated to amount to 142 billion Euros, which does not include the flood risk management plans, which are currently reported to amount to 14 billion Euros. Both volumes are deemed insufficient, due

to the large gaps in reporting and data coverage for RBDs. The currently active reporting cycle ends 2027 and will provide updated information.

Gathered information regarding riverine flooding is available for different RIs (10-500 yrs, European Commission, Joint Research Centre 2022). Exemplary flood inundation depth for select sites are shown in Figure 2 for a flood event resembling a 1:100-year return interval.



*Figure 2: Flood inundation depth in meters and extend for simulated flood scenarios with a 1:100-year return interval. Left pane: Northern Europe, Belgium, The Netherlands, Germany; Right pane: Southern France*

Associated losses due to damage is estimated based on the built-up layer of infrastructure and correlated with population density and GDP per capita (European Commission, Joint Research Centre 2022). Examples are shown in correlate to the examples given in Figure 2.

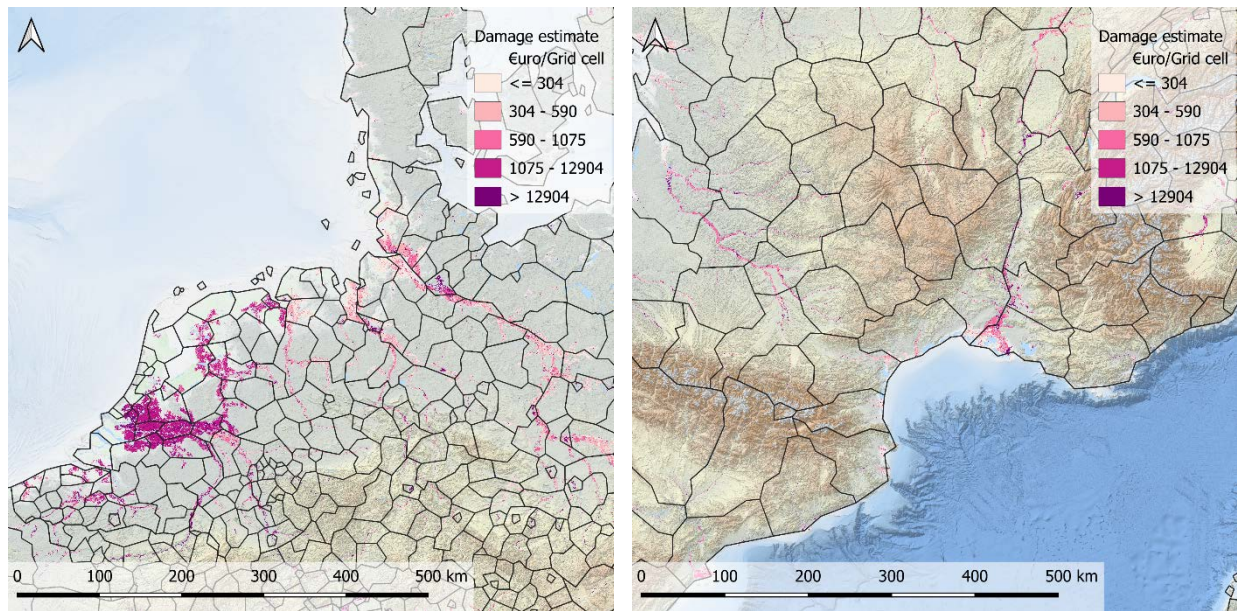


Figure 3: Figure 4: Flood associated damage estimate in Euro for simulated flood scenarios with a 1:100-year return interval. Left pane: Northern Europe, Belgium, The Netherlands, Germany; Right pane: Southern France

In a similar manner, the affected population per grid cell is accessible from the data set and given in for the same exemplary sites.

