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On the use of setback lines for coastal protection in Europe and the Mediterranean: practice, problems and perspectives

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CONTENTS

1 INTRODUCTION

This document is designed to support the European Commission in the preparation of "Guidelines for an integrated method for the definition of set-back lines". This task is carried out in the framework of the 6th FP CONSCIENCE Project, Concepts and Science for Coastal Erosion Management, Task 4.3.

At the same time the document is supposed to support the activities of the WG on the implementation of the ICZM Protocol for the Mediterranean.

The title of this report, "*On the use of setback lines for coastal protection in Europe and the Mediterranean: Practice, problems and perspectives*", intends coastal protection in a broad sense, i.e. protection from physical processes and climate change, protection of coastal ecosystems, protection of cultural heritage and environmentally-sound activities, protection from further uncontrolled building activities and development.

A set-back line (SBL) can be defined as the landward limit of the buffer zone behind the coastline. This buffer zone is the area where restrictions in constructions and other activities should be applied. This document deals with the criteria used to identify the coastline and the distance of the setback line from the coastline.

A setback lines should be considered as a planning and operational tool for ICZM implementation, as their definition should be based on an integrated approach which cover aspects such as the understanding and control of physical processes, the ecosystem efficiency, coastal safety for economic and recreational activities and landscape protection from a natural and cultural heritage perspective.

The identification of setback lines for the coastline at the European and Mediterranean level have been lately considered an important issue in the agenda of the EU and of the UNEP/MAP. Set back lines are essentially thought to protect human activities from extreme and chronic physical processes and climate change, as well as to preserve the ecosystems functions and the landscape along the coast. Setback lines are therefore established to physically separate the human activities from physical and ecological processes when it is considered necessary for the preservation of the overall quality of the system. Setback lines must be therefore thought as a tool to avoid new developments in the coastline, preserving the human cultural heritage and valuable human landscapes. It is therefore necessary to identify setback lines with a strong technical approach on one hand, which can give a clear vision of the physical and ecological dimensions of the processes and with a systematic participatory approach on the other hand, which can give a clear vision of the socio-economic implications at the local level.

The first part of this report is based on a review of the experiences, instruments, approaches and tools at the international, European and national level, in order to answer to the following key questions:

- What is a SBL?
- Which processes should be taken into consideration for the definition of (a) SBL(s)?
- What are the international experiences in defining a SBL?
- Which are the relevant legal instruments and how are SBL typically used by the member states?

- What is the state of the art science and the available technology to support its definition?

The second part of the report is dedicated to the proposal of common methodology for the definition of set-back lines at the European level.

2 OBJECTIVES

The overall objective of this document is to set the basis for future works on the definition of setback lines for the coastal zone of the European Union and the Mediterranean.

The specific objectives of this document are the following:

- To provide concepts as a common base for the definition of SBL.
- To review the international experiences in the use of SBL.
- To identify the gaps and the needs in SBL at the EU and Mediterranean Level.
- To set the basis for an integrated methodology for the definition of SBL which considers physical and ecological processes, coastal landscape, cultural heritage and stakeholders perception.

3 STATE OF THE ART

This chapter deals with the relevant experience in the definition and use of SBL to protect human activities and the environment. An introduction to the concepts and definitions is done in Chapter 3.1; these concepts will be used as a reference throughout the document. Chapter 3.2 makes a review of two relevant experiences from developed countries, the US and Australia. Chapter 3.3 is a review of the European and Mediterranean requirements which can be considered relevant for coastal planning while chapter 3.4 is based on the review of some Member State experiences. Finally, chapter 3.5 analyses the available science and technology which can improve the SBL definition.

3.1 Processes and definitions

A setback line is normally defined as the distance of a building from a spatial limit or feature where building restrictions or prohibitions are applied. A setback line for the coastal zone is therefore determined by a buffer applied to the coastline. The width of this buffer depends on environmental and socio-economic criteria.

