Interreg North-West Europe SURICATES

European Regional Development Fund

WP T1 Deliverable 1.3. Identification of 3 New Sediment Use Opportunities

Partners Involved in this activity :

University of Lille (UL), University College of Cork (UCC),

Munster Technological University (MTU). Scottish Canals (SC), Port of Rotterdam (PoR)

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WP T1 Deliverable 1.3. Identification of 3 New Sediment Use Opportunities

SUMMARY

INTRODUCTION

This deliverable T1.1.3 is one of the three reports of activity 1 of work package T1 of the SURICATES project. The objectives of Activity 1 were to use the RAIES model and to develop a method for assessing social risks and prioritising opportunities to increase the acceptability of sediment reuse in projects. This activity was divided into three parts:

- Development and testing of a GIS add-on based on ready-to-use CEAMaS results. This sediment management GIS system will be available for use and application by port authorities (Deliverable T1.1.1, not this report).
- Implementation of the GIS complement in ports/inland waterways using real local data to identify the most attractive and socially acceptable territories; pilot port sites in Northern France and Southern Ireland, Port of Rotterdam and SC as dissemination sites (Deliverable T1.1.2, not this report).
- 3 sites with potential for new sediment use opportunities will be identified in the four NWE regions (Northern France, Southern Ireland, the River Bowling site in Scotland and the Netherlands) using field-tested and validated GIS (Deliverable T1.1.3, this report).

To achieve the objectives set by activity T1.1.3, it was decided to organise interviews with sediment managers or port authorities in the four countries involved in the Suricates project using the RAIES model developed as an extension to QGIS software. The question put to the interviewees was as follows: "In your opinion, what are the geographical constraints to the reuse of dredged materials in applications that comply with environmental regulations?

1 LOCATING 3 CASES OF SEDIMENTS REUSE IN HAUT-DE-FRANCE

1.1 MAP RESULT ACCORDING PORT MANAGER VIEWPOINT FOR THE HAUT-DE-FRANCE REGION

The location of 3 opportunities in the Hauts-de-France region was mapped using the RAIES model and input from a public expert from the Direction Inter-Régionale de la Mer. This public service expertise is involved in the regulatory aspect of decision-making (i.e. the granting of permits) for the reuse of sediments in a coastal/marine environment. The respondent has a very conservative viewpoint, focused on nature protection, and only a few areas of interest score below a RAIES territorial constraint level of 0.3 (see Figure 1).

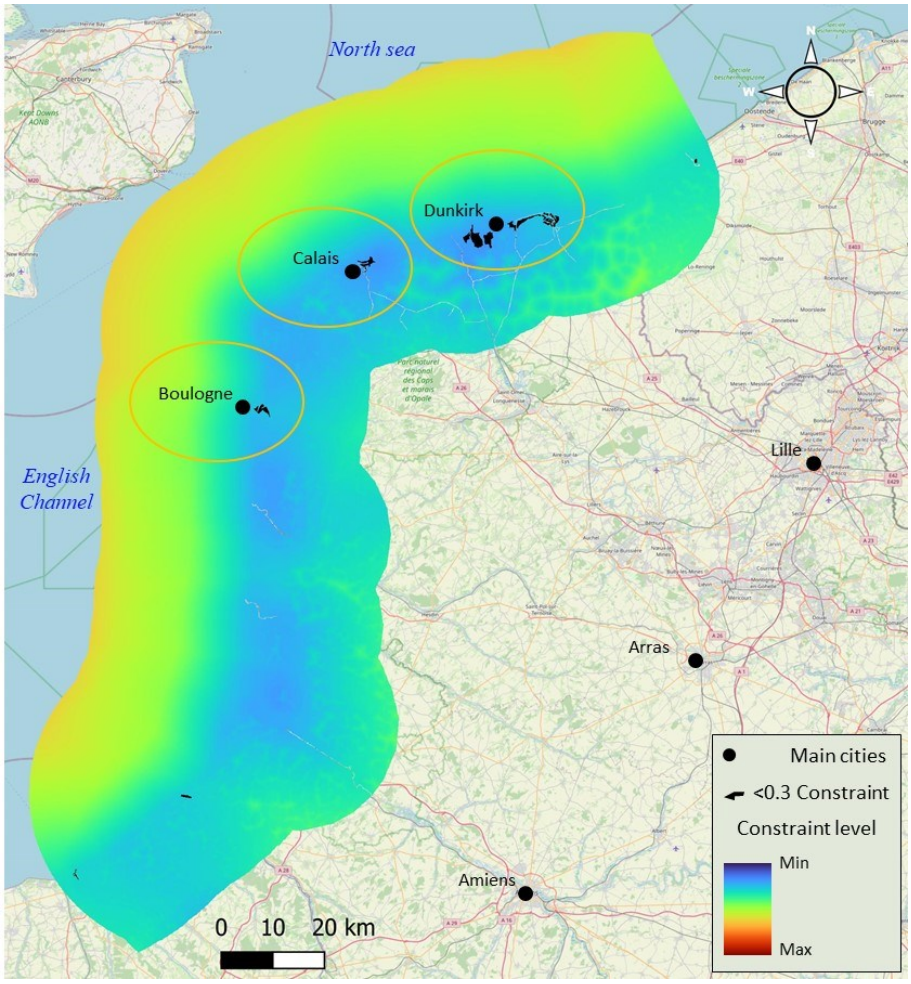

Figure 1: Potential opportunity locations for sediment reuse in the Hauts-de-France Region (France) below a 0.3 territorial constraint value (i.e. black small polygones).

Small estuaries and port infrastructure in the Hauts-de-France region are the only sites that correspond to this expert point of view. Although it is clear that the large ports in the north of France represent the best opportunities for the future reuse of sediments, the RAIES model confirms that other sites may have a higher level of low acceptability according to an expert involved in the decision-making process for granting a permit for the reuse of dredged sediments in the coastal/marine zone.

1.2 THREE POTENTIAL LOCATIONS FOR SEDIMENTS REUSE IN THE HAUT-DE-FRANCE REGION

As well as being one of the largest in France (see Figure 2), the Port of Dunkirk is the first potential site in northern France and is renowned for its many applications for reusing dredged sediments at sea (https://www.sedilab.com/portfolio-item/ecomodele-paysager/ in French). The port's high level of economic activity and its ability to maintain navigable access require regular dredging and maintenance of its protective structures against marine erosion. This site therefore represents a regular opportunity to re-use large volumes of dredged sediments in Northern France.

Figure 2: Satellite view of the Dunkirk port infrastructures (google earth® imagery 2019)

The Port of Calais (see figure 3) is also a second potential location for sediment reuse in northern France. Maintenance dredging regularly provides large volumes of sediment that constitute a renewable resource for future port developments and for safety works against coastal erosion.

Figure 3: Satellite view of the Calais port infrastructures (google earth® imagery 2019)

In addition, during the Suricates project period, the Port of Calais completed its expansion works by using dredged sediments to manufacture concrete tripods and to supply the backfill for the new areas reclaimed from the sea (https://www.portboulognecalais.fr/fr/calais-port-2015-1). The port is therefore already familiar with the reuse of dredged sediments in large-scale projects, which is an asset when it comes to integrating this resource into future development or maintenance projects for its infrastructure.