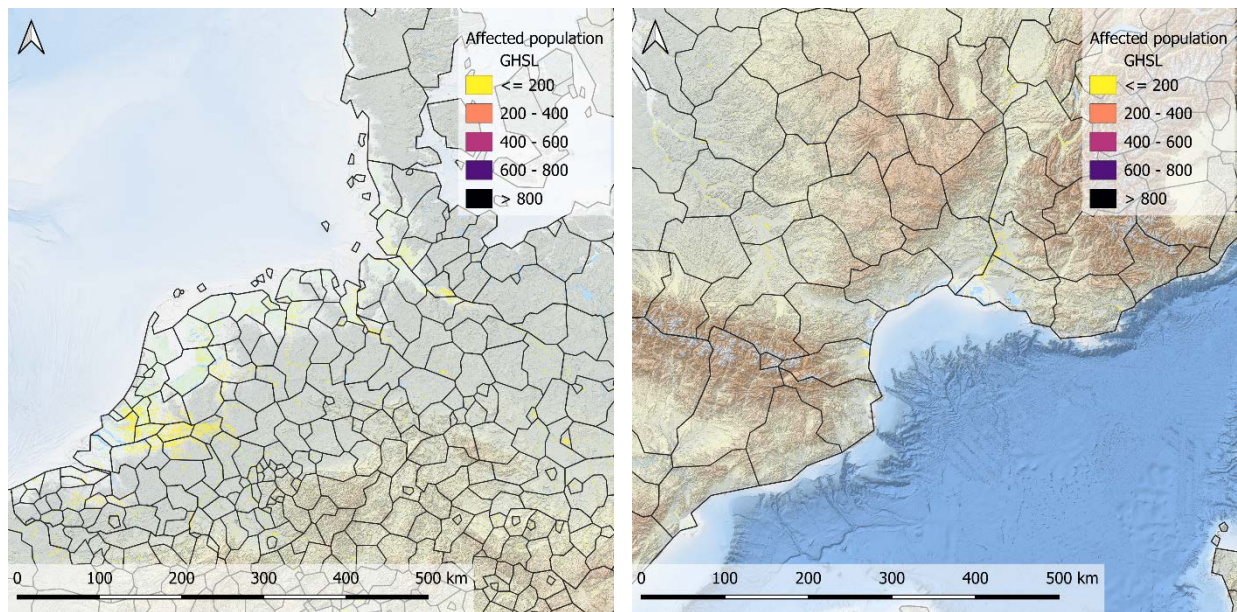


Figure 5: Flood associated affected population estimate for simulated flood scenarios with a 1:100-year return interval. Left pane: Northern Europe, Belgium, The Netherlands, Germany; Right pane: Southern France

Data presented is partially accessible through the European Flood Awareness System (EFAS; [https://european-flood.emergency.copernicus.eu/efas\\_frontend/#/home](https://european-flood.emergency.copernicus.eu/efas_frontend/#/home)).

### 3.2 Coastal flood maps

In addition to the flood extents and associated impacts given in the previous section a dedicated coastal flood map catalogue has recently been developed and is readily accessible (European Commission, Joint Research Centre 2022). The data has been developed within the scope of the European PESETA IV project as part of the European Coastal Flood Awareness System (ECFAS, <https://www.ecfas.eu/>).

The catalogue is based on a methodology described by Dottori et al. (2017) called rapid mapping approach combining hindcast total water level (TWL) data as well as wave contribution to TWL (Paprotny et al. 2024) on a 10x10 m DEM for the European Union. The coastline was segmented into 50-100 km stretches and investigated using the LISFLOOD-FP model at a 25-50 m resolution (Sharifian et al. 2023). Flood maps were created for each coastal sector featuring variable boundary conditions to account for event duration, TWL and infiltration. The catalogue contains nearly 8000 flood maps across 15 simulated flood scenarios for 528 coastal sectors. Finally, an event-based flood extension was created using the ECFAS system similar to the European Flood Awareness System.

Furthermore, an impact assessment was conducted for the European member states assessing potentially affected population as well as damage to infrastructure (Dottori F et al. 2023). This information however is restricted. Access has been requested but has not been given at the moment of this report. It is possible that the data base will be updated & extended, if the access is given at a later point in time during the project.

The project report of PESETA IV estimates coastal flood risk and connected impacts as well as adaptation strategies and their mitigation potential to reduce climate change related annual damage volumes. The project estimates that the current 1.4 €billion damages could rise to nearly 240 €billion by 2100, if no adaptation strategies are developed and implemented. Nearly 95% of these climate related impacts and costs could be avoided through (moderate) mitigation measures such as elevating dykes around economic centers and human settlements (Dottori F et al. 2023; European Commission, Joint Research Centre 2022).

As potential mitigation measures, dunes, dykes as well as beach nourishments are advocated. Furthermore, flood proofing of critical infrastructure and retreat from high-risk areas are identified as best adaptation strategies. More than 200 million European citizens currently reside near the coastline, with migration trends towards the coast increasing.

Nature based solutions such as dunes, beach nourishments and salt marshes are preferred over conventional measures. Nevertheless, the report states that despite the co-benefits of NbS, cost-benefit estimates and reports especially regarding long term performance are lacking. This makes an advocacy and upscaling currently very difficult. Conventional hard/grey measures such as dykes and sea walls are currently the most common practice, despite their known negative impacts on landscapes, ecology, habitat dynamics and erosion increases.

Maps represent maximum inundation water levels based on LISFLOOD-LP results for a synthetic storm surge scenario bearing a 50-year RI for three different durations from 12 and 24 hours up to 36 hrs. Examples are shown in Figure 6. Furthermore, calculated water current speeds are available for the different scenarios. Due to the extensive data (>125 GB), only a few examples are showcase here.