The definition of setback lines for the coastal zone is strictly related with two physical processes which can threat human activities and the environment: coastal erosion and coastal floods, which can produce severe damage to the infrastructure and limit activities along the coast. Moreover, the definition of setback lines should be also related to the interference of human settlements with coastal ecosystems. Therefore it is possible to identify two general criteria for the definition of set back lines: the protection of coastal properties from coastal risks and the protection of the coastal system from human activities. Both approaches should be integrated in a common methodology for the determination of setback lines.

The following definitions should be considered as a reference for this document:

1. Shoreline: the intersection between the mean high water line and the shore (the reference line for shoreline retreat which is identified using aerial pictures)
2. Shore: The zone of unconsolidated material that extends from the mean low water line to the place where there is a marked change in material or physiographic form, or to the line of permanent vegetation (the effective limit of storm waves).
3. Coastline: the intersection between the shore and the land behind.
4. Sandy coastline: the coastline made of sand directly affected by waves induced physical processes.
5. Rocky coastline: any cliffs or low rocky coastline.
6. Tidal coastline: the coastline which surrounds tidal marshes, estuaries and rivers which are not directly affected by storms.
7. Infrastructures: any human developed hard structure which is placed on the coastline.
8. Coastal risk line: A line which can be determined through the statistical analysis of extreme events, normally associated with a return period. It can be set above the coastline in the case of very high return periods.
9. Setback line: the legal line defining a buffer zone landward of a geographically bound reference line (i.e. risk line, shoreline, duneline, etc).
10. Coastal erosion: the process of wearing away material from the shore which can result in a shoreline and coastline retreat. The process can be constant or associated with extreme events.

11. Coastal flood: the temporary inundation of land by water that is not normally submerged, typically caused by a flow of water over the coastline during extreme events.
12. Coastal climate change: the long-term process of sea level rise and variations in wave climate.

3.2 International experiences

This chapter reports two significant experiences with SBL(s) for ICZM from two developed countries: the US and Australia.

USA

In the US, the Office of Ocean and Coastal Resource Management (OCRM), part of the National Oceanic and Atmospheric Administration (NOAA), provides strategic direction and guidance to state and territory coastal programs. In accordance with OCRM, approximately two-thirds of coastal states have some type of construction setback or construction control line requiring development to be at a certain distance landward from the coastline. Of those states that do not have state-mandated setback regulations, most have delegated authority to local governments or local coastal programs to establish setbacks.

The type of setback used, including how and from where it is established can vary widely. Setback lines are often measured from a specific feature such as the high-tide line, extreme high water mark, or dune vegetation line.

Some states have arbitrary setback lines. An arbitrary setback line, while the simplest to establish, does not reflect the true erosion threat to shorefront structures. For example, an arbitrary 100 foot setback may not be adequate in a highly erosive area but may be too restrictive in a very stable environment. Therefore, many coastal states, such as North Carolina and Florida, have developed setbacks based on annual erosion rates for beach-front lots. Although erosion along estuarine shores can also be problematic, setbacks based on erosion rate data are rarely used in these environments, to date. Few estuarine shorelines have sufficient annual erosion rate data to be able calculate setbacks based on erosion rate for these shorelines.

While more realistic, establishing setbacks based on the erosion rate can be more difficult because it requires a significant amount of data on past shoreline change—something that may not be available for the entire shoreline or is costly to obtain. Erosion rates can change over time, therefore, the setback lines must also be reassessed routinely. For example, South Carolina updates their setback lines and erosion rate data every 8-10 years.

To overcome gaps in its erosion rate data, Minnesota adopted a hybrid approach to their setback lines along the North Shore of Lake Superior. Minnesota's North Shore Management Plan establishes a setback of 50 times the annual erosion rate plus 25 feet in areas where erosion data is available and reverts to a standard 125-foot setback elsewhere.

Frequently, setback lines based on erosion rates are set 30 or 50 times the annual erosion rate. The assumption being that the structure should last long enough to pay off a 30-year mortgage. However, even a setback line set to the 30-year annual erosion rate may not be adequate

According to OCRM, setback lines reduce the need for costly and/or unsightly shoreline erosion control structures, minimize property damage due to erosion,

maintain natural shoreline dynamics and they help to maintain lateral beach/shorefront access.

