

Social, Economic and Environmental Analyses for Sediment Reuse Applications

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Outline of Presentation

- The SURICATES Project
- Background to the Suite of SURICATES Tools Developed
- Tools Application to Pilot Sites/Case Studies
 - Falkirk, Scotland
 - Port of Fenit, Ireland
 - Port of Rotterdam, The Netherlands
 - Port of Calais, France
- Some Overall Conclusions

The SURICATES Project

- **SURICATES – Sediment Uses as Resources In Circular And Territorial Economies (2018-2023)**
- Funding Programme: EU Interreg NWE
- Aim to increase sediment reuse for erosion & flood protection
- A range of tools were developed, and supported and complemented by Pilot Sites
- Tools developed include:
 - **GIS Social Impact (RAIES)**
 - **Direct Cost & Sediment Suitability (USAR)**
 - **Economic Model (SedEcon)**
 - **Environmental Impact (BROADSEAT)**
- Integrated decision-making tools to inform the sediment management sector.



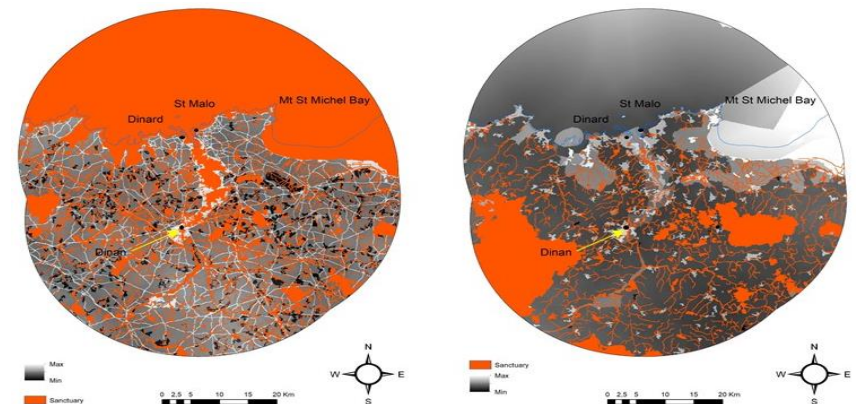
Overall Approach

Develop and apply a suite of tools for assessment purposes to a number of sediment management projects/sites across the SURICATES Partner Countries (Ireland, Scotland, France and The Netherlands)

Tool	Summary Output	Output Units
GIS – RAIES University of Lille	Geographical Location Acceptability Score on GIS map	Geo - coordinates Numerical Acceptability Score (Colour Coded)
Direct Cost – USAR IMT de Douai	Suitability of Application Indicative Direct Cost	Y/N €
Economic – SedEcon Munster Technological University	Direct, Indirect & Induced Contributions to GDP/No. of Jobs Created	€, No. of Jobs
Environmental – BROADSEAT University of Strathclyde	Energy, Waste, Environmental & Societal Rating	Numerical Score