The third most important potential site in northern France, the Port of Boulogne is France's leading fishing port. Over the course of the 20th century, the fishing industry developed port infrastructure that acted as sediment traps and, in certain basins and docks exposed to industrial pollution, to the accumulation of pollutants in historic sediment layers (see Figure 4).

Figure 4: Satellite view of the Boulogne port infrastructures (google earth® imagery 2019)

The Port of Boulogne regularly carries out maintenance work on its infrastructure: in 2022-23, careening work will be carried out on a lock, and in 2024, the Port of Boulogne's road network will be renovated. The latter project, for example, offers the opportunity to reuse sediment from dredging operations in a road application, already tested at a 1:1 scale in the Port of Dunkirk in 2012 (https://www.sedilab.com/portfolio-item/route-du-freycinet-12-de-gpmd/) or in concrete applications for road kerbs.

These three potential sediment reuse sites are all based on an available sediment resource, a frequent need for sediment dredging to maintain port infrastructures and support the industrial activities that have developed there, with a very strong economic interest at both regional and national level. These three locations therefore offer real opportunities for the reuse of dredged sediments, with a very high probability of realisation in the near future, i.e. within the next few years.

2 Locating 3 cases of Sediments reuse in South Western Ireland

2.1 Map Result according port manager viewpoint for South Western Ireland

The location of 3 opportunities in the South West region of Ireland was mapped using the RAIES model and input from a public expert, the Fenit Harbour Master. He recently managed a dredging operation in Fenit Harbour and also benefited from the expertise provided by the Irish partner, MTU, as part of the dissemination activities and long-term work programme of the Suricates project. As soon as the 'regulatory compliance' hypothesis was raised in the interview, this harbour master developed a very open viewpoint about territorial decision-making, focusing on the operational and logistical aspects of the potential applications of the dredged sediments. In fact, much of the south-west of Ireland received a very low RAIES land constraint value of less than 0.1 (see Figure 5).

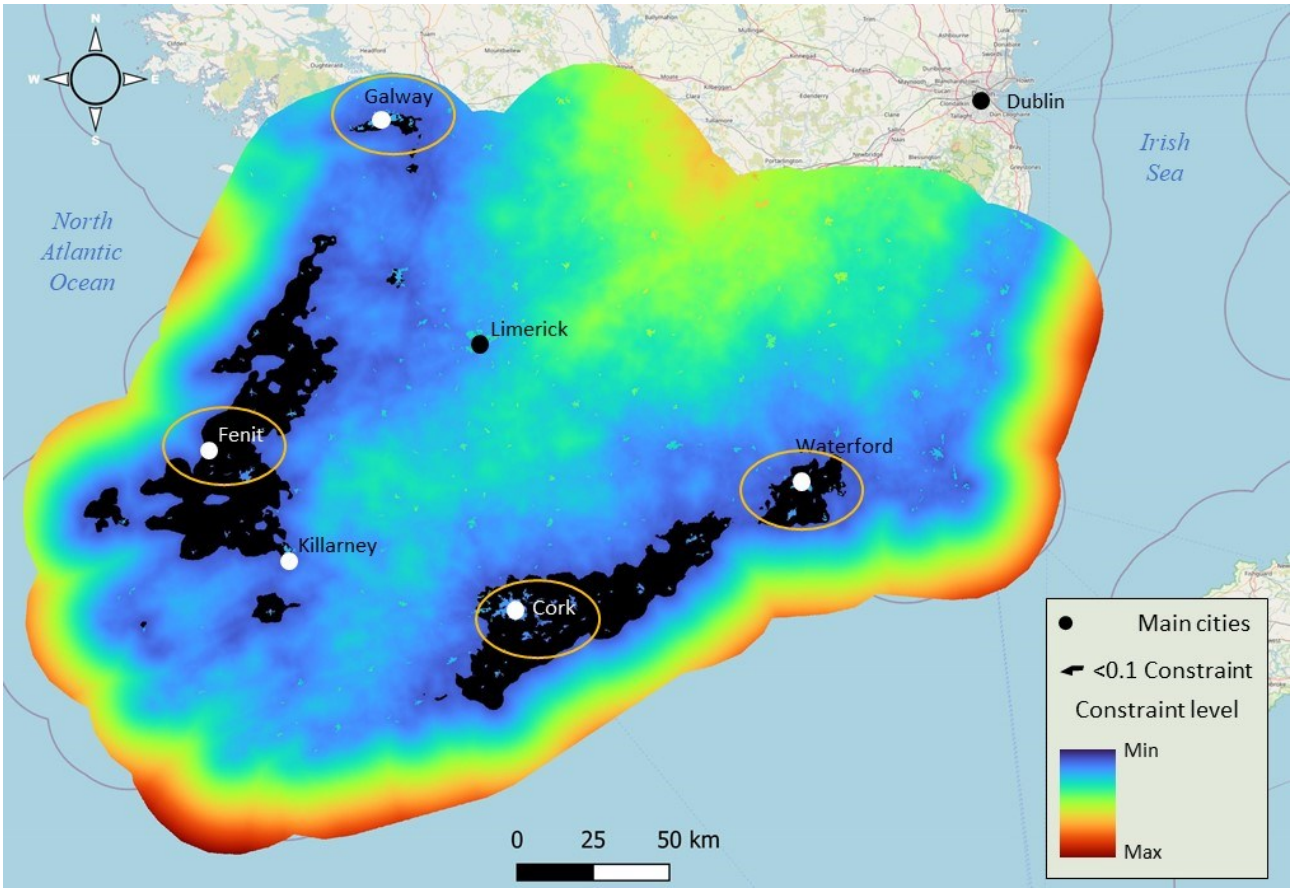

Figure 5: Potential opportunity locations for sediment reuse in South Western Ireland below a 0.1 territorial constraint value (i.e. black small polygones).

In the order of port size, Cork, Waterford, Galway and Fenit are clearly attractive potential sites for reusing dredged sediments in South Western Ireland.

2.2 Three potential locations for sediments reuse in South Western Ireland

In order to select potential locations based on the RAIES model results, we also draw on the Irish Coastal Protection Strategy Study (ICPSS, https://www.gov.ie/en/publication/eed0fb-irish-coastal-protection-strategy-study-icpss/#) for the South West and South of Ireland. We pay particular attention to the maps from WP 9A (i.e. "projected future scenarios for the year 2100 have been taken into account, including adjustments for projected future changes in climate and glacial isostatic adjustment (GIA)". From this WP9A, we select Mid Range Future Scenario (MRFS) maps to confirm the potential for sediment reuse opportunities at the local scale, in locations where the level of land constraint for sediment reuse has a value of less than 0.1 (see Figure 5). The three potential candidates are Port of Cork/City Centre, Fenit Harbour and Port of Galway/ Galway City.

The first potential case is the Lee river estuary with a specific focus on Cork city's historical centre and the old port area (see figure 6).