Australia

An interesting approach is the one applied in Western Australia (Western Australia State Coastal Planning Policy). The Policy distinguishes between coastal foreshore reserves and development setbacks for physical processes. The coastal foreshore reserve is a policy measure which takes into consideration, besides of physical processes, the ecological values, landscape, seascape, visual amenity and cultural heritage. On the other hand setbacks for physical processes are focused on the risks of damage on coastal developments. In the case of setbacks for physical processes, a set of guidelines are provided for their calculation so as to the required total setback will vary according to circumstances. As a general guide a total setback in the order of 100 m from the HSD (Horizontal Setback Datum, i.e. the coastline) will be expected.

The Western Australia State Coastal Planning Policy is a good example of the integration between science and spatial planning.

In this Policy, the objectives of setback lines is to protect development from coastal processes by absorbing the impact of a severe storm sequence, allowing for shoreline movement, allowing for global sea level rise and allowing for the fluctuation of natural coastal processes. Setback lines are based on a 100-year planning time frame and consider ocean forces and coastal processes which have a statistical recurrence of once per one hundred years. Setbacks will be applied from a defined line known as the Horizontal Setback Datum (HSD). The HSD is determined with regard to physical or biological features of the different coastal types – sandy, rocky, and other local specific coastal types. The setback from the HSD is calculated either arbitrary or supported by models when data are available. The total setback is the sum of three factors:

- D1. Distance For Absorbing Acute Erosion (Extreme Storm Sequence)
  This distance requires the modelling of the impact of a sequence of storms on the shore at the development site. The use of models such as SBEACH is acceptable. In order to determine the storm sequence of 100-year recurrence, the model should be run with three successive runs of the recorded storms. D1 shall be the total recession of the mean sea level contour. In the absence of modelling, such as when data is unavailable, the default value of D1 shall be 40 metres, based on modelling of a typical exposed sandy shore.

- D.2. Distance to Allow For Historic Trend (Chronic Erosion or Accretion)
  The chronic erosion setback allowance S2 should be calculated as 100 times the assessed present longer-term annual rate of erosion. The assessment should be based on monitoring of shoreline movement over at least a 40-year term, preferably longer, with the position of the HSD being determined at about five-year intervals. On a relatively stable shore the minimum value of S2 should be a 'safety' allowance of 20 metres, except where there is evidence that chronic accretion in excess of that distance has been identified for the 100-year forward planning term when the value for S2 will be 0 metres.

- D.3 Distance to Allow for Sea Level Change
  The setback to allow for sea level rise is based on the mean of the median model of the latest Assessment Report of the IPCC Working Group. The vertical change predicted by the current model between the years of 2000 and 2100 is 0,38 metres. A multiplier of 100, based on the Bruun Rule

shall be used and gives a value for DS3 = 38 metres for sandy shores. For othershore types, D3 shall be assessed in regard to local geography.

The following example is illustrated for the calculation of the total setback (TS) from the HSD.

Case 1. Beach environment, completely monitored, with the distance of the 100 years storm calculated in 28 m, an erosion rate of 0,3 m*year.

D1= 28 m
D2= 30 m
D3 = 38 m

Total setback: 96 m

Case 2. Beach environment, stable, no other data.
D1= 40 m
D2= 20 m
D3 = 38 m

Total setback: 98 m

In case of rocky shorelines, the coastal processes setback is to be determined following a geotechnical survey accounting for possible erosion over a 100-year period. In the absence of any survey, the minimum setback shall be 50m from the HSD.

3.3 European and Mediterranean requirements

The European Union has developed in the last 10-15 years a set of requirements, most of them Recommendations and Directives, which can be related with ICZM and SBL. These requirements cover most of the environmental aspects of the coastal zone: habitats, water, ocean and seas, environmental information. A preliminary analysis of this set of European Requirements brings out that no specific mention to SBL is done as a mean for their implementation.