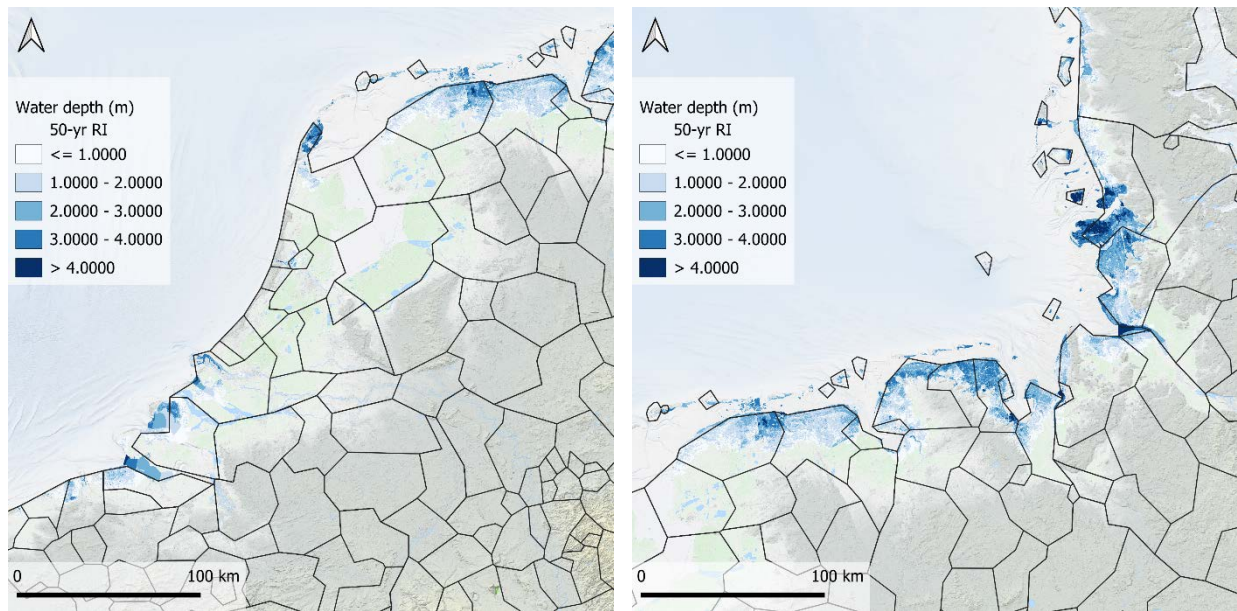


Figure 6: Simulated inundation depth according to the ECFAS flood impact catalogue for a 50-year return interval storm surge event lasting 36 hrs. Left pane: Belgium and the Netherlands; Right pane: Germany.

## 4. Marine sediments

Seabed sediment information was acquired through the EMODnet data base, specifically the EMODnet Geology project, which harmonizes multiple different sedimentological classification schemes (EMODnet 2023). The presented one in Figure 7 contains the most basic one Folk 5. Finer classification schemes are available, but not for all of the European coastal sea floor (see Folk 7 and Folk 16<sup>1</sup>).

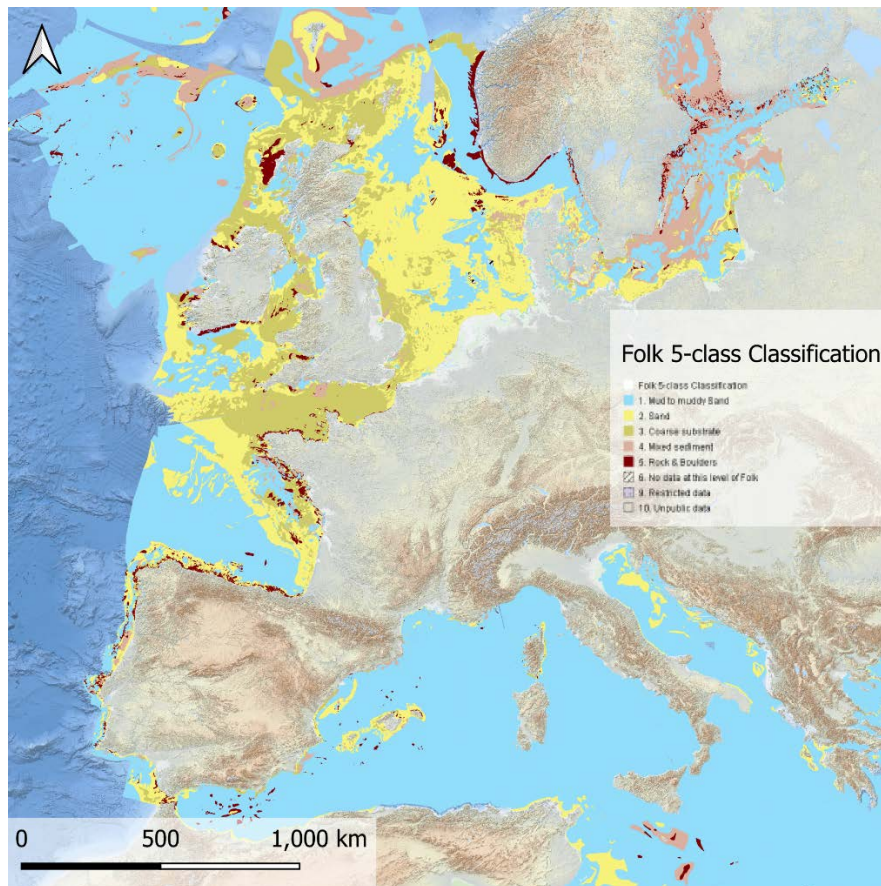
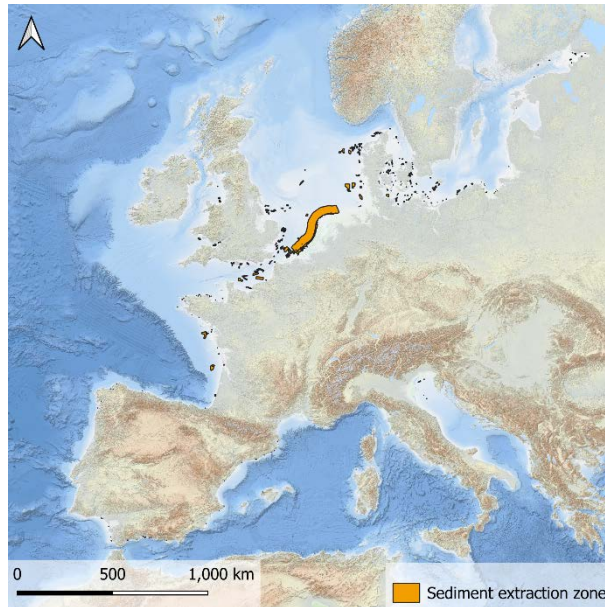


Figure 7: Marine seabed sediments according the harmonised Folk V classification. Data is obtained from the EMODnet data base.