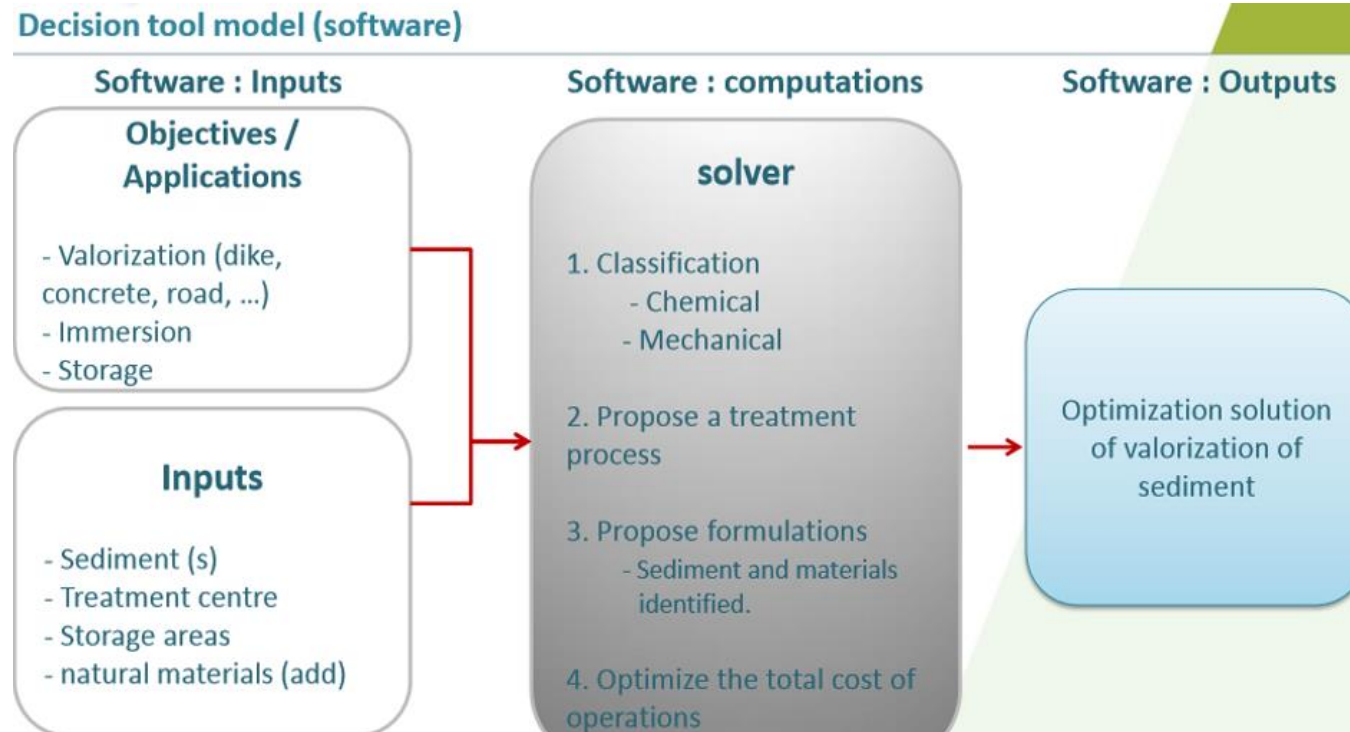
The GIS Tool (RAIES) – An Overview

- Developed by the University of Lille, France
- The **RAIES (Repulsion-Attraction-Included-Excluded-Sanctuarised) GIS tool** aims to provide different stakeholders with a GIS solution to help them find the best location(s) for sediment reuse projects
- It uses a spatial decision support system, which determines the best location available based on inputs from stakeholders
- It uses GIS layers as inputs and provides geographic output
- It provides theoretical relationships between a specific location and an object in a GIS layer (based on stakeholder opinion)
- A multicriteria tool following Nimby/Yimby principles.



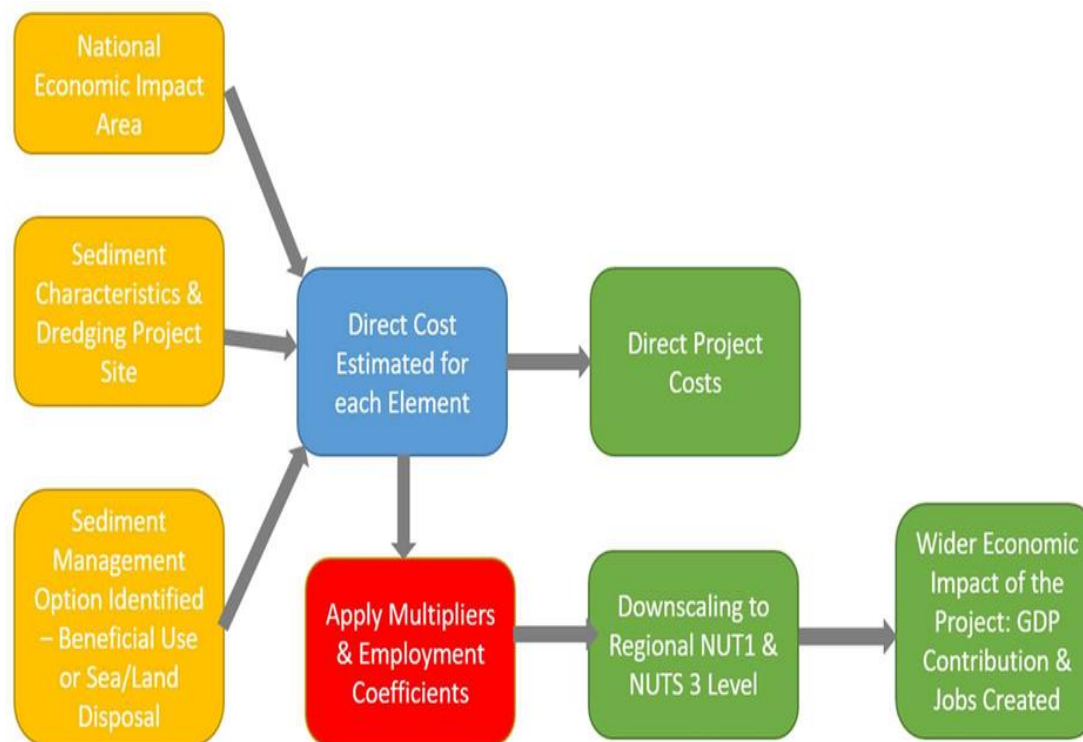
The Direct Cost Tool (USAR) – An Overview

