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Economic modelling of the management of dredged marine sediments

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Outline of Presentation

- Introduction
- The Economic Model, Framework & Structure
- Direct Project Costs
- Economic Impacts
- Modelling Application to Land Reclamation (Ireland)
- Modelling Application to Disposal (The Netherlands)
- Conclusions

Introduction

- Economic importance of dredging to ports and harbours
- Sediment management is a key feature of dredging projects
- A range of dredge sediment management options are available
- Influencing factors for sediment management include:

    Technical

    Economic

    Environmental

    Legislative

    Societal

- The focus here is on the **Economic Aspect**
- Work undertaken as part of the CEAMaS Project under Work Package 3

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Economic Modelling

- An economic model has been developed to allow the modelling of Specific Civil Engineering Applications.

- Available direct unit costs have been gathered for the Partner Countries

  → **Model Output: Direct Project Costs**

- Economic multiplier and wage data gathered (where available) for the individual Partner Countries

  → **Model Output: Wider Economic Impact**

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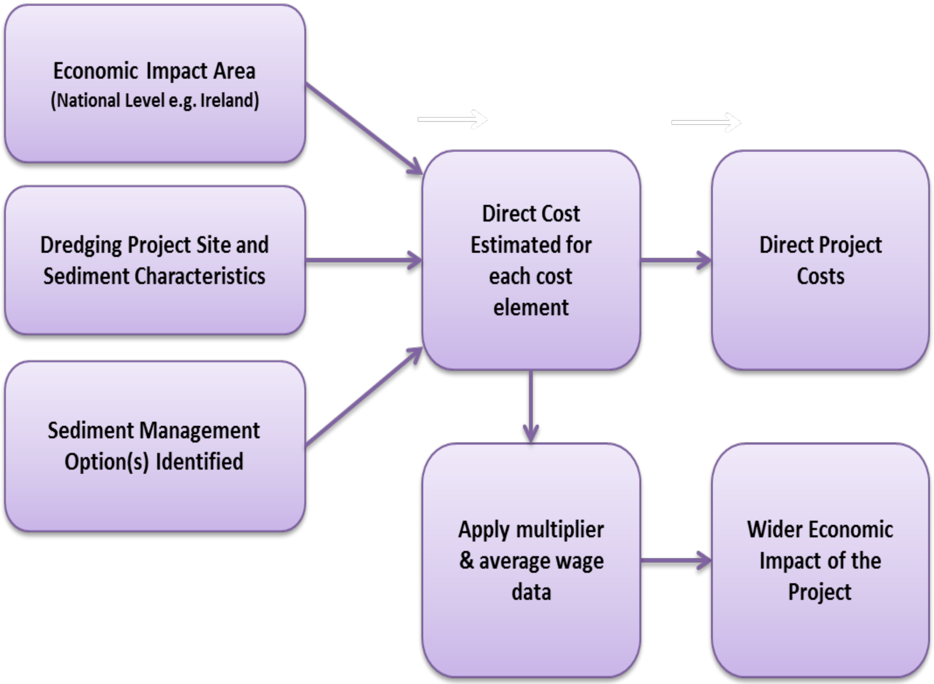
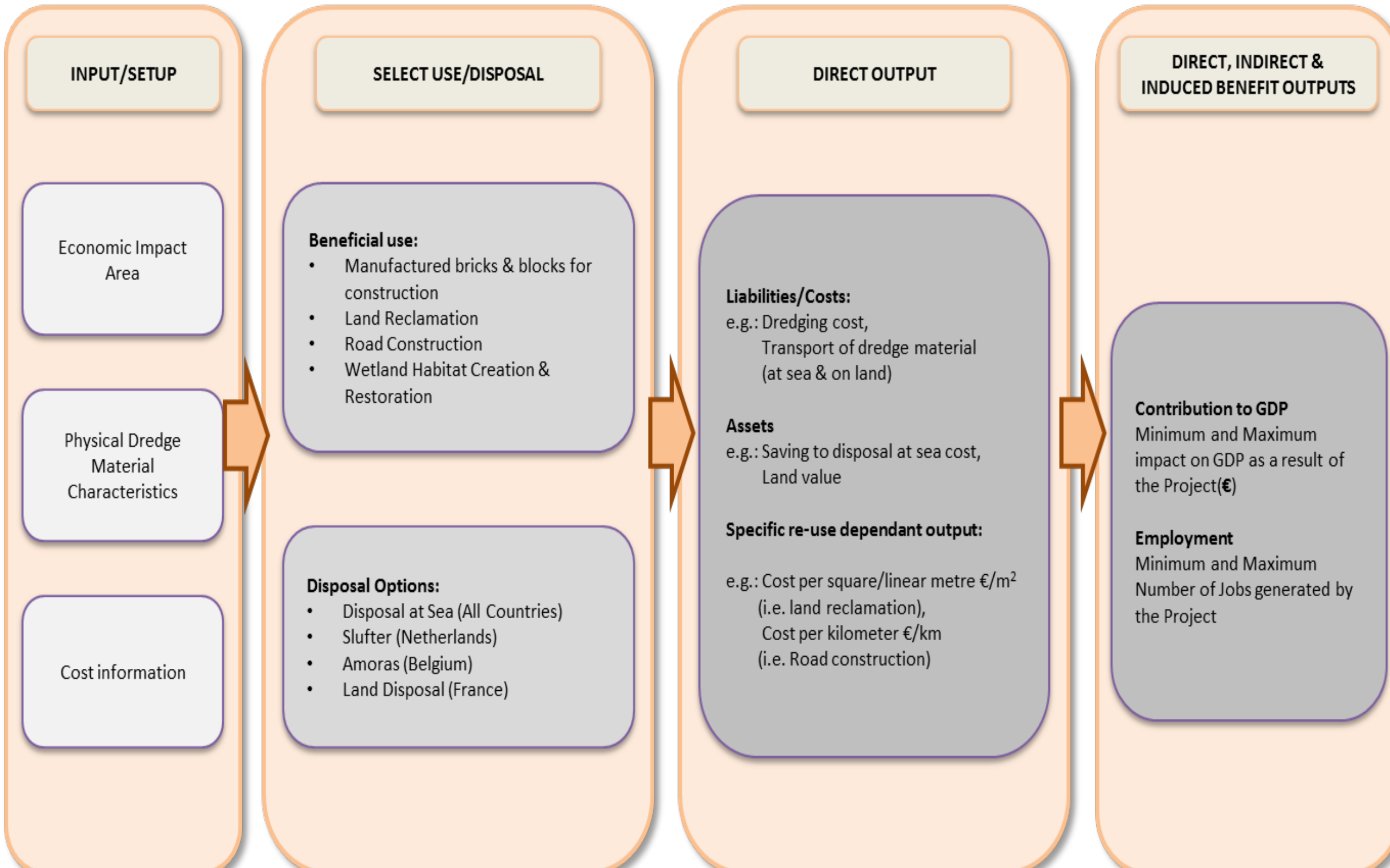
The Economic Model – General Framework

General Modelling Approach:

- Identification of the National Economic Impact Area
- Identification of the dredging site and its sediment characteristics
- Preliminary selection of the potentially feasible sediment management options
- Direct costs and indirect benefits forms the model output based on multipliers derived from input-output analysis of economic activity