Furthermore, the results of a recent meeting on coastal erosion issues (Beachmed-e final conference, Rome, May 2008) emphasized the lack of European requirements legislation concerning coastal erosion management, as the existing Directives on soil, floods and water don't address the coastal erosion problem as one of the issues to be solved in a European perspective.

On the other hand, the Mediterranean Protocol on ICZM was recently signed by all the European Member States and will be ratified in the future. The Protocol was signed by all the Euro-Mediterranean States (Spain, France, Italy, Croatia, Greece, Cyprus and Malta) and by most of the other Parties to the Barcelona Convention.

One of the implementation tools, specified in in Part II, Article 8, Point 2, is the use of setback lines for coastal management.

The following policies, Recommendations and Directives have been examined in order to identify the implication on the definition of a European Method for the definition of setback lines for the coastal zone.

Recommendation on ICZM

This Recommendation (413/2002/EC) aims to establish a common framework for the implementation of ICZM in the member states. It is based on the experiences and outputs of the Demonstration Programme operated by the commission from 1996 to 1999 and it includes the results of the national stocktaking of actors, laws and institutions concerned with the coastal zone and the national strategies for ICZM with the instruments for its implementation. The recommendation stresses the fact that coastal zones are threatened by the effects of climate change, in particular rising sea levels, changes in storm frequency and strength, and increased coastal erosion and flooding. Working with natural processes and respecting the carrying capacity of ecosystems are also basic principles for protection strategies. The response of the member state was due in 2006 and a Final Report had been prepared which summarize the experiences of the different countries. There is no explicit recommendation for setback lines at the European level.

Water Framework Directive

The Water Framework Directive (WFD) (2000/60/EC) is concerned with the management of the whole fresh water cycle, and its objective is to reach the good status of water in the member states by 2015. Two of the water bodies considered by the directive are directly concerned with the coastal zone: the transitional waters (estuaries and coastal lagoons) and the coastal waters, which include internal waters and the waters that extend 1 mile from the baseline. This Directive also defines the River Basin District, as the main unit for the management of river basins. The directive makes no references to setback lines in the coastal zone.

Marine Strategy Directive

The Marine Strategy Directive, entered into force in December 2007, aims to achieve good environmental status of the EU's marine environment by 2021, in all European waters on the seaward side of the baseline to the limit of the jurisdiction of the member state. It is characterized by the same methodological approach of the WFD in characterizing physical and chemical features, habitat types and biological elements. The directive makes no references to setback lines in the coastal zone.

Flood Risk Management Directive

The objective of the Directive on the assessment and management of flood risks (2007/60/EC) is to reduce and manage flood-related risks to human health, the environment, infrastructure and property. The proposal focuses on the management of catastrophic river and coastal floods suffered by the river basins and coastal zones in Europe, and it stresses the importance of the role of climate change in the increasing frequency and size of these natural phenomena, whose effect can be worsened by bad practices in land use and management in the most sensitive areas. This directive is strictly related to the WFD, and its implementation will be normally carried out in the WFD River Basin District. That will be the basis for a preliminary flood risk assessment, flood risk maps and flood risk management plans. The directive makes no references to setback lines in the coastal zone.

INSPIRE Directive

The Inspire Directive, approved in 2007, aims to establish an infrastructure for spatial information (SDI) for Europe. The European SDI is going to be the common framework and standard for spatial data flow, including technologies, datasets, metadata and services. The INSPIRE directive is strongly related with environmental issues and was first conceived from the environmental sector

characterised by a strong lack of harmonization. Setback lines can be considered as a part of the dataset included in annex III. The preparation and distribution of setback lines should be therefore adapted to the requirements of this directive.

Soil Directive(Proposal)

The proposal for a directive for Soil, COM(2006) 232 final, addresses the sustainable use and preservation of soil, as a non-renewable resource and a very dynamic system which performs many functions and delivers services vital to human activities and ecosystems survival. Soil should be considered as the naturally occurring, unconsolidated or loose covering of broken rock particles and decaying organic matter. Information available suggests that, over recent decades, there has been a significant increase of soil degradation processes, and there is evidence that they will further increase if no action is taken. Soil has not, to date, been subject to a specific protection policy at Community level.

