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Management of dredged marine sediments in southern France: main keys to large-scale beneficial re-use

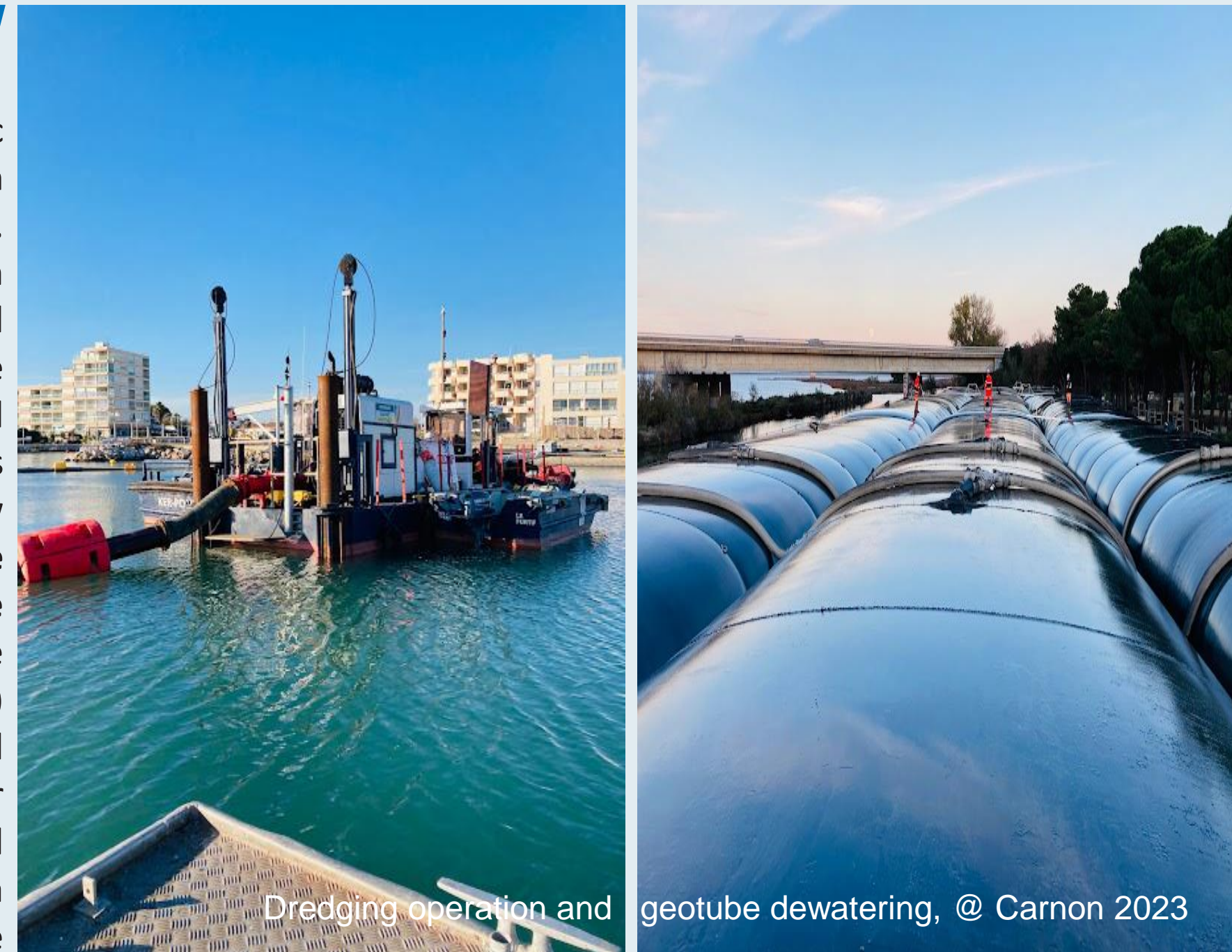