The Economic Model – Model Structure



The Economic Model – Direct Project Costs

Management Process Step		Cost
Disposal costs on land [€/TMS]	Inert waste storage	1[8]
	Environmental tax	75[12]
Disposal at sea [€/m^3]		€0.17[8]
Disposal at Sea Charges [€]		2000-18000[16]
Licencing fees and Charges [€]*		30000[8]
Water transport cost [€/m^3/km]		0.06 – 1.0[8]
Unloading costs [€/m^3]	Non-mechanical	0.76[8]
	Mechanical	4.0[8]
Land transport cost [€/t/km]	Road - Rural Conditions	0.04[8]
	Road - Urban Conditions	0.09[8]
Dredger mobilization [€]		70000[8]
Pipeline Mobilization [€]		80-90[8]
Dredging cost [€/m^3]		3[8]
Pumping/Rainbowing cost [€/m^3]		1.30 – 1.50[8]
Environmental Assessment [€]		15000
Monitoring [€]		35000
Sampling cost [€/Sample]		500
Analysis cost [€/Sample]		610

[8] Sheehan C. (2008), An analysis of Dredge material Reuse Techniques for ireland - DMMAP
[12] Department of the Environment, Community and Local Government – Landfill levy
[11] RPS Ireland (2011), Dunmore East Dredging Study
[16] Irish Dumping at Sea (Fees) Regulations 2012
*Including the Irish Environmental Protection Agency Licence fee, the Foreshore licence Fee and other permitting costs.

The Economic Model – Economic Impacts

- **Economic Impacts**

Contribution to **GDP** and **Impact on Employment**

Direct Contribution

Employment directly related to the Project

Indirect Contribution

The ‘supplier’ effect, upstream & downstream

Type I Industry Multipliers applied

Induced Contribution

Employment created by the expenditure
induced effects within the general economy
Type II Industry Multipliers applied

Economic Impact – Direct Contribution

The GDP is estimated based on expenditure (i.e. how much money is invested in the sector for the specific beneficial use project).

The direct jobs generated include those associated with the project work, and, for example, any additional jobs in research and development etc.

The number of direct jobs created may then be estimated as follows:

*NDJ = (DCGDP) * CE / AAW (for each sector identified with beneficial use)*

where:

NDJ = Number of Direct Jobs

DCGDP = Direct Contribution to GDP (€)

CE = Compensation for Employees

AAW = Annual Average Wage (€)

Economic Impact – Indirect Contribution

The contribution to GDP is calculated by applying specific appropriate multipliers (**Type 1**) to the economic sectors with the inter-sector linkages with the project.

Indirect employment refers to the "supplier effect" of upstream and downstream suppliers including employment in other sub-sectors of the industry such as the manufacture of components for infrastructure and the provision of services.

The number of indirect jobs created can then be estimated based on the following equation:

$$NIDJ = (ICGDP) * \text{National Average CE} / NAW$$

where:

NIDJ = Number of Indirect Jobs

ICGDP = Indirect Contribution to GDP (€)

NAW = National Average Wage (€)

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Economic Impact – Induced Contribution

The contribution to GDP is derived using the same multiplier approach using adjusted Leontief **Type II** multiplier data (which is available for Scotland).

Induced employment effects are jobs created by the expenditure induced effects within the general economy due to the increased economic activity associated with the project and the spending of both direct and indirect employees including non-industry jobs.

The number of induced jobs created can then be estimated based on the following equation:

*NINJ = INCGDP * National Average CE / NAW*

where

NINJ = Number of Indirect Jobs

INCGDP = Induced Contribution to GDP (€)

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CEAMaS
Civil Engineering Applications for Marine Sediments

Economic Multiplier & Wage Data

NACE Code	Definition	Ireland	Belgium	UK
43	Construction & construction works	1.70	2.47	1.77
28	Machinery & equipment n.e.c.	1.30	1.75	1.65
26	Computer, electronic & optical products	1.17	1.71	1.67
71	Architectural & engineering services	1.46	1.84	1.63
74	Other professional, scientific services	1.68	2.14	1.52
49	Land transport services	1.70	1.72	1.64
50	Water transport services	1.71	2.90	1.98
52	Warehousing	1.69	1.82	1.92

Type 1 Multiplier Data

CEAMaS Partner Countries	Multipliers		Wage Data/Multiplier
	Type I	Type II	
Belgium	✔		✔
France	Belgian Multipliers		Belgian method/data
Ireland	✔	Adjusted Scottish Multipliers	✔
The Netherlands	Belgian Multipliers		Belgian method/data
UK	✔		✔