Some soil protection aspects can be found scattered hence different Community policies can contribute to protect soil. This is the case of many provisions in the existing environmental Community legislation in areas such as water, waste, chemicals, industrial pollution prevention, nature protection and pesticides.

Following this Draft Directive, Member States shall identify the areas in their national territory, at the appropriate level, where there is decisive evidence, or legitimate grounds for suspicion, of soil degradation. It considers eight soil degradation processes: erosion, organic matter decline, contamination, salinisation, compaction, soil biodiversity loss, sealing, landslides and flooding. This includes erosion by wind or water. However, the text of the Draft Directive does not address coastal erosion as being one of the soil degradation processes nor the functional relation between soil management and coastal sediment management.

This directive has therefore no direct relation with coastal zone management and setback lines in the coastal zone.

Landscape convention

The European Landscape Convention ETS 176, applies to the entire territory of the Parties and covers natural, rural, urban and peri-urban areas. It includes land, inland water and marine areas. It concerns landscapes that might be considered outstanding as well as everyday or degraded landscapes. Its objective is to protect and restore European natural and cultural landscapes through the establishment of policies aimed at landscape protection, management and planning and through the integration of landscape into its regional and town planning policies. This should be done using procedures for the participation of the general public, local and regional authorities. No specific provisions are given for the definition of SBL.

Protocol on ICZM in the Mediterranean

This international treaty, signed in January 2008, is a protocol to the Barcelona convention of 1976. The protocol focuses on the Mediterranean coastal zones, including Europe, North Africa and the Middle East countries as parties and it aims to establish a common framework for the integrated management of the Mediterranean coastal zone. The protocol gives special importance to the implementation of sustainability principles in the economic activities, in the ecosystem management, cultural heritage public participation and education.

The implementation of specific instruments is considered as being the key for ICZM: these instruments shall include coastal observatories, national coastal strategies and plans, environmental assessment. As it covers most of the aspects

which can be related with ICZM it can not have specific implementation rules, which should be defined by each of the parties. In spite of this, there is a clear reference to the establishment of setback lines. Following the protocol, the member state shall establish in coastal zones, as from the highest winter waterline, a zone where construction is not allowed. Taking into account, inter alia, the areas directly and negatively affected by climate change and natural risks, this zone may not be less than 100 meters in width. Exceptions can be made for projects of national interest or areas having particular geographical or other local constraints, especially related to population density or social needs, where individual housing, urbanisation or development are provided by national legal instruments.

3.4 European Member States criteria

This chapter analyses some experiences in the current use of SBL at the European level.

Spain
Any new initiative for the Spanish Coastal Zone has to be designed considering its main regulation, the Coastal Law of 1988. This legal instrument defines the landward limit of the Public Domain as the limit of the coastal dynamics influence and the seaward limit as the limit of the external continental shelf or of the Exclusive Economic Zone (EEZ). This law also defines a protection zone that extends 100 meters from the limit of the Public Domain (or 20 m for zones occupied by urbanizations before 1988), where housing is forbidden and urban plans can be modified to protect the Public Domain in an area of influence that extends 500 m from its seaward limit.

The organization in charge of Public Domain management is the Ministry for the Environment, Rural and Marine Affairs, and their more recent coastal policy added a new instrument, the acquisition of land in the most sensitive coastal areas to be included in the Public Domain, even if they are out of the legal boundaries.