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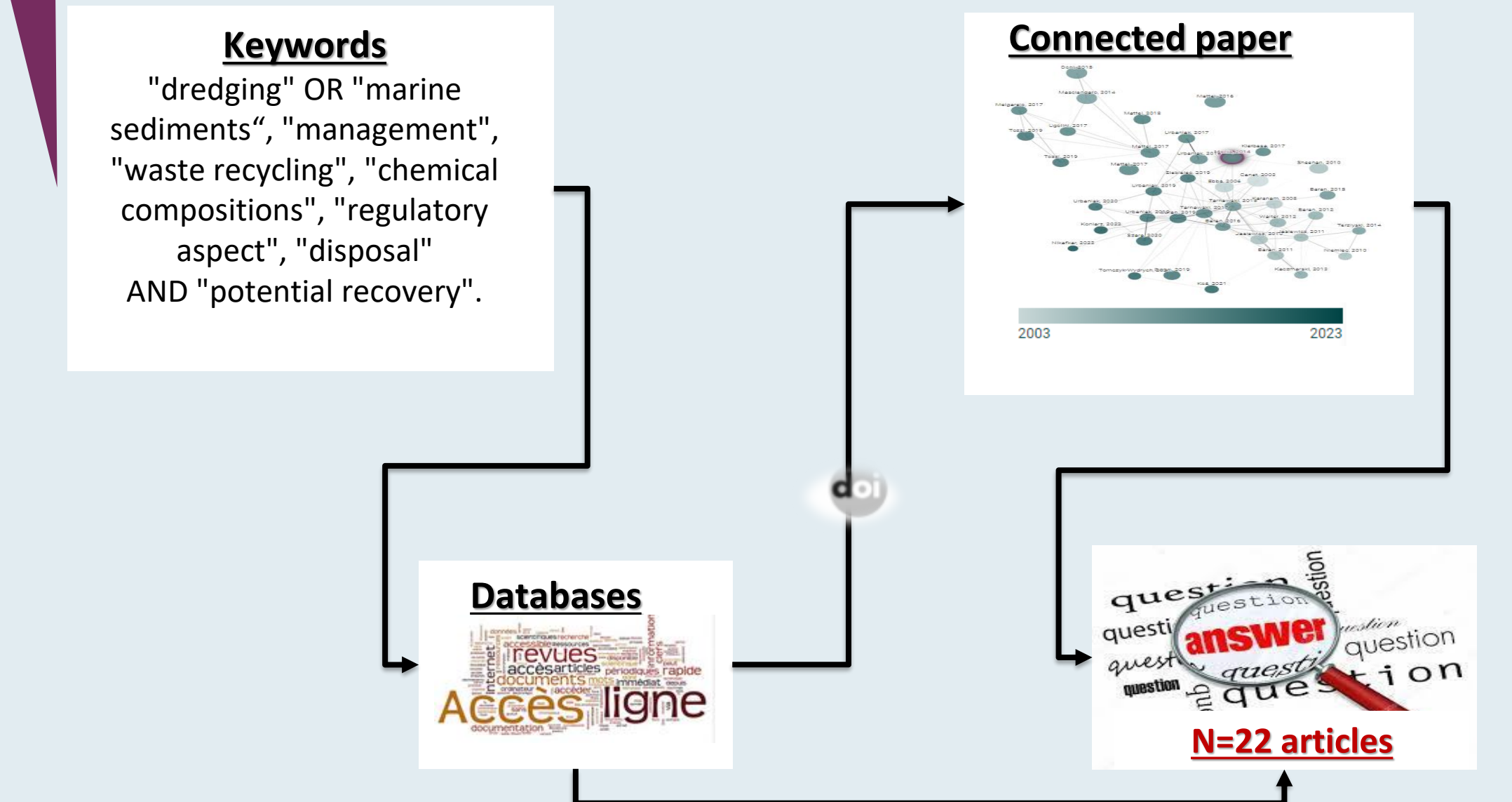
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Introduction