Summary of Multiplier Data Applied

Sediment Management Scenarios Modelled

CEAMaS Partner Country	Beneficial Use Scenarios							
	Land Reclamation	Wetland Creation/ Building with Nature	Brick Manufacture	Road SubBase Construction	Amoras	Slufter/ Disposal on Land	Underwater Cell	Disposal at Sea
Belgium					●			●
France			●	●		●		●
Ireland	●	●						●
The Netherlands						●	●	●

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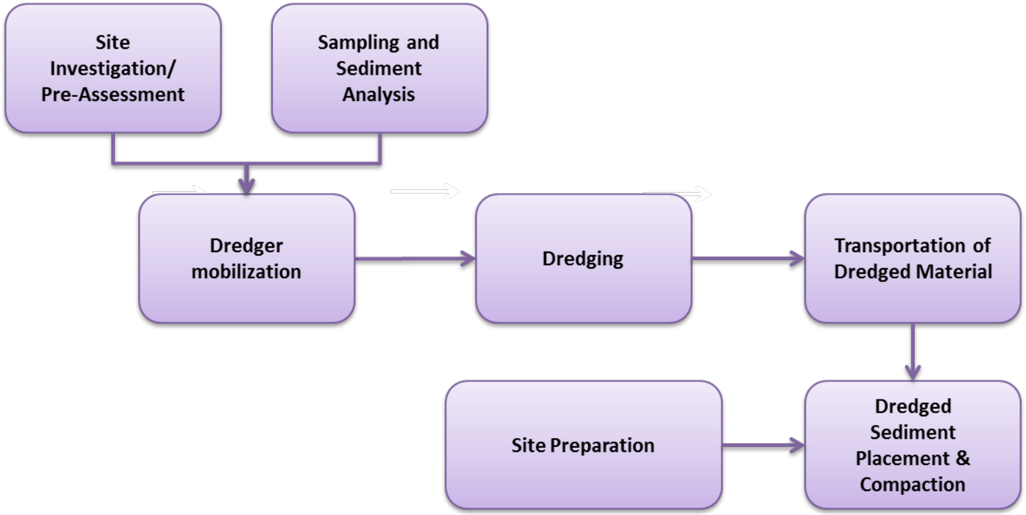
CEAMaS Civil Engineering Applications for Marine Sediments

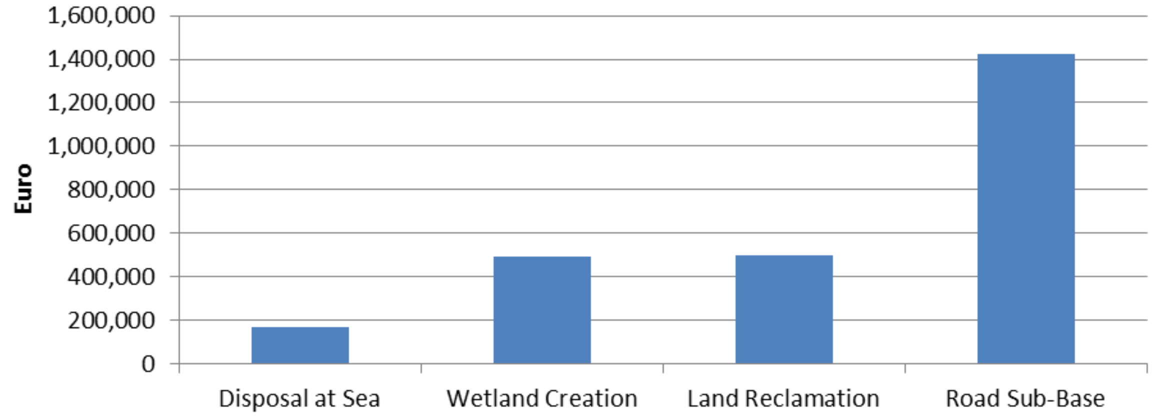
An Application to Land Reclamation (Ireland)