Italy
The situation in Italy is not homogeneous because of the distribution of competences between the State, the regions and the municipalities. The concept of Maritime Public Domain is also applied and the art. 822 of the Italian Civil Code states that the shoreline and the beaches are part of Maritime Domain owned by the State. Their upper limit is generically related with coastal dynamics. On the other hand The 1982 law on (979/1982) identifies a "plan for coastal and marine defence" as a national instrument for the protection of coastal and marine systems, but it had never been implemented. The only instrument which can be identified at the national level is defined by the L. 312/1985, the so-called "decreto Galasso", which identifies the 300 m distance from the coastline as the stretch of the coast with special requirements and limitations for landscape protection. Other specific instruments and tools are normally defined and implemented by coastal regions or coastal municipalities (e.g. Regional Coastal Plans, Maritime Domain Use Plans), under the framework of the national laws. A recent example of regional policy is the new Landscape Plan for the Sardinia region which forbids constructions near the coast and institutes the "Conservatoria delle coste" for coastal land purchase. An emergency measure, with arbitrary setback was applied in 2004, as a temporary instrument applicable before the regional plan entered in force.

The Netherlands
It is widely known that half of the land in the Netherlands lies below sea level, in an area which accommodate more than half of the population and of the country's economic activities. This area relies on the coastal zone as the buffer for coastal protection from storm surges. The basal coastline (BKL) of 1990 is the reference line which is maintained through yearly monitoring and beach nourishment at the national level. A 10.000 years risk line is also provided to the local authorities as a tool for planning but no strict regulation explicitly forbid construction seaside of this line, even if negotiations between coastal managers at the Rijkswaterstaat, local waterboards and private stakeholders are normally carried out. A great part of the coastline of the Netherland is protected in any case from building activities through the establishment of wide dune systems.

3.5 Methods and tools

The common methods and tools for the identification of setback lines cover physical criteria for the identification of highest water level under certain return-time scenarios (The Netherlands, Spain, etc.) and they can also include climate change trends (IH Cantabria, 2007). Ecological criteria are normally applied to protect special area of interest by purchasing land and protecting it from further development (France, Spain, UK). These aspects are not yet covered in this draft document.

From a Physical perspective, two technological procedures are taken into consideration: the methodology in use in Spain and the methodology used in The Netherlands.

The objective of the first methodology is to identify the upper limit of the Public Domain in Spain defined by the Coastal Law of 1988. The Coastal Law stands that the area covered or temporally affected by waves during the highest storms are part of the public domain. The law doesn't identify any return time for the highest storm. A reasonable and normally applied return time for storms is 50 years. The methodology applied for the calculation of the limit of the Public domain is based on the calculation of the maximum water levels and it is normally applied to beaches. The maximum water level is the sum of the effects of the tide, surge and the run-up of waves on the beach. A simplified scheme, which don't consider the surge as a primary effect, is the following:

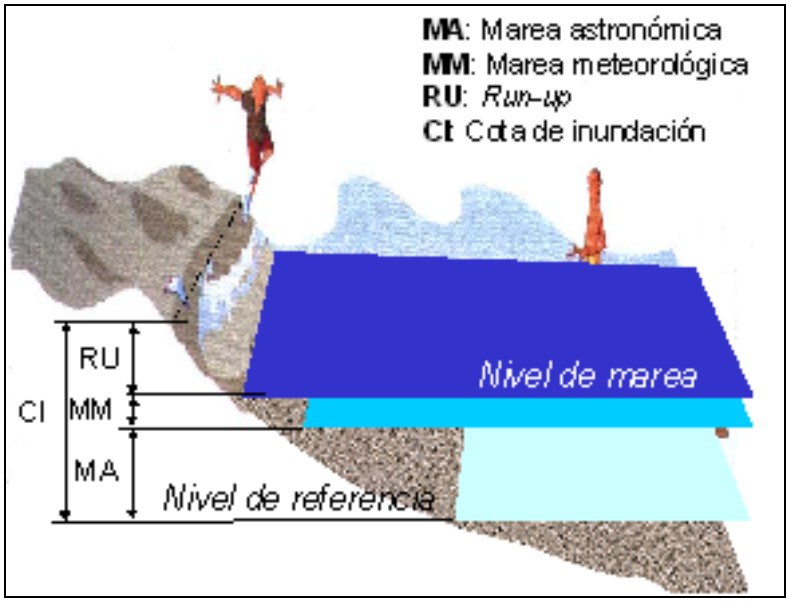

Figure 1. Processes that determine sea level under storm conditions (IH Cantabria, 2007).