<sup>1</sup> "Seabed substrate map of the European marine areas (e.g. the Baltic Sea, the Greater North Sea, the Celtic Sea, the Iberian Coast, and the Mediterranean Sea within EU waters). The map is collated and harmonized from seabed substrate information within the EMODnet Geology project. Where necessary, the existing seabed substrate classifications (of individual maps) have been translated to a scheme that is supported by EUNIS. This EMODnet reclassification scheme includes at least five seabed substrate classes. Four substrate classes are defined on the basis of the modified Folk triangle (mud to sandy mud; sand; coarse sediment; and mixed sediment) and one additional substrate class (rock and boulders) was included by the project team. If the original seabed substrate dataset has enabled more detailed substrate classification, classifications with 7 and 16 substrate classes might be available. The EMODnet-Geology project started in 2013 with 36 marine departments of the geological surveys of Europe, with an objective to assemble marine geological information from all European sea areas. Note: The data may include some errors e.g. data discontinuities." EMODnet Geology, 2024 <https://emodnet.ec.europa.eu/geoviewer/>

Information regarding sediment extraction volumes and dredging intervals is not easily obtainable, since the data is usually safeguarded by dredging companies. Therefore, a comprehensive overview over dredged volumes cannot be compiled. What is accessible is a compilation of established and authorised extraction areas within European coastal waters with active/inactive status (EMODnet 2014). An overview of the sediment extraction zones is given in Figure 8.



*Figure 8: Established and authorized marine sediment extraction zones in European coastal waters.*

The extraction polygons contain meta data detailing issued permits, responsible agencies, area and in some cases available volume and dredged material. Due to the inconsistency of the data set, a case sensitive analysis will have to be conducted at a later stage in the DuneFront project for specific demonstrator site conditions or for upscaling estimates.

## 5. Agencies

A list containing federal and state agencies tasked with monitoring water body states, coastal flood protection planning and maintenance as well as operating storm surge warning systems has been researched and compiled through project partners from DuneFront, the RiscKit (RiscKit 2017) project and has been supplemented by an internet research. The information is given in Table 1 for the states where authorities could be identified. If states are not listed, this means that no viable information could be acquired.

Table 1: List of agencies tasked with monitoring (coastal) water bodies, maintaining, planning and constructing hydraulic flood protection works and warning of impending storm surge events.

EU Memberstate	Agency	URL
Norway	Norwegian Water Resources and Energy Directorate (NVE flood notifications)	<a href="http://www.varsom.no/flom-og-jordskredvarsling/">http://www.varsom.no/flom-og-jordskredvarsling/</a>
Norway	Norwegian Water Resources and Energy Directorate (Discharge compared to normal)	<a href="http://www2.nve.no/h/hd/plotreal/Q/konturkart.html">http://www2.nve.no/h/hd/plotreal/Q/konturkart.html</a>
Sweden	Swedish Meteorological and Hydrological Institute (SMHI) - Hydrological warnings issued	<a href="http://www.smhi.se/vadret/vadret-i-sverige/varningar">http://www.smhi.se/vadret/vadret-i-sverige/varningar</a>
Sweden	Swedish Meteorological and Hydrological Institute (SMHI) - Hydrological measurements (discharge, water levels, snow water equivalent)	<a href="http://vattenwebb.smhi.se/station/">http://vattenwebb.smhi.se/station/</a>
Sweden	Swedish Meteorological and Hydrological Institute (SMHI) - Hydrological forecasts for selected stations (discharge, deterministic model with station updating)	<a href="http://www.smhi.se/vadret/vadret-i-sverige/vattenforing">http://www.smhi.se/vadret/vadret-i-sverige/vattenforing</a>
Sweden	Swedish Meteorological and Hydrological Institute (SMHI) - Hydrological forecasts for all of Sweden (discharge, deterministic model)	<a href="http://vattenwebb.smhi.se/hydronu/">http://vattenwebb.smhi.se/hydronu/</a>
Finland	Finnish Environment Institute SYKE (Hydrological warnings)	<a href="http://www2.ymparisto.fi/i2/yleisoEnnusteetJaVaroitukset/#homeFi">http://www2.ymparisto.fi/i2/yleisoEnnusteetJaVaroitukset/#homeFi</a>
Finland	Finnish Environmental Institute SYKE (Hydrological forecasts)	<a href="http://www.ymparisto.fi/vesitilanne">http://www.ymparisto.fi/vesitilanne</a>
Estonia	Estonian Meteorological and Hydrological Institute (Hydrometeorological warnings)	<a href="http://www.ilmateenistus.ee/ilm/proгноosid/hoiatused/?lang=en">http://www.ilmateenistus.ee/ilm/proгноosid/hoiatused/?lang=en</a>
Estonia	Estonian Meteorological and Hydrological Institute (Water level observations)	<a href="http://www.ilmateenistus.ee/siseveed/vaatlusandmed/kaart/?lang=en">http://www.ilmateenistus.ee/siseveed/vaatlusandmed/kaart/?lang=en</a>
Latvia	Latvian Environment, Geology and Meteorology Centre (Hydrometeorological warnings)	<a href="https://www.meteo.lv/bridinajumi/?nid=484">https://www.meteo.lv/bridinajumi/?nid=484</a>
Latvia	Latvian Environment, Geology and Meteorology Centre (Water level observations)	<a href="http://www.meteo.lv/hidrologijas-operativa-informacija/?nid=464">http://www.meteo.lv/hidrologijas-operativa-informacija/?nid=464</a>
Latvia	Latvian Environment, Geology and Meteorology Centre (Water levels forecasts)	<a href="http://212.70.174.36/s/60">http://212.70.174.36/s/60</a>