- **Developed by IMT de Douai, France**
- USAR helps the decision making process for dredged sediment management
- Selection of the most suitable sediment management option is based on criteria including sediment granulometry & chemical characteristics, project costs, environmental criteria, site locations and local & national regulations
- USAR output is an optimised solution for a sediment reuse project with associated direct costs



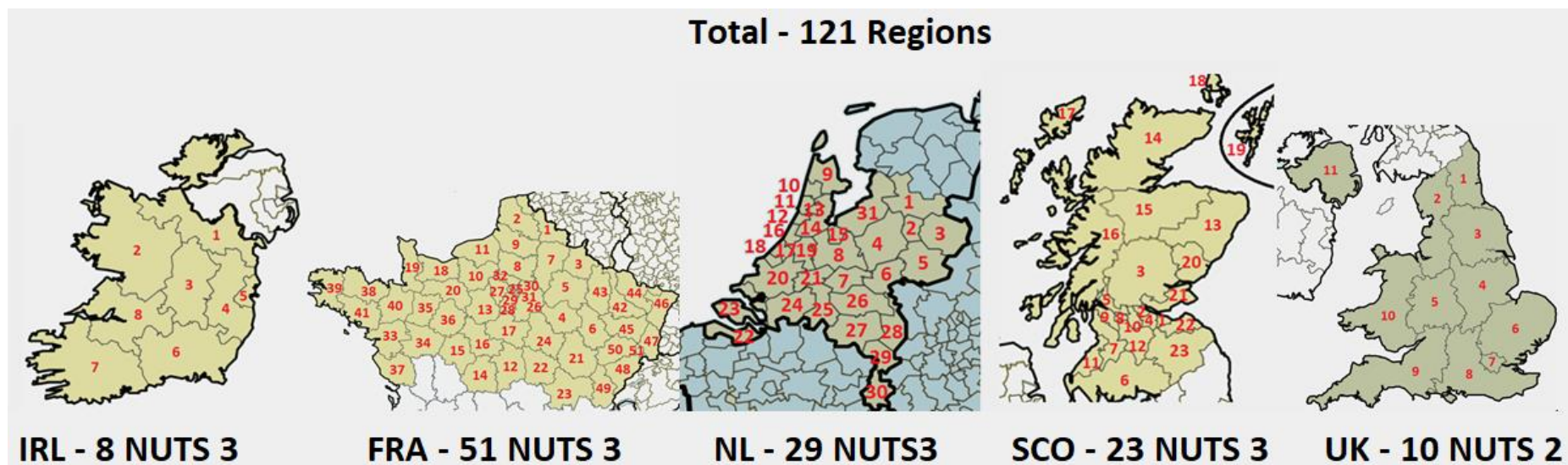
The Economic Tool (SedEcon) – An Overview

- **Developed by Munster Technological University, Ireland**
- The model focuses on the **Economic Analysis and Evaluation** of sediment management projects
- The approach used is based on **Multipliers** derived from input-output analysis of economic activity
- These input-output models generate a **Multiplier Index** that measures the total effect of an increase in investment on employment or income
- The model has been developed for application in the SURICATES Partner Countries of Ireland, Scotland, France and the Netherlands (and the United Kingdom).



SedEcon - Geographic Spread and Downscaling

- SedEcon is downscaled to a regional NUTS 3 level (except with the UK at NUTS 2 level)
- Application of the Simple Location Quotient approach allows quantification of the concentration of a particular industry or occupation in a region compared to at the national scale.