Where the *marea astronomica* is the tide, the *marea meteorologica* is the surge and the *cota de inundacion* is the maximum final water level.

This water level, though, is not completely deterministic but is based on statistic calculations about the probability of the occurrence of a certain event. The only deterministic part of the calculation is the tide. The run-up depends on the following factor, which can change the final area affected by an extreme storm:

1. Return times for the extreme event. A reasonable return time for the extreme event is 50 years.

2. Databases for the wave climate. Hindcasting models of dynamic processes are today commonly used. These models are able to recreate the wave climate of the past 40 years. This information is then used to forecast the trend in wave climate (energy and direction) for the next 50 years.
3. Wave propagation to the point of interest. Extreme wave conditions are propagated to the area of interest.
4. Calculation of the run-up. The actual run-up is finally calculated on the current topography of the area.

As an example, the calculation of return times for the inundation of a beach in the canary island, used for the identification of the limit of the Public Domain, is reported here (IH Cantabria, 2001). In this case the return times were 2, 10 and 100 years.

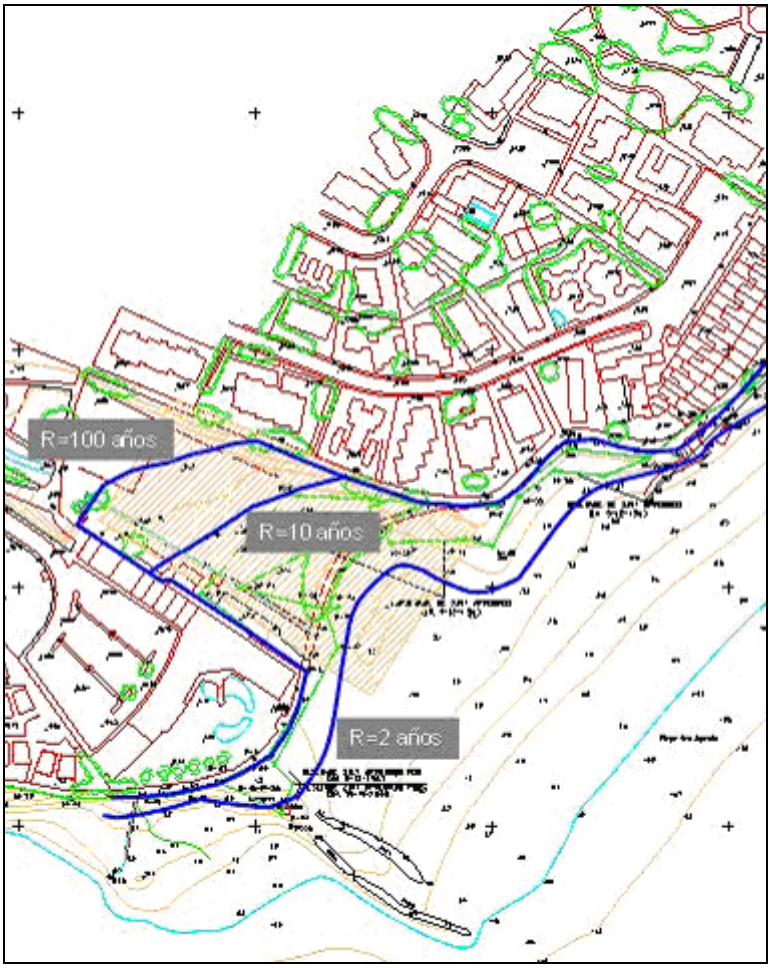

Figure 2. Calculation of risk lines, Gran Canaria, Spain (IH Cantabria, 2001).

The case of the Netherlands is special because a large part of the country lies below sea level and the criteria for setback are therefore applied as risk lines of erosion of the coastal dunes that protect the low lying lands. Dunes and dikes along the coast should be able to withstand the effects of a storm which has a probability of occurrence of once per 10.000 years. This roughly corresponds to a storm surge level of + 5 m Dutch Ordnance Level (NAP), which varies slightly along the coast. These storm surge water levels are called base levels. The base level is the general standard used to determine the minimum requirements which should be met by the flood defenses. The actual dimensions of the flood defenses however, also depend on hinterland characteristics. If a flood defense structure

protects an area with a large economic value the design level of the flood defense should be higher than the base level.