Dredging operations are essential to maintain harbor activities. Therefore, millions of cubic meters of sediments are dredged from harbors areas in France as worldwide each year in order to develop harbor activities and sustain the economy of littoral territories [1, 2]. Because of anthropogenic activities in and around these harbors, sediments are often enriched in pollutants that can be released when dredging and induce a risk for human and environment. French regulations come to govern the management of dredged marine sediments, considering them 'safe' and possibly to be dumped at sea or 'contaminated' and needed to be treated on land as waste [4]. However, sediments can be considered as valuable resources but they remain today lowly reused [5]. This poster offers an overview of the technical and regulatory aspects related to the management of dredged marine sediments in France and aims to determine why they are not fully reused as a resource and whether these barriers can be overcome. A review of the available literature on the subject made it possible to (1) describe the volume dredged in France and elsewhere, (2) summarize the French regulatory framework relating to the management of dredged marine sediments, (3) identify potential applications for their reuse with regard to their physicochemical properties, (4) appreciate the economic aspect of recycling dredged sediments, (5) determine the bottlenecks explaining why they are not fully reused as a resource, and (6) make some recommendations on future policy options for the sustainable management of dredged sediments.



Method: literature review on the subject



Results

1. Production of dredged marine sediments in France and abroad

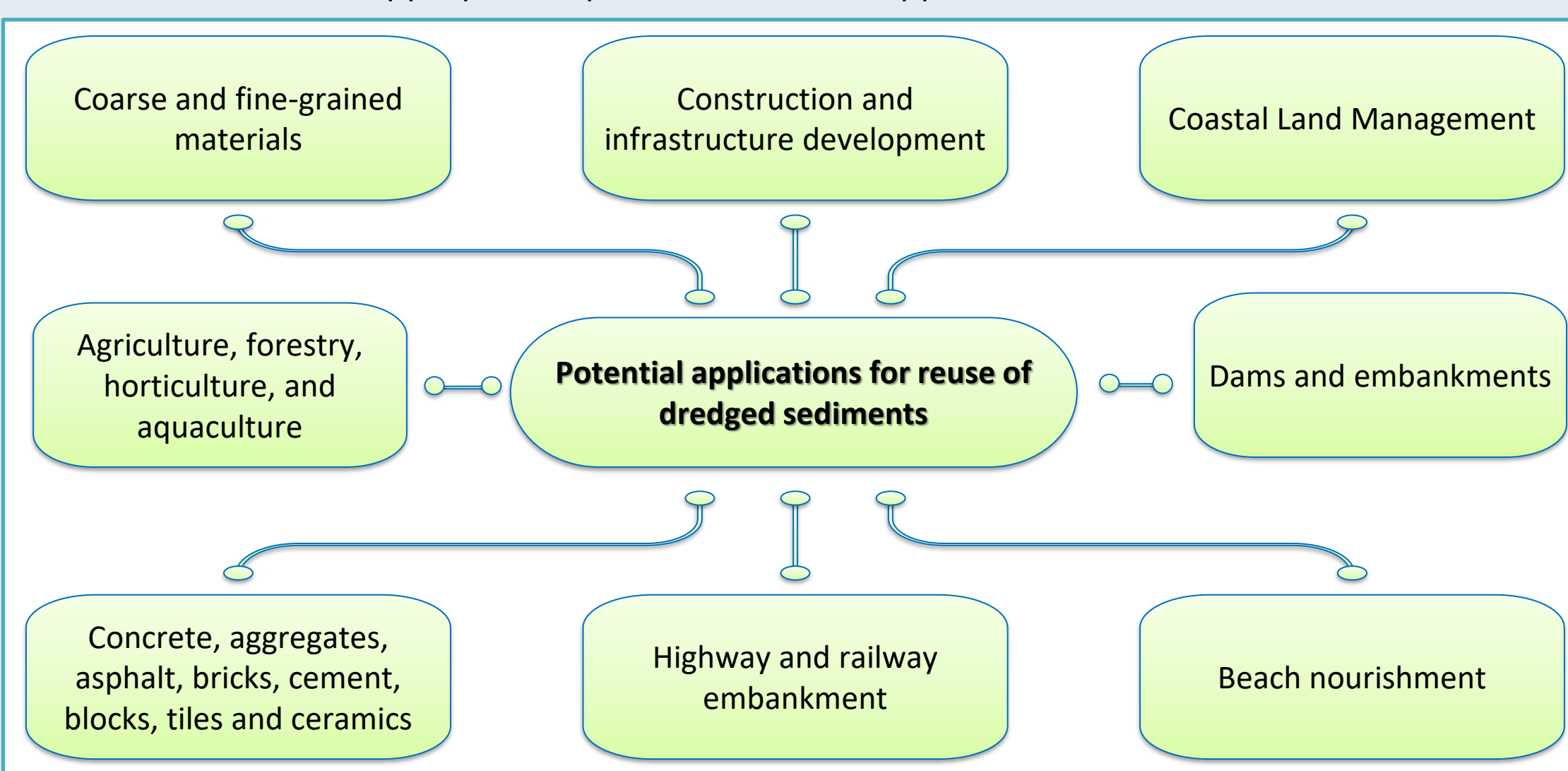
The presence of anthropogenic activities throughout the globe and the harbors generate an enormous amount of dredged sediments.