The Environmental Tool (BROADSEAT) – An Overview

- **Developed by the University of Strathclyde, Scotland**
- BROADSEAT (Beneficial Reuse Of Any Dredged Sediment Environmental Assessment Tool)¹ is designed to analyse the environmental merits of a beneficial use dredging project
- It compares a real or hypothetical ***Beneficial Reuse Option (BRO) to the Business as Usual (BAU) Case***
- It is a qualitative assessment on a binary scale – ‘the better’/’the same’/’worse’
- 54 stakeholder questions are grouped into 4 main categories - Energy, Waste, Environment, Societal
- 10 subcategories - transport, energy, circular economy, waste management, waste regulation, water environment, ecosystem services, biodiversity & conservation, socio-economic impacts and UN Sustainable Development Goals (SDGs)
- The resulting score comparing the *BRO* to *BAU*.

¹ Lord R, Torrance K (2022) BROADSEAT (Beneficial Reuse Of Any Dredged Sediment Environmental Assessment Tool). University of Strathclyde.
<https://doi.org/10.15129/2e620d12-44bc-42fb-9b14-b0e89a8a7457>

Tools Application to Specific Projects/Sites

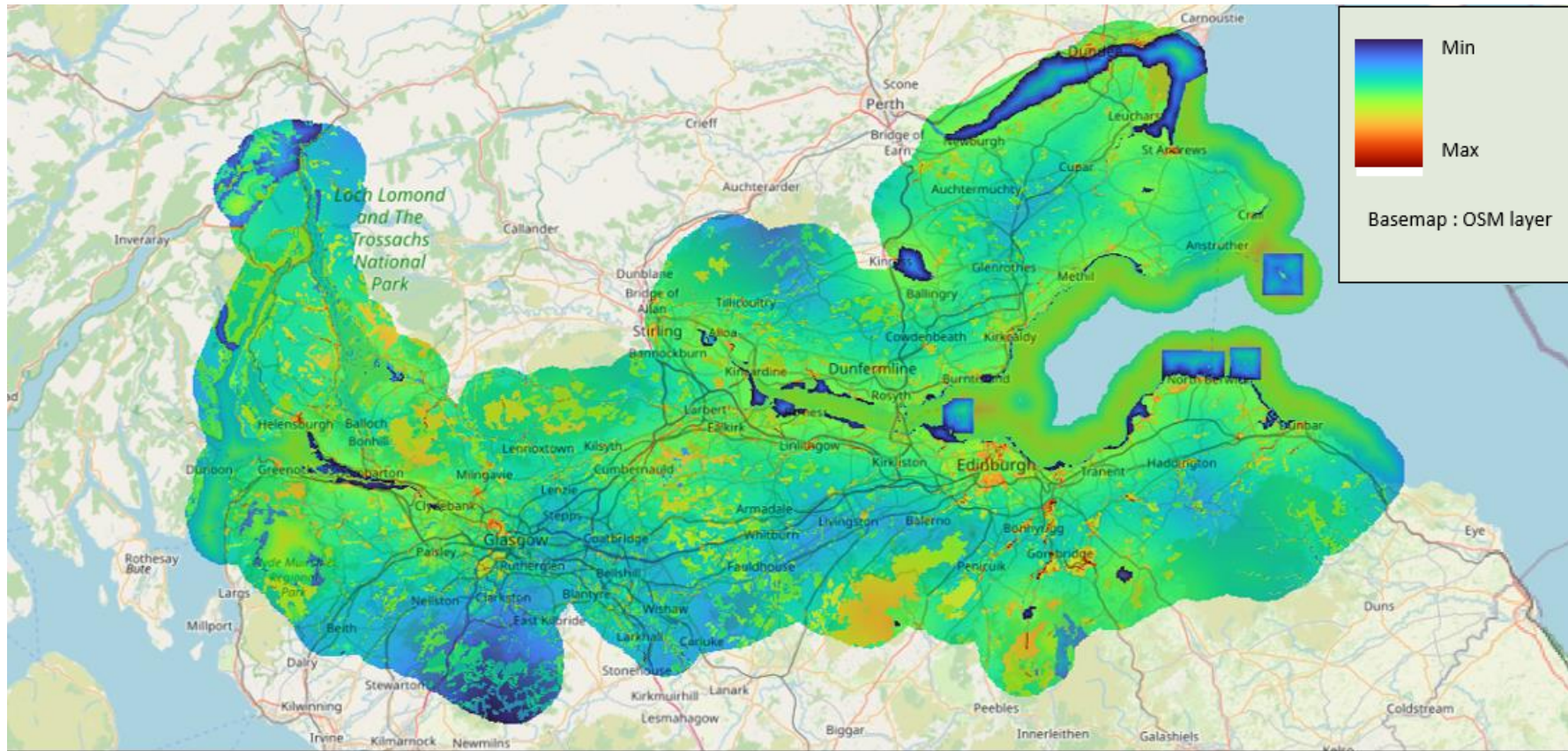
SURICATES Partner Country	Pilot Site/Case Study	Site Owner	SURICATES Partner(s) Responsible	Sediment Management Application
Scotland	Falkirk	Scottish Canals	Scottish Canals & University of Strathclyde	Bioremediation
Ireland	Port of Fenit	Port of Fenit, Kerry County Council	Munster Technological University	Disposal at Sea Dyke Construction Wetland Nourishment
The Netherlands	Port of Rotterdam	Port of Rotterdam	Port of Rotterdam & Deltares	Sediment Reallocation
France	Port of Calais	Port of Calais	IMT Douai BRGM	Land Reclamation Breakwater Construction