Lithuania	Lithuanian Hydrometeorological Service (Dangerous events)	<a href="http://www.meteo.lt/lt/pavojingu-meteorologiniu-ir-hidrologiniu-reiskiniu-prognozes">http://www.meteo.lt/lt/pavojingu-meteorologiniu-ir-hidrologiniu-reiskiniu-prognozes</a>
Belarus	Pogoda (water levels - daily map)	<a href="http://www.pogoda.by/gidroarchive/">http://www.pogoda.by/gidroarchive/</a>
Poland	Institute of Meteorology and Water Management (Hydrological warnings - Map of warnings)	<a href="http://www.pogodynka.pl/ostrzezeniahydro">http://www.pogodynka.pl/ostrzezeniahydro</a>
Poland	Institute of Meteorology and Water Management (Water levels and discharges)	<a href="http://pogodynka.pl/polska/hydro">http://pogodynka.pl/polska/hydro</a>
Poland	Institute of Meteorology and Water Management (Monitoring)	<a href="https://hydro.imgw.pl/#/">https://hydro.imgw.pl/#/</a>
Germany	Hochwasserzentralen (water levels, discharges, hydrological warnings -- including further weblinks)	<a href="http://www.hochwasserzentralen.de/">http://www.hochwasserzentralen.de/</a>
Germany	Pegel Online (water levels)	<a href="http://www.pegelonline.wsv.de/gast/karte/standard.jsessionid=04C88E2EC5540780648C75C1A95F34E4">http://www.pegelonline.wsv.de/gast/karte/standard.jsessionid=04C88E2EC5540780648C75C1A95F34E4</a>
Germany	Storm surge warning service lower saxony	<a href="https://www.nlwkn.niedersachsen.de/sturmflutvorhersage/www-nlwkn-niedersachsen-de-wasserstandsvorhersage-44307.html">https://www.nlwkn.niedersachsen.de/sturmflutvorhersage/www-nlwkn-niedersachsen-de-wasserstandsvorhersage-44307.html</a>
Germany	Storm surge warning and information system Schleswig Holstein	<a href="https://hsi-sh.de/">https://hsi-sh.de/</a>
Germany	National storm surge warning service;	<a href="https://www2.bsh.de/aktdat/wvd/sturm/">https://www2.bsh.de/aktdat/wvd/sturm/</a>
Germany	National weather forecast and warning system	<a href="https://www.dwd.de/DE/wetter/warnungen_gemeinde_n/warnWetter_node.html;jsessionid=A32D81BF6518E292F43C172836001687.live21074">https://www.dwd.de/DE/wetter/warnungen_gemeinde_n/warnWetter_node.html;jsessionid=A32D81BF6518E292F43C172836001687.live21074</a>
Denmark	Storm surge warning service	<a href="https://kyst.dk/english/storm-surge-warning-management">https://kyst.dk/english/storm-surge-warning-management</a>
The Netherlands	Fairway Information Services (water levels, forecasts)	<a href="https://www.vaarweginformatie.nl/frp/main/#/hydro/water_level">https://www.vaarweginformatie.nl/frp/main/#/hydro/water_level</a>
The Netherlands	Rijkswaterstaat Water Information (water levels, discharges and other information)	<a href="http://www.rijkswaterstaat.nl/geotool/waterhoogte_tov_nap.aspx?cookieLoad=true">http://www.rijkswaterstaat.nl/geotool/waterhoogte_tov_nap.aspx?cookieLoad=true</a>
The Netherlands	Rijkswaterstaat Water Bulletin (water bulletin with forecasts up to 48 hours in advance included)	<a href="https://www.rijkswaterstaat.nl/water/waterdata-en-waterberichtgeving/waterbericht/index.aspx">https://www.rijkswaterstaat.nl/water/waterdata-en-waterberichtgeving/waterbericht/index.aspx</a>
Belgium	Hydrologisch InformatieCentrum (HIC)	<a href="https://www.waterbouwkundiglaboratorium.be/en/water-management-0">https://www.waterbouwkundiglaboratorium.be/en/water-management-0</a>
Belgium	Vlaamse Milieumaatschappij	<a href="https://en.vmm.be/">https://en.vmm.be/</a>
Belgium	Water Info (water levels with critical thresholds)	<a href="http://www.waterinfo.be/">http://www.waterinfo.be/</a>