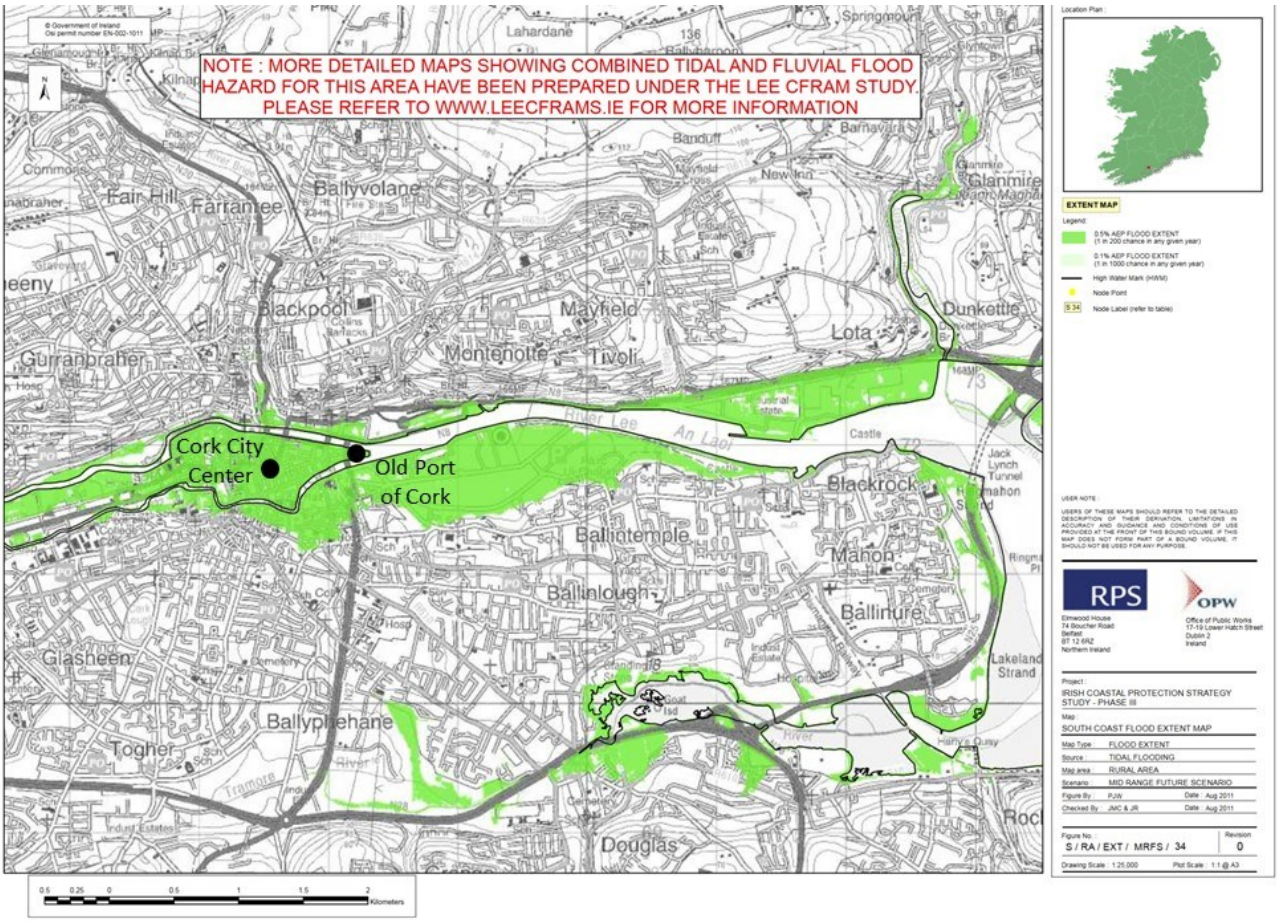

Figure 6: Old port and city center of Cork flood risk exent map (from Office of Public Works)

Figure 6 highlights the need for flood protection against marine flooding in the upper reaches of the Lee Estuary, where the city and harbour of Cork developed centuries ago. This potential opportunity should also benefit from two recent projects located downstream of the estuary:

- the ferry extension and the development of a new container terminal at Ringaskiddy, delivered in May 2022. (https://www.portofcork.ie/cork-container-terminal-official-launch/).

- the Haulbowline island amenity park project delivered on 17 July 2021 (https://www.corkcoco.ie/en/resident/environment/haulbowline-island-remediation-project-archive).

In both projects, dredging operations as sediment resources were involved to varying degrees in the decision-making process, project building and operational works. But flood security is a major driving force that flood defense in the Lee estuary.

A second potential case is Fenit Harbour and the surrounding coastal area of Tralee Bay (see Figures 7 and 8). We know from the harbour master (i.e. discussions for the RAIES model interview and expert collaboration with partner MTU) that any opportunity to reuse dredged sediments may be an economic asset to Fenit harbour when compared to other approaches to sediment management.

According to the EMODnet project (see figure 7), many kilometres of coastline are threatened by erosion in Tralee Bay, in the vicinity of Fenit Harbour.

Figure 7: Fenit Harbour's coastal erosion assessment (from the EMODnet project).

According to the Office of Public Works of Ireland Coastal Flood Risk Map (see Figure 8), most of the coastline near Fenit Harbour if not exposed to coastal erosion is exposed to coastal flooding.

The exposure of the coastline to flooding and erosion, together with future dredging operations, the need for which has been confirmed by the Harbour Master for the remainder of the decade, provides a perfect set of conditions for this second Irish opportunity for the potential reuse of Fenit Harbour sediments.