- General Project Details:
  - Dredged volume of 100,000m^3
  - Uncontaminated sediment, suitable for land reclamation
  - Dredge site close to land reclamation area (2km)
  - Disposal at Sea option (10km sail distance assumed)
  - Alternative quarry based material source (10km trucking distance)



Comparison of Modelled Scenarios for Ireland

- Dredged volume of 10,000m^3



- Disposal at Sea typically provides lowest direct cost
- Other management options potentially economically feasible under certain circumstances
- Other management options provide greater economic impact
- Environmental & societal impacts not included in this analysis

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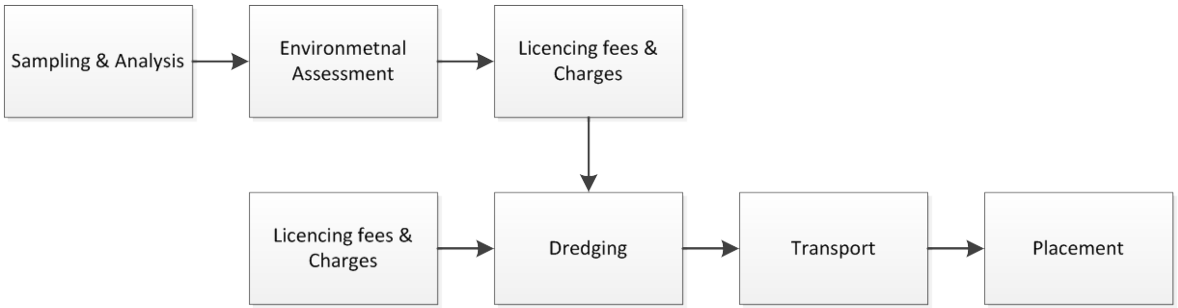
An Application to Disposal (The Netherlands)

General Project Details:

- Dredged volume of 100,000m^3
- Sediment Quality may vary
- Disposal may be to an underwater cell or to the Slufter



Conclusions

- An economic model has been developed including direct costs and a range of economic impacts
- The model has been applied to a range of sediment management scenarios for the CEAMaS partner countries
- The cost input information is indicative only
- Model results show the potential economic impact (on GDP and employment) of a range of sediment management scenarios
- The optimum dredged sediment management solution will depend on the specific site conditions
- The model has the capacity to provide results for a wide range of site conditions and different scenarios

- Economic modelling results need to be considered in the context of the broader environmental and societal impacts and the needs and requirements of the stakeholder community.

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CEAMaS
Civil Engineering Applications for Marine Sediments

Acknowledgements

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Sources of Economic Data

Irish Central Statistics Office

United Kingdom Office for National Statistics

Scottish Government's National Statistics Office

Belgium Federal Planning Bureau

CEAMaS Project Partners

Belgian Building Research Institute (BBRI), Belgium

Bureau de Recherches Géologiques et Minières (BRGM), France

Création Développement Eco-Entreprises (cd2e), France

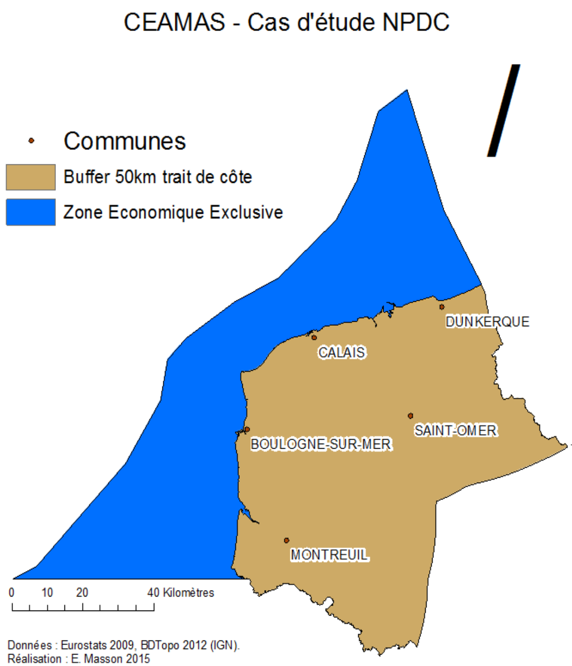
Ecole Centrale de Lille (EC Lille), France