Belgium	Direction générale opérationnelle de la Mobilité et des Voies hydrauliques (water levels with critical thresholds)	<a href="https://hydrometrie.wallonie.be/home.html">https://hydrometrie.wallonie.be/home.html</a>
France	Ministère de l'Ecologie, du Développement durable et de l'Energie (flood warnings)	<a href="http://www.vigicrues.gouv.fr/">http://www.vigicrues.gouv.fr/</a>
Spain	SAIH Guadalquivir (Guadalquivir River Basin)	<a href="http://www.chguadalquivir.es/saih/">http://www.chguadalquivir.es/saih/</a>
Spain	SAIH Ebro (Ebro River Basin)	<a href="http://www.saihebro.com/saihebro/index.php?url=/datos/introduccion">http://www.saihebro.com/saihebro/index.php?url=/datos/introduccion</a>
Spain	SAIH Duero (Douro River Basin)	<a href="http://www.saihduero.es/">http://www.saihduero.es/</a>
Spain	SAIH Miño-Sil ( Mihnó and Sil River Basins in north-western Spain)	<a href="http://saih.chminosil.es/index.php?url=/datos/mapas/mapa:H1/area:HID/acc:">http://saih.chminosil.es/index.php?url=/datos/mapas/mapa:H1/area:HID/acc:</a>
Spain	Agència Catalana de l'Aigua (Catalan basins)	<a href="http://aca.gencat.cat/ca/laigua/proteccio-i-conservacio/">http://aca.gencat.cat/ca/laigua/proteccio-i-conservacio/</a>
Spain	SAIH Hidrosur (Mediterranean Basins and Guadalete-Barbate Basins in Southern Spain )	<a href="http://www.redhidrosurmedioambiente.es/saih/">http://www.redhidrosurmedioambiente.es/saih/</a>
Spain	Sistema Automático de Información Hidrológica (hydrological information)	<a href="https://www.miteco.gob.es/es/agua/temas/evaluacion-de-los-recursos-hidricos/SAIH/">https://www.miteco.gob.es/es/agua/temas/evaluacion-de-los-recursos-hidricos/SAIH/</a>
Spain	Agua embalsada en España (information about the reservoirs)	<a href="http://www.embalses.net/">http://www.embalses.net/</a>
Portugal	National Civil Protection Authority (warnings)	<a href="http://www.prociv.pt/en-us/Pages/default.aspx">http://www.prociv.pt/en-us/Pages/default.aspx</a>
Portugal	SNIRH water levels	<a href="http://snirh.pt/index.php?idMain=2&amp;idItem=2">http://snirh.pt/index.php?idMain=2&amp;idItem=2</a>
Portugal	SNIRH hydrological monitoring network	<a href="http://snirh.apambiente.pt/">http://snirh.apambiente.pt/</a>
Italy	Dipartimento della protezione civile	<a href="https://mappe.protezionecivile.gov.it/en/risks-maps/criticality-bulletin">https://mappe.protezionecivile.gov.it/en/risks-maps/criticality-bulletin</a>
Italy	Interregional Agency for the Po River	<a href="http://www.agenziainterregionalepo.it/dati-idrologici.html">http://www.agenziainterregionalepo.it/dati-idrologici.html</a>
Italy	Tevere River Basin Authority	<a href="http://www.abtevere.it/node/591">http://www.abtevere.it/node/591</a>
Italy	Regione Piemonte	<a href="http://www.regione.piemonte.it/meteo/idrometri/#stazioni">http://www.regione.piemonte.it/meteo/idrometri/#stazioni</a>
Italy	Agenzia Regionale per la protezione Ambiente	<a href="http://webgis.arpa.piemonte.it/meteoidro_webapp/">http://webgis.arpa.piemonte.it/meteoidro_webapp/</a>
Italy	Servizio Idro-Meteo-Clima	<a href="http://www.arpa.emr.it/sim/?osservazioni_e_dati/ultime48h">http://www.arpa.emr.it/sim/?osservazioni_e_dati/ultime48h</a>
Italy	Servizio Idro-Meteo-Clima	<a href="http://www.arpa.emr.it/sim/?idrologia/dati_e_grafici">http://www.arpa.emr.it/sim/?idrologia/dati_e_grafici</a>