Falkirk Site, Scotland - General Description

Item	Description
Dredging Approach	Mechanical
Sediment Volume	533 m ³
Dewatering method	Natural
Treatment method	Phytoconditioning
Transport	Water transport (1.8 km) + Road transport (38km)



GIS Tool Output - Falkirk



Interviewee: Paul Berry, Scottish Canals

Summary Tools Output – Falkirk Project

TOOL		OUTPUT	VALUE		
RAIES		Suitability/Acceptability Score	Graphical Output		
	SedEcon	Direct contribution to GDP	€ 57,343		
Indirect contribution to GDP		€ 31,162			
Induced contribution to GDP		€ 2,697			
Direct jobs created		0.41 FTE			
Indirect jobs created		0.21 FTE			
Induced jobs created		0.02 FTE			
Overall cost per m ³		€ 108			
Overall cost per tonne		€ 67.5			
USAR		Sediment chemical properties suitability for chosen application	✓		
		Sediment physical properties suitability for chosen application	✓		
		Overall cost per tonne	€ 59.24		
		Transport cost per tonne	€ 9.24		
BROADSEAT	Energy rating [-100:100]		BAU (Landfill Disposal)	BRO	Difference
			-4	+4	+8
	Waste rating [-100:100]		+52	+68	+16
	Environment rating [-100:100]		+32	+28	-4
Societal rating [-100:100]		+64	+56	-8	

Some Conclusions – Falkirk Project

- Application of tools successful and shows feasibility of the Tools Application concept
- The application of the models to a small scale project has confirmed that the selected phytoconditioning application is suitable for the sediment dredged from a canal environment
- The estimated modelled overall direct cost using SedEcon agrees well with the actual project cost (model validation achieved)¹
- BROADSEAT indicates positive energy, waste & environment ratings with a slightly negative rating for the societal category.

¹Harrington, J. et al.:

[A downscaled economic model validated and applied to sediment management projects in Ireland and Scotland](#)