Delft University of Technology (TU Delft), The Netherlands

Universite de Lille 1, France

Spatial Decision Support System

- Geographical Information System (GIS) based:
  - European GIS data sets
  - Upgraded with national/regional GIS data set



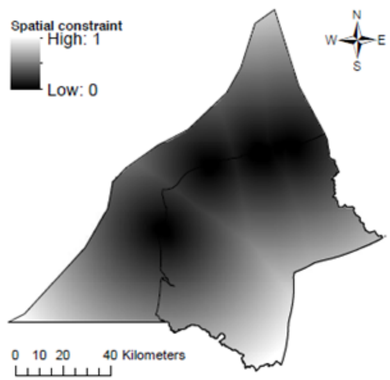
- French_Case
  - Positive_Constraints_TransportNetworks
  - Positive_Constaints_Industrial
  - Positive_Constraints_Coastal
  - Positive_Constraints_LandUse
  - Negative_Constraint_LandUse
  - Negative_Constaints_Industrial
  - Negative_Constraints_Nature
  - Negative_Constraints_Water
  - Legal_Constraints_Water
  - Legal_Constraints_Nature
  - Incitative_Economical_Constraints

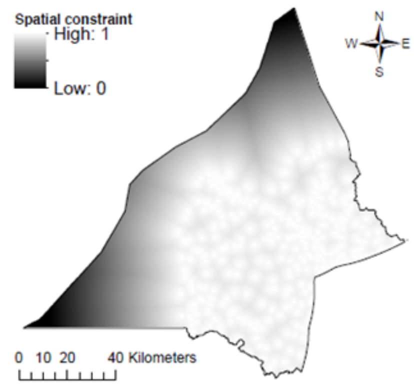
Spatial Decision Support System - Constraints

Attractiveness constraint

corresponds to an investigation of the proximity in relation to an attractive element in an urban, or regional context.

Ex.: Attractiveness constraint to ports





Repellence constraint

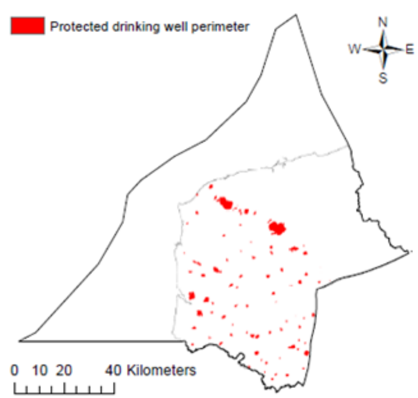
corresponds to an investigation of the remoteness in relation to a repellent element in an urban, or regional context.

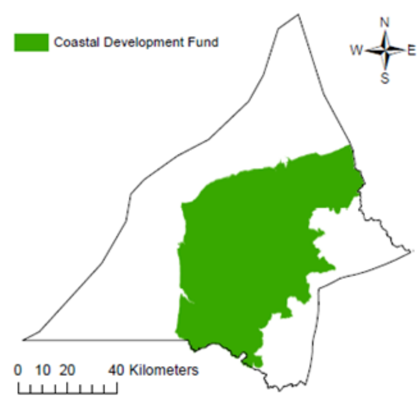
Ex.: Remoteness to drinking water wells

Regulatory constraint

is considered as a surface area to be excluded from the final scenario.