Italy	Regione Lazio - Ufficio Idrografico e Maregrafico	<a href="http://www.idrografico.roma.it/default.aspx">http://www.idrografico.roma.it/default.aspx</a>
Italy	Regione Lazio - Ufficio Idrografico e Maregrafico	<a href="http://www.idrografico.roma.it/asp.net/default_ok.aspx">http://www.idrografico.roma.it/asp.net/default_ok.aspx</a>
Italy	Regione Lazio - Ufficio Idrografico e Maregrafico	<a href="http://www.idrografico.roma.it/std_page.aspx?Page=cartografia">http://www.idrografico.roma.it/std_page.aspx?Page=cartografia</a>
Italy	Provincia autonoma di Bolzano - Alto Adige	<a href="http://www.provincia.bz.it/meteo/stazioni-idrometriche.asp">http://www.provincia.bz.it/meteo/stazioni-idrometriche.asp</a>
Italy	Regione Autonoma Valle d'Aosta	<a href="http://www.regione.vda.it/territorio/centrofunzionale/rischioidrogeologico/bollettinodettaglio/altezze_idro_i.asp">http://www.regione.vda.it/territorio/centrofunzionale/rischioidrogeologico/bollettinodettaglio/altezze_idro_i.asp</a>
Italy	Girovagli (Tuscany)	<a href="http://www.girovagli.it/METEO/livelli_idrometrici_regione_liguria.php">http://www.girovagli.it/METEO/livelli_idrometrici_regione_liguria.php</a>
Italy	Department of Civil Protection	<a href="http://www.floods.it/public/PreDati.php">http://www.floods.it/public/PreDati.php</a>
Italy	Regione Toscana - Servizio Idrologico Regionale	<a href="http://www.cfr.toscana.it/index.php?IDS=42&amp;IDSS=276">http://www.cfr.toscana.it/index.php?IDS=42&amp;IDSS=276</a>
Italy	Dipartimento di Protezione Civile e Sicurezza Locale	<a href="http://protezionecivile.regione.marche.it/viewdoc.asp?CO_ID=379">http://protezionecivile.regione.marche.it/viewdoc.asp?CO_ID=379</a>
Slovenia	Ministry of Environment and Spatial Planning - water levels, discharges	<a href="http://www.arso.gov.si/vode/podatki/amp/">http://www.arso.gov.si/vode/podatki/amp/</a>
Slovenia	Ministry of Environment and Spatial Planning - warnings	<a href="http://www.arso.gov.si/vode/napovedi/">http://www.arso.gov.si/vode/napovedi/</a>
Croatia	Croatian Waters Authority (water levels and discharges with warning levels)	<a href="http://vodostaji.voda.hr/">http://vodostaji.voda.hr/</a>
Croatia	Meteorological and Hydrological Service (water levels, including tendency and alert levels - Daily)	<a href="https://meteo.hr/naslovnica_hidro.php?tab=hidro">https://meteo.hr/naslovnica_hidro.php?tab=hidro</a>
Greece	Hellenic National Meteorological Service (only meteorological information)	<a href="http://www.hnms.gr/hnms/english/index_html">http://www.hnms.gr/hnms/english/index_html</a>
United Kingdom	Environment Agency and Scottish Environment Protection Agency - Flood warnings for England	<a href="https://flood-warning-information.service.gov.uk/warnings">https://flood-warning-information.service.gov.uk/warnings</a>
United Kingdom	Environment Agency and Scottish Environment Protection Agency - Flood warnings for Wales	<a href="https://naturalresources.wales/flooding?lang=en">https://naturalresources.wales/flooding?lang=en</a>
United Kingdom	Environment Agency and Scottish Environment Protection Agency - Flood warnings for Scotland	<a href="http://www.sepa.org.uk/environment/water/flooding/">http://www.sepa.org.uk/environment/water/flooding/</a>

United Kingdom	Environment Agency and Scottish Environment Protection Agency - 5-day flood risk forecast for England and Wales	<a href="https://flood-warning-information.service.gov.uk/5-day-flood-risk">https://flood-warning-information.service.gov.uk/5-day-flood-risk</a>
United Kingdom	Shoothill - flood risk	<a href="http://www.checkmyfloodrisk.co.uk/">http://www.checkmyfloodrisk.co.uk/</a>
United Kingdom	Shoothill - flood information	<a href="http://www.shoothill.com/floodmap/">http://www.shoothill.com/floodmap/</a>
United Kingdom	Shoothill - water levels	<a href="http://www.gaugemap.co.uk/">http://www.gaugemap.co.uk/</a>
Ireland	Office of Public Works (water levels, discharges)	<a href="http://waterlevel.ie/">http://waterlevel.ie/</a>
Ireland	Environmental Protection Agency (water levels, discharges)	<a href="http://www.epa.ie/hydronet">http://www.epa.ie/hydronet</a>
Ireland	Met Office Ireland (meteo warnings that can include flooding en heavy rain (see explanation on site))	<a href="https://www.met.ie/warnings">https://www.met.ie/warnings</a>
Iceland	Icelandic Met Office (flow monitoring and warnings)	<a href="https://en.vedur.is/alerts">https://en.vedur.is/alerts</a>
Iceland	Icelandic Met Office (water levels and discharges in relation to normal stream flow ratio)	<a href="http://en.vedur.is/#tab=vatnafar">http://en.vedur.is/#tab=vatnafar</a>
Iceland	Icelandic Met Office (water levels and discharges (more stations))	<a href="http://vmkerfi.vedur.is/vatn/vdv_gmap.php">http://vmkerfi.vedur.is/vatn/vdv_gmap.php</a>

## 6. Conclusions

This report showcases the spatial data collected and catalogued within Work Package 4.3 on socio-economic/administrative boundary conditions. Spatial flood risk/inundation maps based on state-of-the-art numerical flood simulations have been acquired, which are part of the European Coastal Flood Awareness System (ECFAS) as well as the European Flood Awareness System (EFAS). Projected impact estimates regarding affected population and incurred financial losses associated to the simulation results have been found and catalogued as well for the DuneFront project. More detailed impact assessments for coastal floods do exist but access is currently restricted. Access has been requested and the access is awaited.

Coastal flood protection for Europe has been acquired and mapped on the basis of the European Flood directive and its current (6<sup>th</sup>) assessment report (European Commission 2021). Protection levels have been verified within the DuneFront project and represent actually implemented coastal protection design levels.

Marine seabed sediment composition data has been acquired from the EMODnet data base for the Folk V classification scheme. On the one hand more detailed data with finer sediment classifications exists only for select EU countries and would render the spatial data patchy. On the other hand, the DuneFront project embarks on testing and projecting mitigation impacts of hybrid-DD NbS, which require primarily sand for building and/or nourishing non-cohesive sand. Therefore, the main interest for this project regarding marine sediment resources available concentrates on sand only and renders other classification data at the current situation less important. Extraction sites have been acquired as well from the EMODnet data base. The delineation of the dredging zones and their associated meta data details area size and in some cases estimates for available sediment volume for extraction. However, this is not consistently available for all sites. Demonstrator site sensitive analysis in later project stages will likely have to contact permitting agencies, which are outlines/given in the meta data for more information if needed.