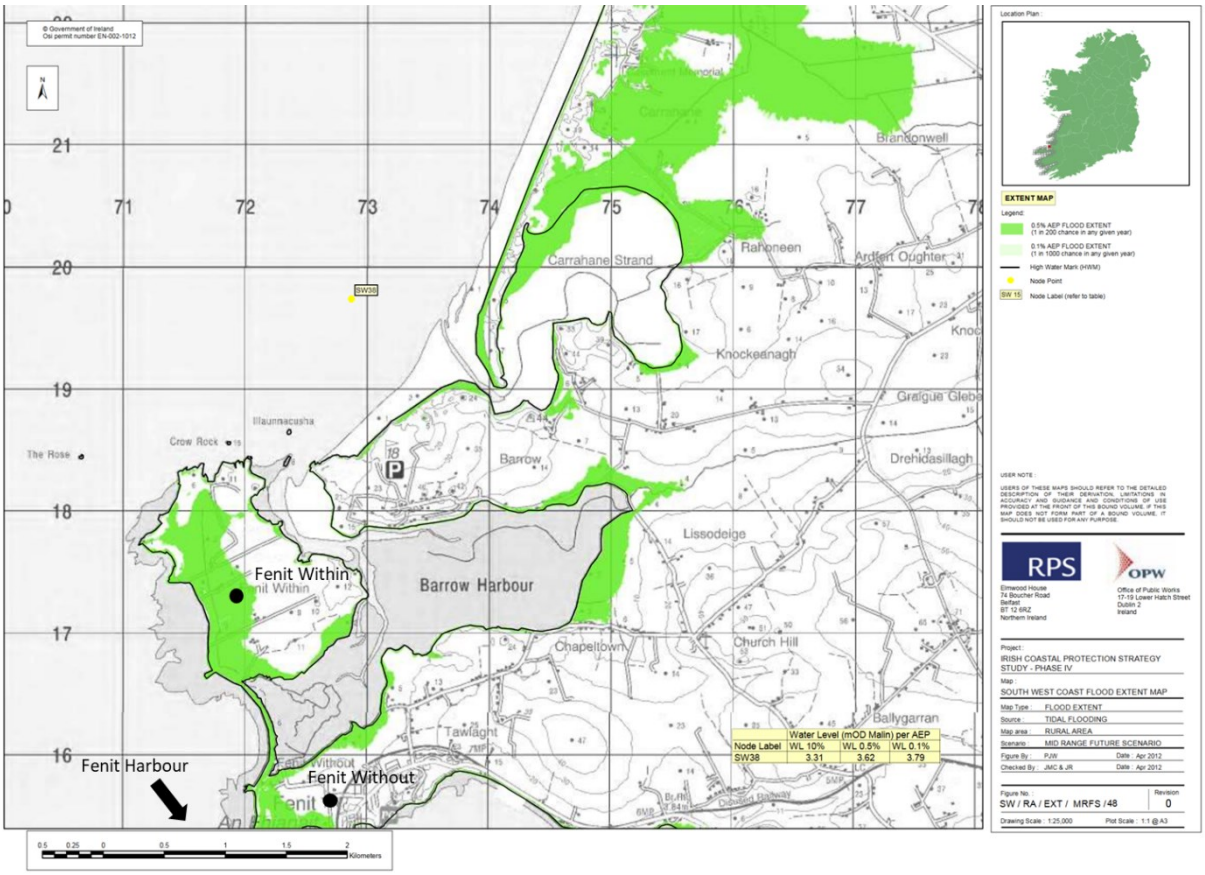

Figure 8: Fenit Harbour's flood risk exent map (from Office of Public Works)

A third potential case in the West of Ireland in the Galway Bay coastal area (see Figures 9 and 10), with a particular focus on Galway City itself. Here, the potential opportunity relates to defence against coastal erosion and flood risk, as demonstrated by the EMODnet erosion map (Figure 9) and the Office of Public Works flood map (Figure 10).

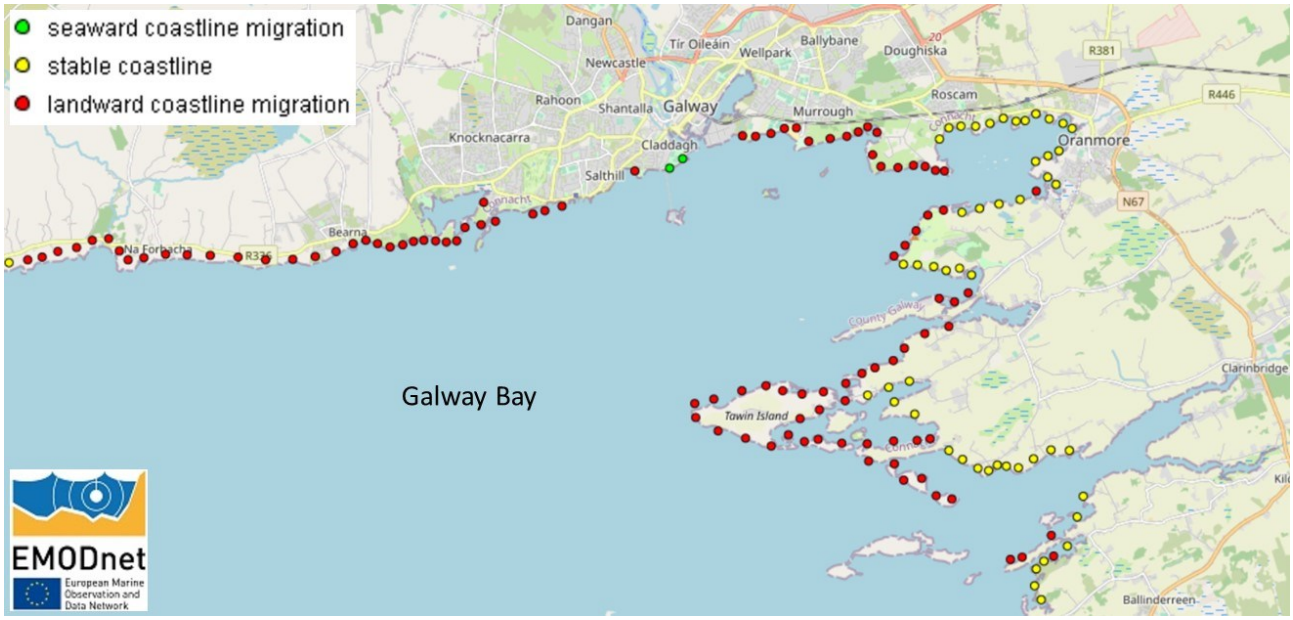

Figure 9: Inner Galway Bay's coastal erosion map (from EMODnet Project)

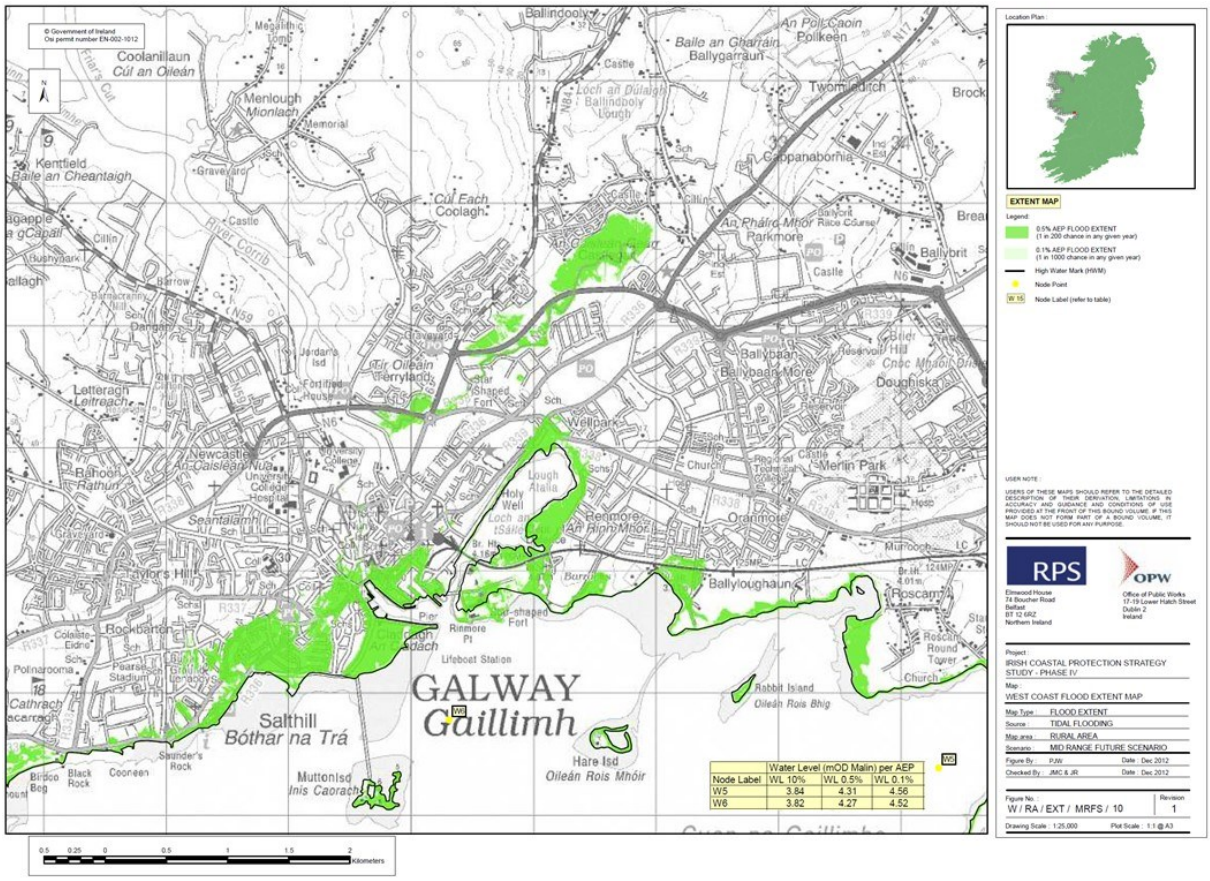

Figure 10: Galway shoreline flood risk extent map (from Office of Public Works)