Ex.: Drinking water wells' protection perimeter



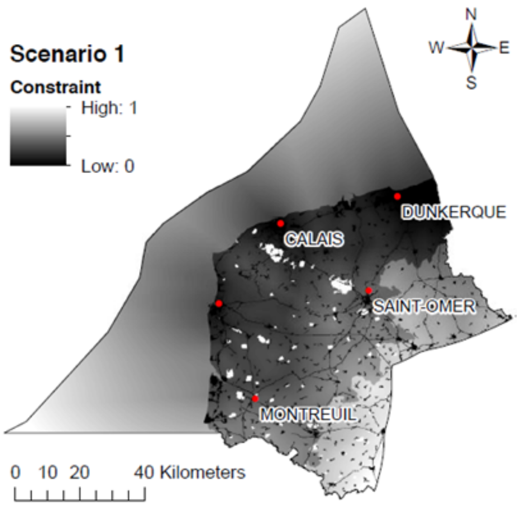


Incentive constraint

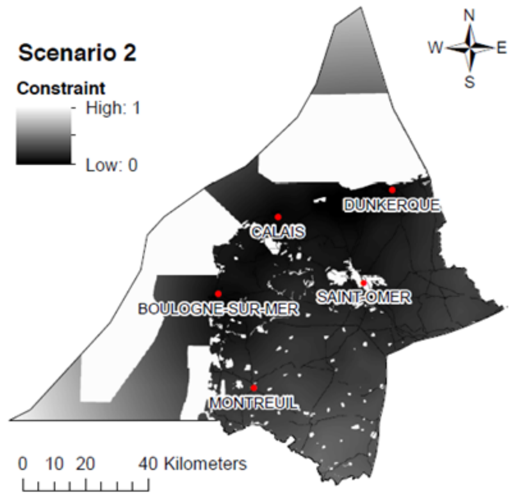
is considered as a surface area relevant to an opportunity (development fund, politics, soil use…) to plan the implantation of industrial or storage facilities.

Ex.: Coastal development fund area

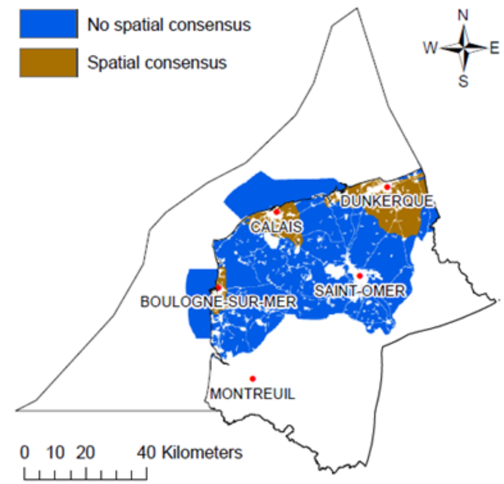
Spatial Decision Support System - Constraints



Scenario 1, where ports, roads, urban and coastal development fund are positive constraints, with respective weights of 0.3; 0.2; 0.1 and 0.1, and where aggregate quarries are negative constraints, with a weight of 0.3. Drinking wells protection perimeters are excluded from the area of interest (i.e. maximal constraint value of 1).



Scenario 2, where ports, roads, waterways and quarries are positive constraints, with, respectively, weights of 0.3, 0.2, 0.2 and 0.3. Drinking wells protection perimeters, Ramsar and Natura 2000 sites are excluded from the area of interest (i.e maximal constraint value of 1).



Spatial consensus. Here the spatial consensus is the result of a combination of both scenarios where a [0-0.2[constraint threshold has been applied for validation in each scenario.

Conclusions – Spatial Decision Support System

- The Spatial DSS is a GIS tool including:
  - Participation (decision makers-public)
  - User defined scenario building
  - Transparent and understandable GIS calculations
  - Adapted to multi-stakeholder decision making
  - Delivering spatial perception of individual environmental values

- This CEAMAS output is a contribution:
  - The wide community of sediment management
  - To cope with the spatial application of potential sediment re-use solutions