Finally, a list of responsible government agencies with regards to (coastal) water body status monitoring, flood protection planning, design and construction as well as maintenance and finally storm surge warning services has been compiled with the help of project partners of DuneFront complemented by an extensive internet research (see Table 1).

Data acquired and catalogued has been ingested into a Geo Information System (GIS) data base using the open source software Quantum GIS (QGIS Development Team 2024). The data base contains >250 GB of data. For further use within the project a combination with Deliverables D4.1 and D4.2 is in discussion and will be tested, when the other milestones in work package 4 are due (M15).

## 7. Publication bibliography

Dottori, Francesco; Alfieri, Lorenzo; Bianchi, Alessandra; Skoien, Jon; Salamon, Peter (2021): River flood hazard maps for Europe and the Mediterranean Basin region.

Dottori, Francesco; Kalas, Milan; Salamon, Peter; Bianchi, Alessandra; Alfieri, Lorenzo; Feyen, Luc (2017): An operational procedure for rapid flood risk assessment in Europe. In *Nat. Hazards Earth Syst. Sci.* 17 (7), pp. 1111–1126. DOI: 10.5194/nhess-17-1111-2017.

Dottori F; Mentaschi L; Bianchi A; Alfieri L; Feyen L (2023): Cost-effective adaptation strategies to rising river flood risk in Europe. In *NATURE CLIMATE CHANGE* 13, pp. 196–202. DOI: 10.1038/s41558-022-01540-0-0.

EMODnet (2014): Human Activities Dredging. EMODnet\_HA\_Dredging\_20231106. With assistance of EMODnet. EMODnet. EU. Available online at <https://emodnet.ec.europa.eu/geonetwork/srv/eng/catalog.search#/metadata/d3e86612-35a7-4c0f-a995-245062fd2792>, updated on 6/11/2023, checked on 07/2024.

EMODnet (2023): Seabed Substrates. With assistance of Geological Survey of Finland GTK. Edited by Aarno Kotilainen. EMODnet. Available online at <http://drive.emodnet-geology.eu/geoserver/gtk/ows?SERVICE=WMS&>, updated on 9/22/2023, checked on 05/2024.

European Commission (2021): Report on the implementation of the Water Framework Directive (2000/60/EC), the Environmental Quality Standards Directive (2008/105/EC amended by Directive 2013/39/EU) and the Floods Directive (2007/60/EC). Implementation of planned Programmes of Measures New Priority Substances Preliminary Flood Risk Assessments and Areas of Potential Significant Flood Risk. 52021DC0970. 6th. With assistance of European Commission. Edited by European Commission. Brussels (6). Available online at <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:0970:FIN>, checked on 5/2024.

European Commission, Joint Research Centre (2022): Flood impacts and adaptation strategies under future scenarios.

European Union (2007): Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (Text with EEA relevance). Directive 2007/60/EC. Source: EUR-Lex, pp. 27–34. Available online at <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32007L0060>, checked on 05/2024.

EUROSTAT (2024): Territorial units for statistics (NUTS). With assistance of European Union. Edited by EUROSTAT. Available online at <https://ec.europa.eu/eurostat/web/gisco/geodata/statistical-units/territorial-units-statistics>, checked on 04/2024.

Paprotny, Dominik; Rhein, Belinda; Vousdoukas, Michalis I.; Terefenko, Paweł; Dottori, Francesco; Treu, Simon et al. (2024): Merging modelled and reported flood impacts in Europe in a combined flood event catalogue, 1950–2020.

QGIS Development Team (2024): Quantum GIS. Version Long Term Release (LTR) 3.24.5. Open Source Geospatial Foundation Project: Quantum Geographic Information System. Available online at <http://qgis.osgeo.org>, checked on 02/2024.

RiscKit (2017): RISC-KIT project. EU Horizon grant No. 609906. Climate ADAPT. Edited by Dr. Camilla Bausch. Ecologic Institute gemeinnützige GmbH Pfalzburger Str. 43/44 D-10717 Berlin. Brussels. Available online at <https://coastal-management.eu/index.html>, updated on 2023, checked on 03/2024.

Scussolini, Paolo; Aerts, Jeroen C. J. H.; Jongman, Brenden; Bouwer, Laurens M.; Winsemius, Hessel C.; de Moel, Hans; Ward, Philip J. (2016): FLOPROS: an evolving global database of flood protection standards. In *Nat. Hazards Earth Syst. Sci.* 16 (5), pp. 1049–1061. DOI: 10.5194/nhess-16-1049-2016.

Sharifian, Mohammad Kazem; Kesserwani, Georges; Chowdhury, Alovya Ahmed; Neal, Jeffrey; Bates, Paul (2023): LISFLOOD-FP 8.1: new GPU-accelerated solvers for faster fluvial/pluvial flood simulations. In *Geosci. Model Dev.* 16 (9), pp. 2391–2413. DOI: 10.5194/gmd-16-2391-2023.

Vousdoukas, Michalis I.; Mentaschi, Lorenzo; Mongelli, Ignazio; Ciscar, Juan Carlos; Hinkel, Jochen; Ward, Philip et al. (2020): Adapting to rising coastal flood risk in the EU under climate change. JRC PESETA IV project : Task 6. Luxembourg: Publications Office of the European Union (EUR, 29969).