Country / Locations	Period	Volume or Quantity of dredged sediments	Sources
France, Germany, the Netherlands and United Kingdom		30–50 million m ³ each annually	[2]
United States		200–500 million m ³	[2, 7]
India		359.6 million m ³	[6]
United States	2011–2018	2.4 million m ³ annually	[8]
Bremen, Germany		0.6 million m ³	[9]
Brazil		80.3 million m ³	[10]
France	2013–2017	174.0 million tonnes	[1]
Netherlands		158.4 million tonnes	[1]
United Kingdom		103.2 million tonnes	[1]
Atlantic coasts		11.3 million tonnes	[1]
Mediterranean coasts		2.4 million tonnes	[11]
Sweden		1.4 million tonnes	[11]
Belgium	2008–2014	267.2 million tonnes	[1]
Germany	2008–2014	228.7 million tonnes	[1]

3. The beneficial use of dredged sediments for various applications

Managing waste with proper disposal facilities became a crucial challenge [12–20]. Due to a shortage of land, the cost of waste dumping gradually increases. Unmanaged dumping of dredged sediments leads to damage to environmental and ecological systems. Using dredged sediments through the recycling process is a sustainable approach towards supplementing natural resources, reducing pollution and greenhouse gas (GHG), energy optimization, enhancing economic development [28], improve sustainability on marine ecosystems.

Exploring the required mechanical, chemical, and physical properties of dredged sediments would lead to a most appropriate option for different applications:



5. Bottleneck preventing bulk re-use of dredged sediments

Major bottlenecks [21] towards managing bulk usage of the dredged sediments are as follows.

- Unfavorable market forces
- Legal/policy/governance challenges at the international and national
- Disposal capacity and process
- Critical barrier on transporting of dredged sediments to a different location regarding cost, safety, physicochemical properties, environmental issues, etc.
- Major investments
- Lack of government initiative in respect of promoting mission zero waste and to make realize that dredged sediments is wealth
- Delay in necessary approval and responses from the government official pertaining to dealing of dredged sediments
- Lack of policy frameworks, especially in the context of managing dredged sediments
- Transparency of information systems among the government and industry partner
- Introduce code and standards on the secondary product from dredged sediments so that users can use the products.