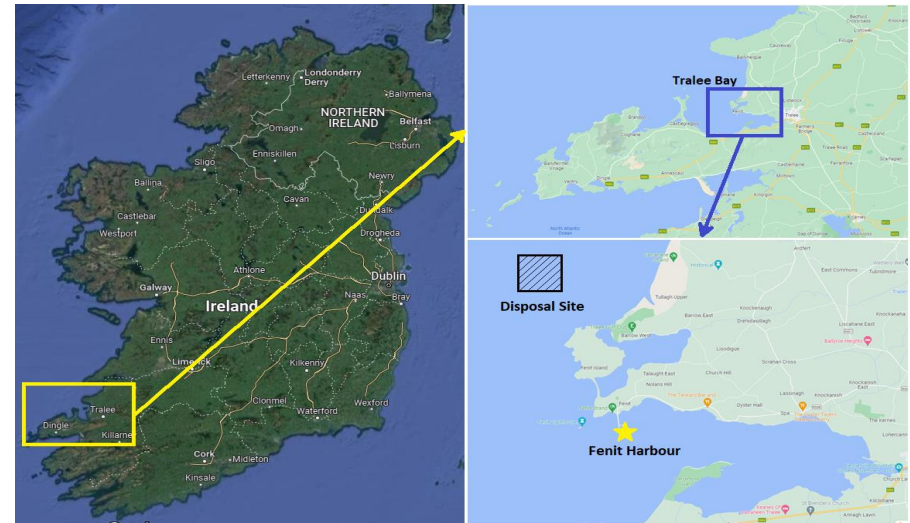
Journal of Soils and Sediments. 2022

DOI: 10.1007/s11368-022-03267-z



Port of Fenit, Ireland - General Description

- The Port of Fenit is a mixed function seaport with ongoing maintenance dredging – 1m tonnes of dredging planned
- Dredge Sediment Scenarios:
 - Disposal at Sea – ‘Business as Usual’
 - Wetland Nourishment
 - Dyke Construction



Port of Fenit – Disposal at Sea & Wetland Nourishment

Disposal at Sea

Item	Description
Dredging Approach	Hydraulic Dredger
Sediment Volume	200,000 m ³
Transport	Water Transport (7 km)

Wetland Nourishment

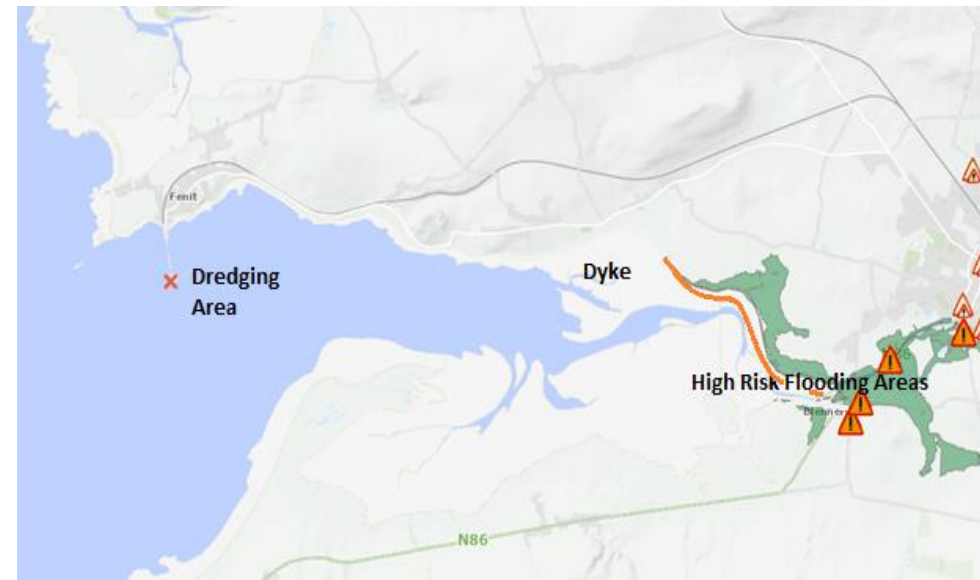
- The nearby wetland area covers approximately 314 hectares and contains silts and clays
- Finer sediments from the Port are potentially suitable for nourishing/enhancing existing valuable wetlands the Bay
- The nearby wetland area covers approximately 314 hectares and contains silts and clays

Item	Description
Dredging Approach	Hydraulic Dredger
Sediment Volume	200,000 m ³
Transport	Water Transport (2.5 km)



Port of Fenit – Dyke Construction

- Flood protection dyke proposed for a coastal stretch with a high probability of flooding (Ref: Irish Office of Public Works) – approx. 4km long dyke, 6m dyke height



Item	Description
Dredging Approach	Hydraulic Dredger
Sediment Volume	200,000 m ³
Imported Rock Volume	24,400 m ³
Dewatering Method	Natural
Transport	Water Transport (dredged sediment - 7km) + Road Transport (rock import – 11km)