3 LOCATING 3 CASES OF SEDIMENTS REUSE IN SCOTLAND

3.1 MAP RESULT ACCORDING PORT MANAGER VIEWPOINT FOR SCOTLAND

The location of 3 opportunities in the Scottish Midlands between Glasgow and Edinburgh was mapped using the RAIES model and the input from a civil engineer operating at Scottish Canals but also involved in the Suricates Project. As soon as the 'regulatory compliance' hypothesis was raised in the interview, this sediment expert provided a quite open viewpoint about territorial opportunities to reuse dredged sediments. The three selected areas of interest have a territorial constraint value below 0.2 (see Figure 11). They are located in the Clyde estuary, downstream Glasgow (Bowling and Dumbarton sites), as well as in the Firth of Tay (Dundee) and in the Firth of Forth (Grangemouth and Charlestown Ports).

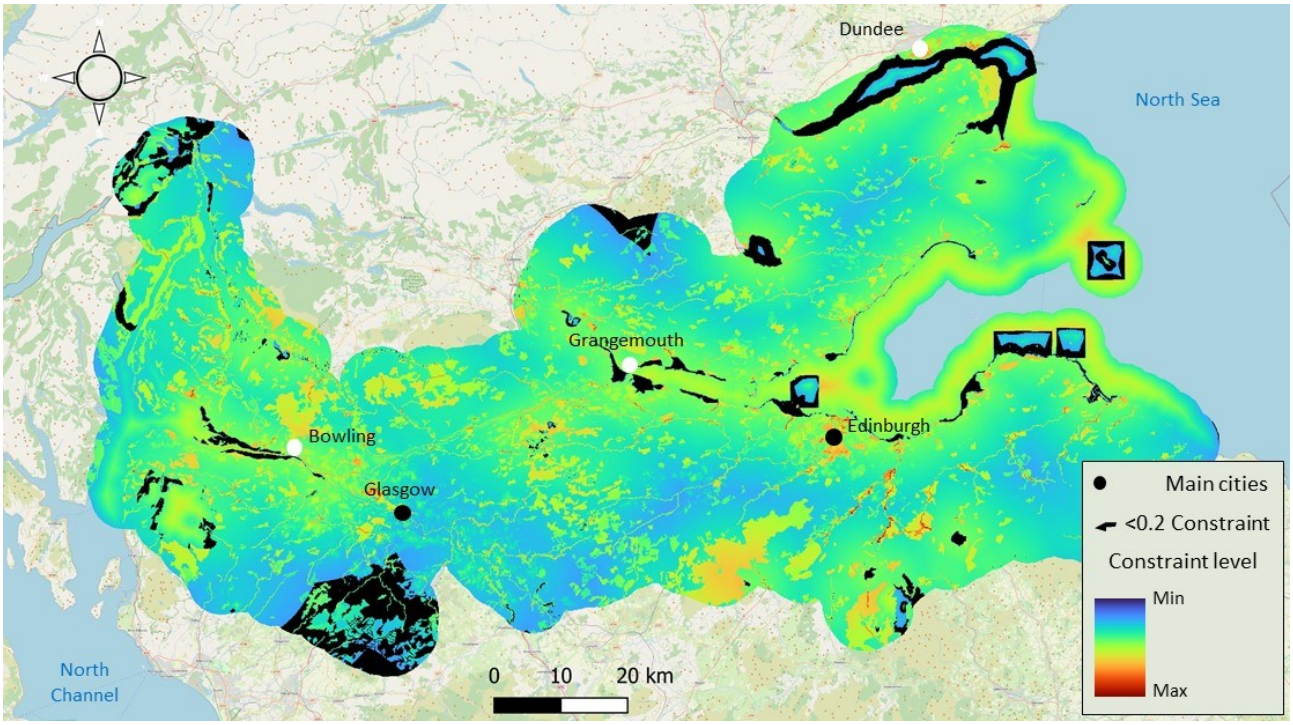

Figure 11: Potential opportunity locations for sediment reuse in the Scottish midlands below a 0.2 territorial constraint value (i.e. black small polygones).

Another source of information to locate new opportunities for reuse is the EMODnet project and its web GIS (https://emodnet.ec.europa.eu/geoviewer/#) which provides erosion maps for the western coast of Europe.

3.2 THREE POTENTIAL LOCATIONS FOR SEDIMENTS REUSE IN SCOTLAND

The first potential case is Dundee which is located in the Firth of Tay (see figure 12). According the EMODnet project the estuary shoreline shows clear sign of coastal erosion in various locations. It means that projects of coastal defense will also be included with sediment reuse opportunities for port maintenance and development (see figure 13). The Green Circular is a cycle/foot path built upon a hard coastline infrastructure protecting Dundee city as well as Dundee Airport track (see figure 13) against storm surges and flooding. This location is therefore a potential sediment reuse opportunity in the context of sea level rise and climate change.

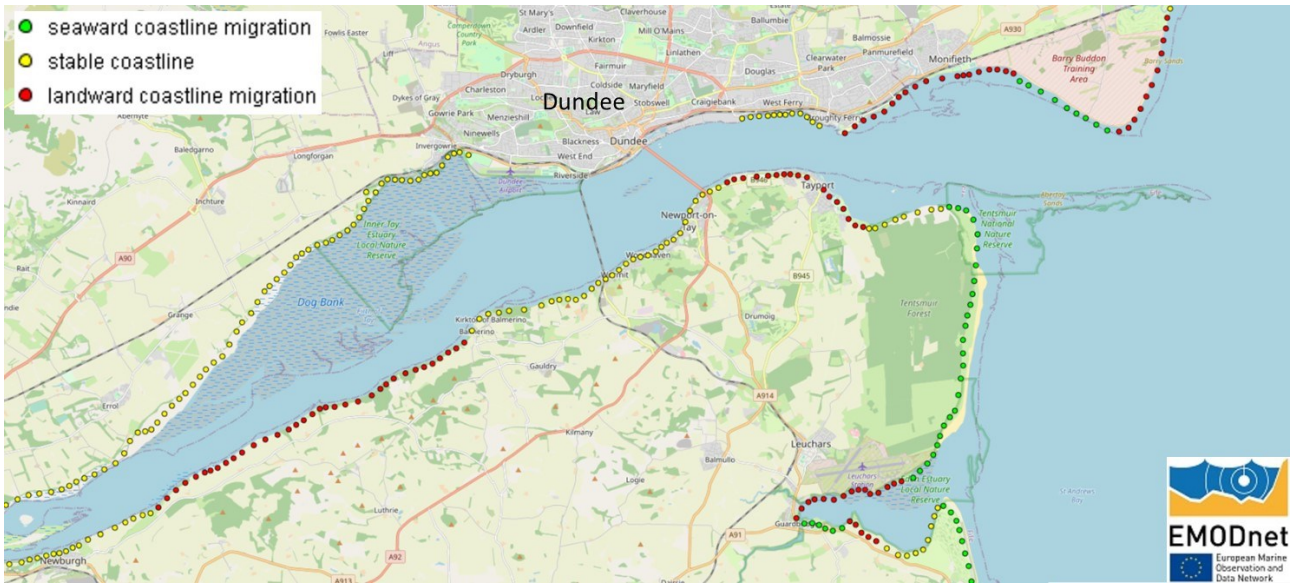

Figure 12: Firth of Tay coastal erosion map (from EMODnet Project).