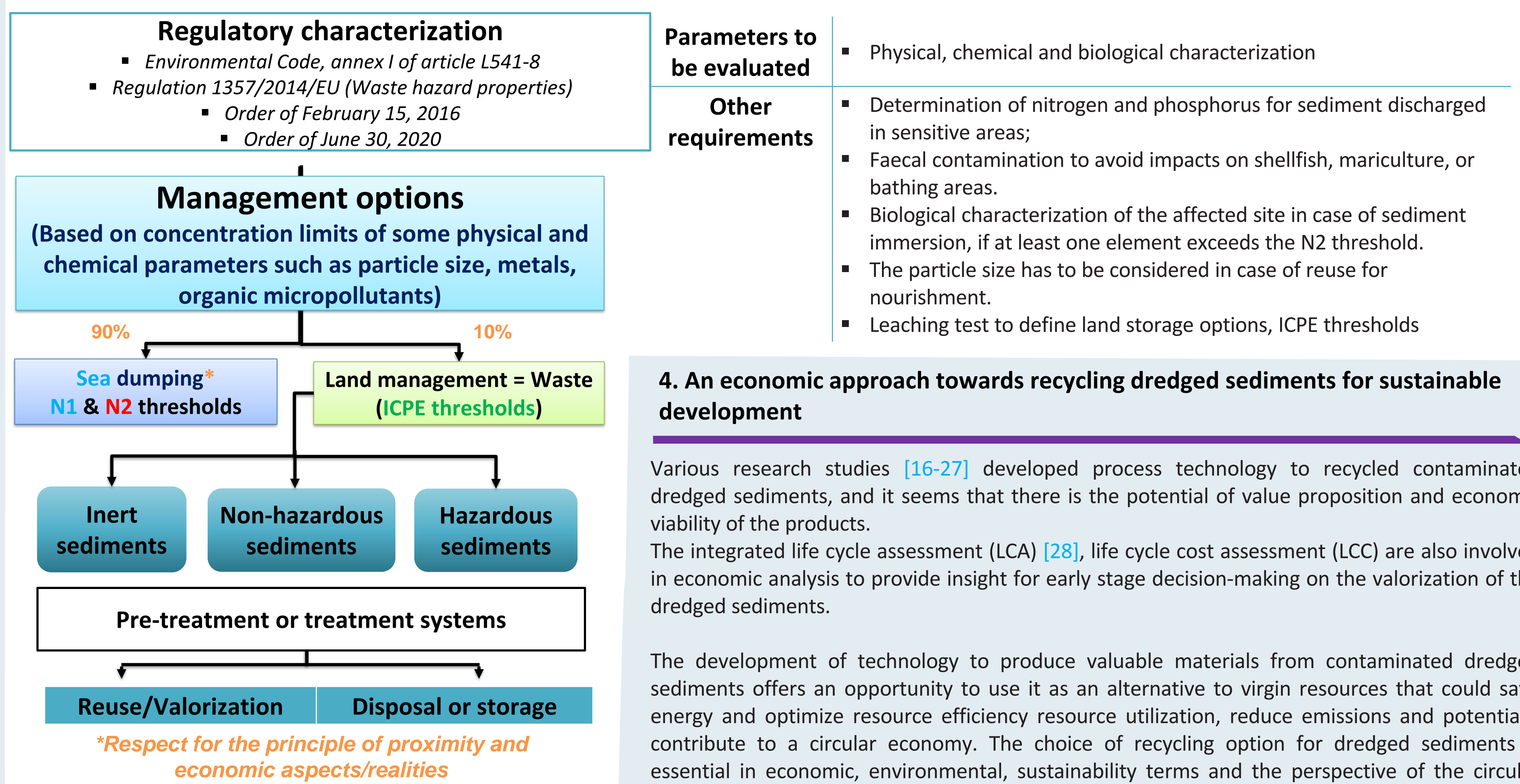
Conclusion

- A sustainable approach towards managing dredged sediments requires a change of view rather than a waste; dredged materials need to be seen as valuable resources.
- Perception issues remain crucial challenges to those promoting sustainable sediments management through the dredging process and activities.
- National level support will be necessary for helping to change attitudes and to promote sustainable dredged sediments management within the existing policy framework or introducing a new policy to succeed the mission.
- An effective and favorable policy would be accomplished to achieve the sustainable utilization of dredged sediments for different applications and valuable products.
- It may be expected that sediment management may change in the future, requiring more sustainable and circular approaches to dredged sediment management.

2. French regulatory framework for the management of dredged sediments is complex

In France, the decision on sediment suitability for sea dumping or land disposal is primarily based on chemical findings, being the ecotoxicological analyses only advised to be done on guidelines. According to the concentration limits of the required chemical parameters (such as metals, trace elements and organic micro-pollutants), N1 (high quality, low pollutant concentrations) and N2 (medium quality, mid pollutant concentrations) levels are legally defined. Only in the cases where any of the compounds exceeds the N2 threshold, a biological characterization of sediments is needed to define their ecotoxicity [1, 2, 4, 27].

Dredged sediments (France)



- Parameters to be evaluated**
- Physical, chemical and biological characterization
- Other requirements**
- Determination of nitrogen and phosphorus for sediment discharged in sensitive areas;
 - Faecal contamination to avoid impacts on shellfish, mariculture, or bathing areas.
 - Biological characterization of the affected site in case of sediment immersion, if at least one element exceeds the N2 threshold.
 - The particle size has to be considered in case of reuse for nourishment.
 - Leaching test to define land storage options, ICPE thresholds

4. An economic approach towards recycling dredged sediments for sustainable development

Various research studies [16–27] developed process technology to recycled contaminated dredged sediments, and it seems that there is the potential of value proposition and economic viability of the products.

The integrated life cycle assessment (LCA) [28], life cycle cost assessment (LCC) are also involved in economic analysis to provide insight for early stage decision-making on the valorization of the dredged sediments.

The development of technology to produce valuable materials from contaminated dredged sediments offers an opportunity to use it as an alternative to virgin resources that could save energy and optimize resource efficiency resource utilization, reduce emissions and potentially contribute to a circular economy. The choice of recycling option for dredged sediments is essential in economic, environmental, sustainability terms and the perspective of the circular economy.

Example below of the strategy developed for the management of dredged marine sediments from harbor Carnon (south of France)



Valorization dredged sediments of harbor Carnon

- Carnon beach nourishment : 3000 m³
- backfill, landscaped berm : 2800 m³
- rehabilitation of pedestrian walkways
- Municipal landfill cover

6. Recommendation on future policy options for the management of dredged sediments

The future policy options available with the policymakers for managing dredged sediments are to promote necessary schemes and facilities within the framework of policy and regulation by different nationalities with the alliance of industry partners. The problems related to the management of dredged sediments that need to be resolved as soon as possible to promote sustainable development through dredged sediments management are the following:

- Facilities for transportation of enormous amount of sediments
- Flexible licensing systems to process dredged sediments
- Safely policy
- Insurance scheme
- Startup facilities
- Financing facilities to set up a plant
- Emerging circular economic concept
- Approach to introduce code and standard
- Policy to design life cycle assessment (LCA) to reduce sediments
- Policy for compulsory use of sediments as secondary products wherever applicable
- Policy for restricting the use of natural resources
- Policy for limiting the use of certain unsustainable methods or technology to specific industries
- The particular policy required for penalties wherever applicable

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