Overall Summary Output – Port of Fenit

MODEL	OUTPUT	Disposal at Sea	Wetland Nourishment	Dyke Construction
RAIES	Suitability/Acceptability Score	Graphical Output	Graphical Output	Graphical output
SedEcon	Direct contribution to GDP	€ 1,708,000	€ 2,217,000	€ 6,492,000
	Indirect contribution to GDP	€ 1,002,000	€ 1,251,000	€ 3,722,000
	Induced contribution to GDP	€ 82,100	€ 108,860	€ 327,800
	Direct jobs created	12.19 FTE	13.45 FTE	36.96 FTE
	Indirect jobs created	7.59 FTE	7.79 FTE	21.34 FTE
	Induced jobs created	0.60 FTE	0.67 FTE	1.88 FTE
	Overall cost per m ³ (including transport)	€ 8.54	€ 11.09	€ 32.46
	Overall cost per tonne (including transport)	€ 5.34	€ 6.93	€ 20.29
USAR	Sediment chemical properties suitability for chosen application	✓	✓	✓
	Sediment physical properties suitability for chosen application	✓	✓	✓
	Overall cost per tonne	€ 2.5	€ 2.2	€ 9.49
	Overall Cost	€ 800,000	€ 704,000	€ 2,254,800
BROADSEAT	Energy rating [-100:100]	0	+4	-44
	Waste rating [-100:100]	0	+12	+12
	Environment rating [-100:100]	0	+16	+28
	Societal rating [-100:100]	0	+52	+44

Some Conclusions – Port of Fenit

- USAR assessed sediment physical & chemical properties as suitable for the scenarios investigated
- Disposal at sea provides the lowest direct cost
- Wetland nourishment provides the highest positive rating based on BROADSEAT
- SedEcon indicates that dyke construction provides the largest economic impact (but would be the most challenging in other ways)¹.

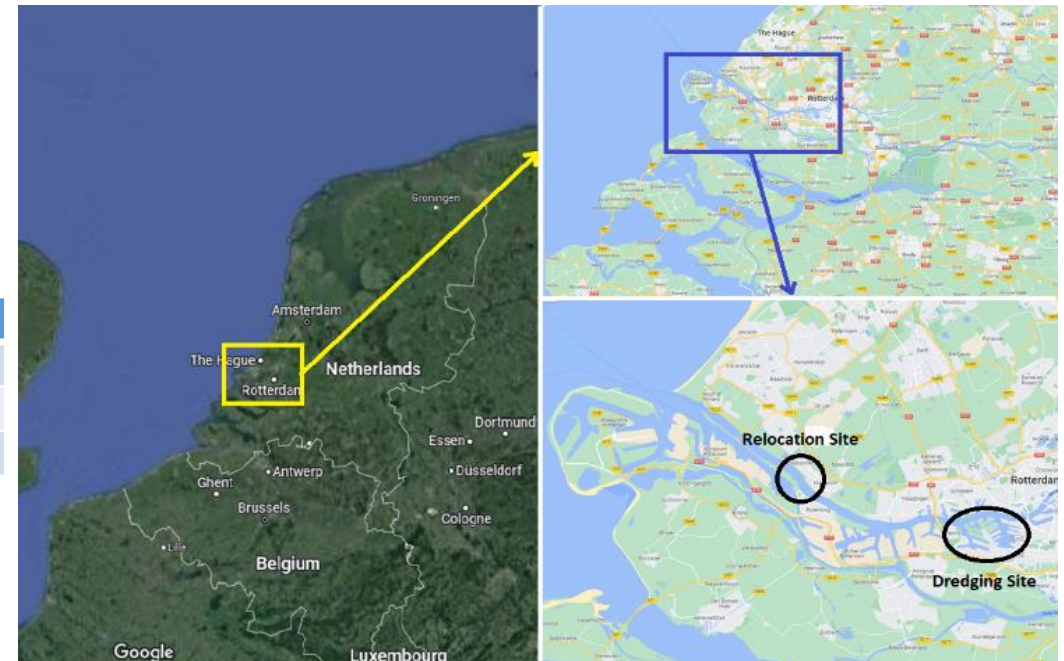
¹ Harrington et al. (2022), *The Application of a Downscaled Economic Model for Sediment Management Projects in Ireland and The Netherlands*, CERl 2022 Conference, Dublin, Ireland.