Figure 13: Potentials sites of interest for projects based on dredged sediment reuse in the Dundee area (Scotland UK). Images dated from 2021 are sourced from Google Streetview (last access October, 2023).

The second potential case is twofold and located in the Firth of Forth in the port areas of Grangemouth (south bank) and Charlestown (north bank). The Grangemouth case is a commercial port located nearby a coastal erosion area (see figure 14) but also nearby a pilot site from the Suricates project (i.e. WPT2 Falkirk bioengineering site). The Charlestown case is an old industrial site dedicated to a 14 lime kiln facility of heritage interest near port infrastructure in need for maintenance for its quays walls (see figure 15). Lime availability in the neighbourhood of the Firth of Forth is a strategic asset for concrete production with dredged sediment. This was one of the limiting factors for the investment work package 2 works, considering the lack of calcium in the dredged sediments available in the surrounding of Bowling pilot site within the project timeframe. The Firth of Forth location is therefore

a potential sediment reuse opportunity for the Grangemouth port development as well as for the maintenance of Charlestown port.

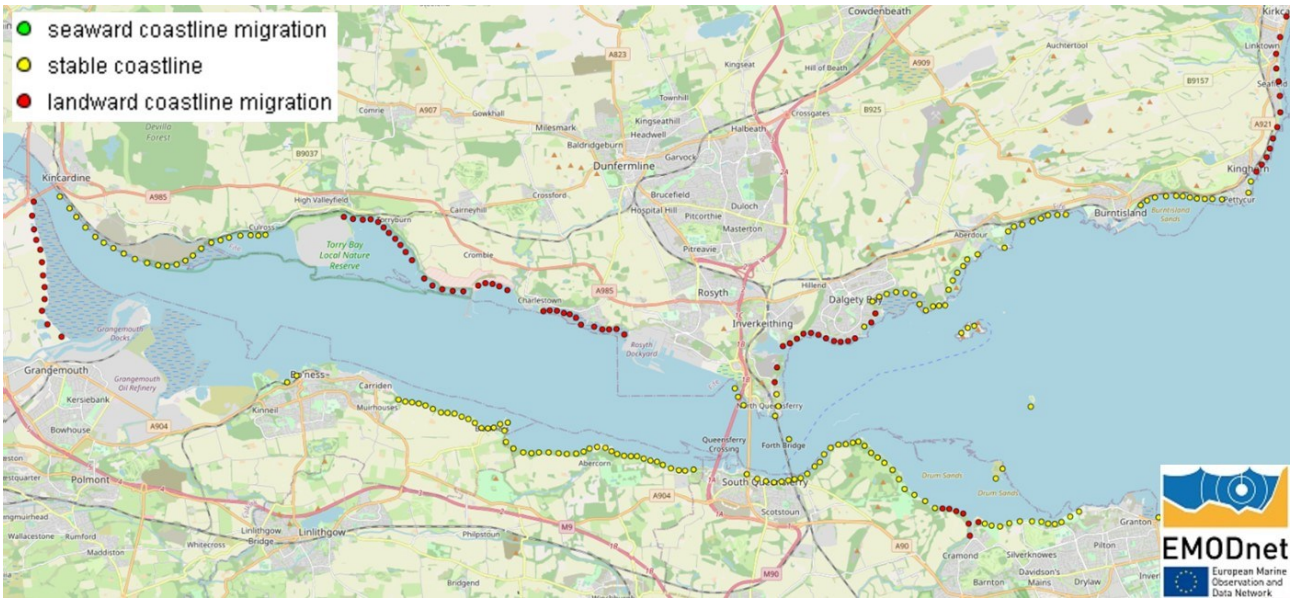

Figure 14: Firth of Forth coastal erosion map (from EMODnet Project).

Figure 15: Potentials sites of interest for projects based on dredged sediment reuse in the Firth of Forth (Scotland, UK). Images are sourced from Google Earth and Streetview (last access October, 2023).

A third potential case in the Scottish Midlands is that of the Clyde Estuary, from Bowling Harbor and further downstream past Dumbarton (see Figures 16 and 17), with particular emphasis in this report on the Bowling site . The potential opportunity here relates to the need for defense against coastal erosion, as demonstrated by the EMODnet erosion map (Figure 16). For the Bowling site, the Meerkats project activities of technical work package 2 and investment work packages i2 and i3 confirmed that:

- Future land development and coastal defense against erosion can benefit from dredged sediment from Scottish canal waterways.
- a small-scale coastal defense application using concrete blocks made from dredged sediment has already been carried out at the Bowling site, opening the possibility of a larger-scale application.

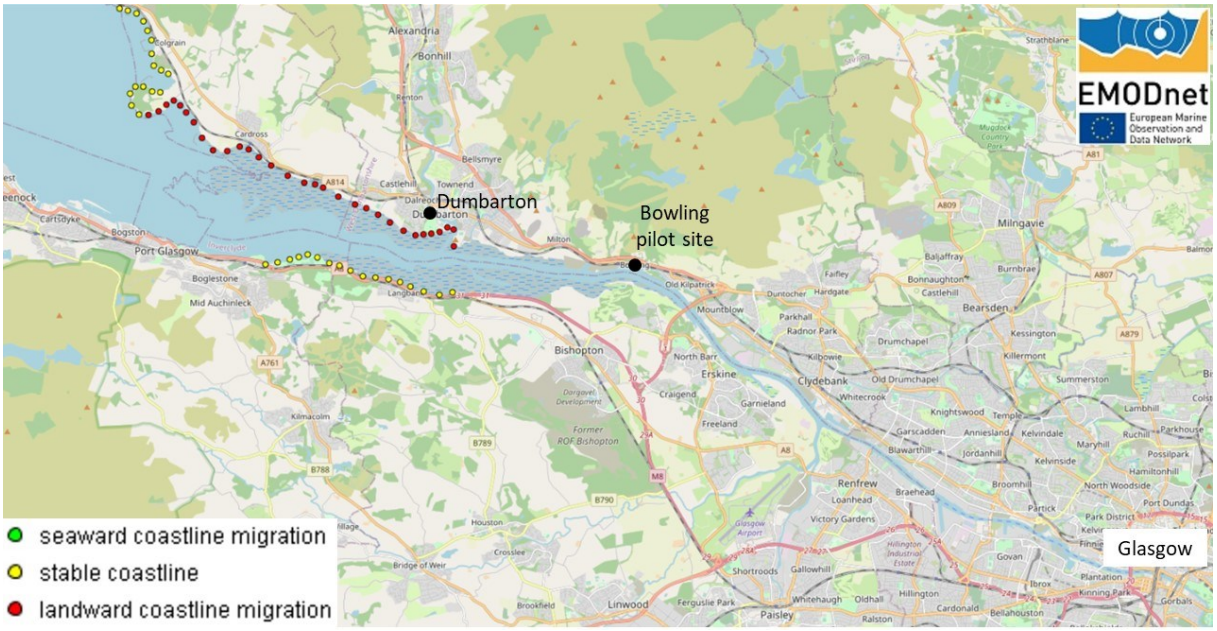

Figure 16: Clyde estuary coastal erosion map (from EMODnet Project).