Port of Rotterdam (PoR), The Netherlands - General Description

- Large-scale pilot project involving dredging and reallocation of approximately 500,000 m³ of sediment

Item	Description
Dredging Approach	Hydraulic Dredger (Port Owned <i>Ecodelta</i>)
Sediment Volume	500,000 m ³
Transport	Water Transport (10 km)



MODEL	OUTPUT	VALUE		
RAIES	Suitability/Acceptability Score	Graphical Output		
SedEcon	Direct contribution to GDP	€ 1,212,000		
	Indirect contribution to GDP	€ 675,300		
	Induced contribution to GDP	€ 61,700		
	Direct jobs created	10.22 FTE		
	Indirect jobs created	6.41 FTE		
	Induced jobs created	1.44 FTE		
	Overall cost per m ³	€ 2.42		
	Overall cost per tonne	€ 1.51		
USAR	Sediment chemical properties suitability for chosen application	✓		
	Sediment physical properties suitability for chosen application	✓		
	Overall cost per tonne	€ 6.33		
	Transport cost per tonne	€ 1.33		
BROADSEAT	Energy rating [-100:100]	BAU (Sea Disposal)	BRO	Difference
		0	+86	+86
	Waste rating [-100:100]	0	+24	+24
	Environment rating [-100:100]	0	+75	+75
Societal rating [-100:100]	0	+44	+44	

Some Conclusions – Port of Rotterdam

- SedEcon estimated the overall direct cost/contribution to GDP as in general agreement with the actual project cost (further validation of the economic tool)¹
- BROADSEAT model ranked this sediment management approach very positively in the Energy and Environment categories.

¹ Harrington et al. (2022), *The Application of a Downscaled Economic Model for Sediment Management Projects in Ireland and The Netherlands*, CERI 2022 Conference, Dublin, Ireland.



Port of Calais, France - General Description

- Large scale dredging/development project including:
 - Breakwater (> 3 km long)
 - 170-hectare berthing basin
 - 45 hectares land reclamation
 - 3 new ferry berths
 - rail-road-sea infrastructure

An Indicative Analysis

Item	Description
Dredging Approach	Hydraulic
Sediment Volume	4,000,000 m ³
Transport	Pipeline transport (2.5 km) + Road transport (2 km)
Land reclamation	2,400,000 m ³ (60% sediment)
Breakwater construction	1,600,000 m ³ (40% sediment)
Rock Import	170,000 m ³ (30 km)



Summary Output – Port of Calais

TOOL	OUTPUT	VALUE		
RAIES	Suitability/Acceptability Score	Graphical Output		
SedEcon	Direct contribution to GDP	€ 111,800,000		
	Indirect contribution to GDP	€ 89,600,000		
	Induced contribution to GDP	€ 14,100,000		
	Direct jobs created	585 FTE		
	Indirect jobs created	469 FTE		
	Induced jobs created	75 FTE		
	Overall cost per m ³	€ 27.95		
	Overall cost per tonne	€ 17.2		
USAR	Sediment chemical properties suitability for chosen application	✓		
	Sediment physical properties suitability for chosen application	✓		
	Overall cost per tonne	€ 6.82		
	Overall Cost	€ 43,700,000		
BROADSEAT	Energy rating [-100:100]	BAU (Landfill Disposal)	BRO	Difference
		-4	+4	+8
	Waste rating [-100:100]	+52	+68	+16
	Environment rating [-100:100]	+32	+28	-4
Societal rating [-100:100]	+64	+56	-8	

Some Conclusions – Port of Calais

- This actual large-scale project was simplified significantly, for tools application purposes
- Tools results are indicative but demonstrate potential application
- BROADSEAT indicates very positive societal & environment ratings and positive ratings for the energy & waste categories.



Some Overall Conclusions

- A suite of tools has been developed in the SURICATES project to assess Social Impacts, Sediment Suitability and Direct Cost, GDP and Employment Economic Impact and Environmental Impact for Sediment Management Projects
- Tools have been applied to a range of sediment management projects:
 - Falkirk Site (Phytoremediation)
 - Port of Fenit (Disposal at Sea, Wetland Nourishment, Dyke Construction)
 - Port of Rotterdam (Sediment Reallocation)
 - Port of Calais (Breakwater Construction & Land Reclamation)
- Each tool has its own strengths and limitations
- This integrated set of tools can provide new insights into the assessment of sediment reuse projects and strategies and can provide the stakeholder community and the decision-making process with an additional resource.

Acknowledgements

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Thank You