Figure 17: Coastal erosion at Bowling pilote site. Satellite image sourced from Google Earth (last access October 2023).

4 LOCATING 3 CASES OF SEDIMENTS REUSE IN THE NETHERLANDS

4.1 MAP RESULT ACCORDING PORT MANAGER VIEWPOINT FOR THE NETHERLANDS

The location of 3 opportunities in The Netherlands was based on the RAIES model results according to the viewpoint of a civil engineer operating at Port of Rotterdam, also involved in the Suricates Project. As soon as the 'regulatory compliance' hypothesis for sediment reuse was raised in the interview, this sediment expert provided a very open viewpoint about territorial opportunities for dredged sediments applications. According to the expert viewpoint, the areas of interest for this report have a territorial constraint value below 0.15 (see Figure 18). They are all located in the Zeeland and South Holland regions, in the vicinity of Zierikzee and Ouddorp, of The Hague and within Port of Rotterdam.

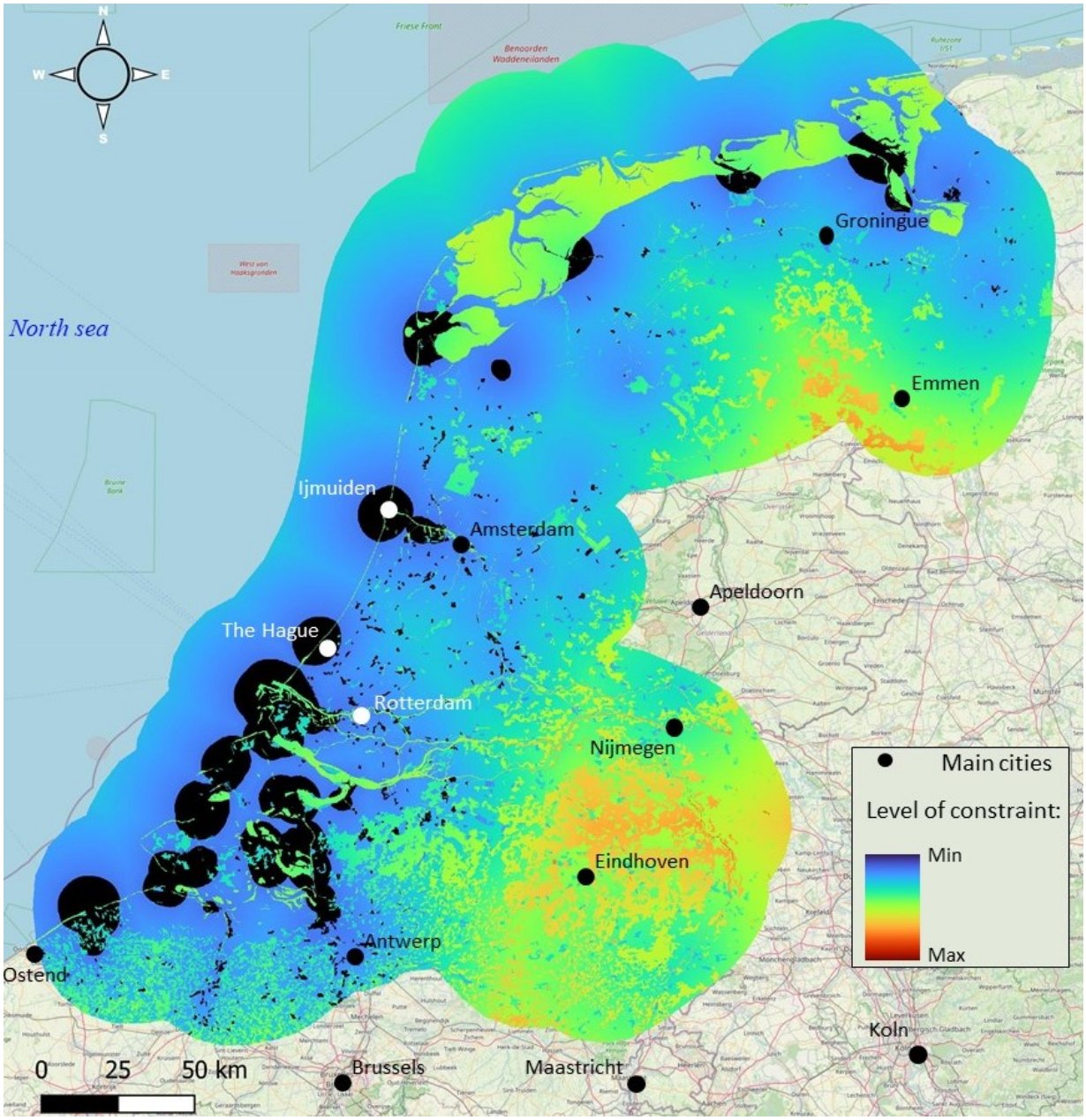

Figure 18: Potential opportunity locations for sediment reuse for The Netherlands below a 0.15 territorial constraint value (i.e. black small polygones).

For the first two cases, we are relying on the national objectives of the Delta Programme which is to provide flood security for the coastal lowland parts of the Netherlands. According to this objective (https://english.deltaprogramma.nl/three-topics/flood-risk-management/sand-decision) *"The sand along the Dutch coast provides natural protection against the sea. Because of the action of wind, waves and currents, sand is continuously lost to the sea. To maintain the protection afforded by the beaches and dunes, Rijkswaterstaat maintains the coast with nourishment operations involving millions of cubic metres of sand taken from the bed of the North Sea. The Sand Decision defines the goals and implementation of these operations."* For now, sediment for coastal defence are sourced from the bed of North Sea according to Rijkswaterstaat and the Delta programme. A contribution from dredged sediment matching environmental/physical-chemical requirements would also be a potential opportunity to limit the induced environmental impact of seabed extraction together with no dredged sediment reuse while keeping the objective of *"dunes and beaches being the basis for coastal protection. To maintain a proper sand balance, even if sea levels rise and violent storms occur more frequently, larger sand nourishment operations may be needed in the future. These operations contribute not only to preserving the coastline but also to local and regional goals for an economically strong and appealing coast."* (https://english.deltaprogramma.nl/three-topics/flood-risk-management/sand-decision).

The question of cost-benefit between hard protection (i.e. dykes) and soft protection (i.e. beach nourishment) is also a major topic "More knowledge is needed to make sand nourishment more effective and cost-efficient. So learning in practice is an important component of the Sand Decision. That means conducting pilot projects, monitoring and research, and using the results to inform new decisions." (https://english.deltaprogramma.nl/three-topics/flood-risk-management/sand-decision). Another source of information to locate new opportunities for reuse is the EMODnet project and its web GIS (https://emodnet.ec.europa.eu/geoviewer/#) which provides erosion maps for the western coast of Europe.

These main external sources are the baseline for the following proposal of three new opportunities for the sediment reuse in the Netherlands according to the viewpoint of the interviewee from PoR. Here opportunities for sediment reuse are targeted for coastal defence by mean of dredged sediment contribution to beach nourishment or dyke maintenance for the Zierikzee-Ouddorp and The Hague cases whereas a new project of sediment reallocation within the port infrastructure is targeted for the Port of Rotterdam.

4.2 Three potential locations for sediments Reuse in The Netherlands

The first potential location for the Netherlands is the Ouddorp-Zierikzee area (see figure 14) bridges the Zeeland region (sourth part) starting from the Schouwen Duiveland (Zierikzee city, figure 14) to the South Holland region (north part) starting from Goeree-Overflakkee (Ouddorp city, figure 14). In this area the North Sea coastline is known (EMODnet project) for suffering from coastal erosion. Here beach nourishment is a potential opportunity for dredged sediment reuse.

Figure 17: Coastal erosion map from the EMODnet project for the Zeeland/South Holland shoreline around Zierikzee and Ouddorp (The Netherlands).

The second potential location for the Netherlands is The Hague coastline. This second opportunity is driven by the high level of territorial stakes (i.e. population, economy and heritage) in this densely populated area and the proximity of the Port of Rotterdam as a potential source for dredged sediments. Here, the maintenance of dykes and beach nourishment projects using a significative tonnage of dredged sediments, mainly the sand fraction, is in line with the Delta Programme objectives.

Figure 18: Coastal erosion map from the EMODnet project for The Hague shoreline (South Holland, The Netherlands).

The third potential location for the Netherlands is the Port of Rotterdam itself. The arguments in favour of this last dredged sediment reuse opportunity are:

- PoR is operating dredging activities on a very regular basis

- The PoR sediment expert has confirmed that the sediment reallocation application from the Suricates project work package investment i1 was successful and will probably be replicated in a near future.
- Sediment reallocation within the PoR infrastructure is a cost-effective, nature based way to reconnect lateral wetlands with sediment flux, benefiting from the natural dynamic of outflow-inflow in the port.

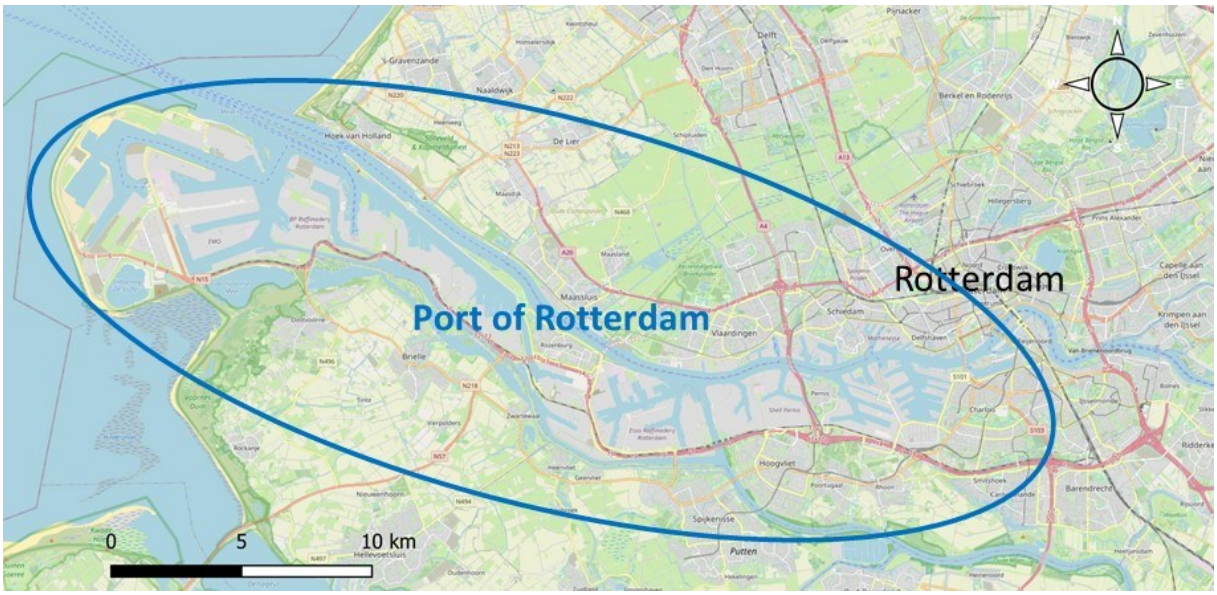

Figure 19: Port of Rotterdam (The Netherlands), OSM Standard October, 2023.

CONCLUSION

The objective of this activity 1.3 from work package T1 was to identify three sites with potential for new sediment use opportunities in the four NWE regions (Northern France, Southern Ireland, the River Bowling site in Scotland and the Netherlands) using field-tested and validated GIS tool (i.e. RAIES tool and QGIS).

In this report the RAIES model has provided various potential locations based on interviews with sediment managers or port authorities in the four countries involved in the Suricates project. From those opportunities we have selected 3 cases in each country according to lesson learnt from the Suricates Interreg NWE project, for instance Bowling site, Fenit Harbour and Port of Rotterdam, together with CEAMAS Interreg NWE project, for instance Haulbowline island or the Port of Cork ferry/container terminal projects. The other cases have benefit from all project partners' knowledge, external GIS data (i.e. maps, satellite images…) and national project information across the four countries for the consolidation of selected potential opportunities for dredged sediment reuse according RAIES model output maps.

The level of territorial constraint selected in each RAIEs model result was adapted to a low value (i.e. 0.1 to 0.3 on a range from 0 to 1) opening space and potential location for these sediment reuse opportunities. Not all the sediment and port experts interviewed have provided a similar view point but the lessons learnt from this social acceptability modelling have provided location where dredged sediment reuse project may be feasible in a near future.

If coastal defence and beach nourishment as well as land reclamation or dyke maintenance are the main applications listed in the four country cases of this report, other relevant sediment reuse applications are of course feasible on any of these locations such as: dyke construction, manufactured topsoil, sediment cell maintenance or wetland creation/nourishment. By reducing the potential areas of a dredged sediment project to those of a lower territorial constraint according stakeholder viewpoint (i.e. using RAIES model), a better territorial strategy on sediment reuse can definitely contribute to better spatial planning and efficiency of a circular economy path that still has to be developed, country based and at a European scale.

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Data and maps from EMODnet project, more information available at https://emodnet.ec.europa.eu/geoviewer/#

Delta programme for flood risk management in The Netherlands, more information available at https://english.deltaprogramma.nl/three-topics/flood-risk-management/sand-decision

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Sedilab website for French applications cases with dredged sediment, more information available at https://www.sedilab.com/portfolio-item/ecomodele-paysager/ or at https://www.sedilab.com/portfolio-item/route-du-freycinet-12-de-gpmd/