Real estate landward of the sea defenses are protected by law via the so-called Flood Defense Act (Wet op de Waterkering) (1996). Those who work and live seaward of the sea defenses (in the 'erosion zone') do so at their own risk (RIKZ, 2002).

The former Technical Advisory Committee for Flood Defenses (TAW, 1995) introduced a method to calculate dune erosion as a result of an extreme storm event and offered criteria to test safety provided by the dunes. If a storm event occurs which reaches the design level, complete safety against failure of the dunes should still be guaranteed (TAW, 1995). The concept of this method is illustrated in figure 3. After the occurrence of an extreme storm event which reaches base level, the part of the coastal profile above water level will be eroded and deposited under water. The erosion profile assumes a shape which is known in advance. The water level during storm surge determines the vertical position of the erosion profile, whereas the horizontal position is determined in such a way that erosion above base level equals deposition beneath water level.

TAW (1995) argued that the probability of failure of the sea defense should even be ten times lower (i.e. 10^{-5} along the Mainland coast), than the probability that the design level is reached (which has a probability of occurrence of 10^{-4} along the Mainland coast). The predefined probability of failure for an arbitrary dune enables calculation of the minimum dune dimensions needed.

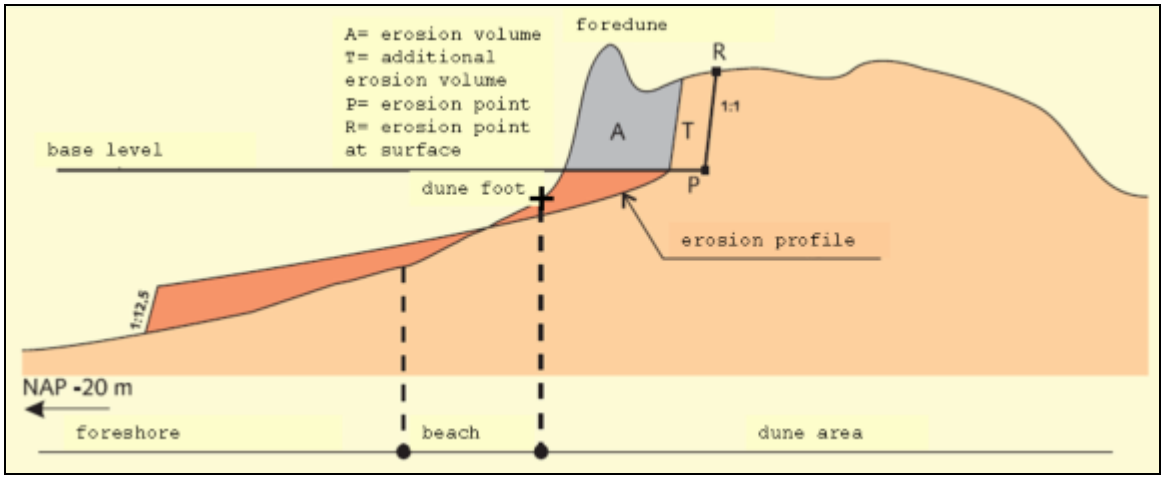

Figure 3 Erosion profile after storm surge (Modified from: TAW, 2002).

From the dune erosion calculations, erosion lines or setback lines can be determined, which indicate how far erosion might reach landward due to the occurrence of an extreme event (see figure 4). These erosion lines are based on interpolation between different positions of R alongshore (see figure 3).

Figure 4. Current and future erosion line positions for a fictitious coastal town (RIKZ, 2002).

4 DRAFT METHODOLOGY

The methodology proposed covers the following aspects which are considered as important for the SBL definition:

1. Type of coast: the coast , in Europe and the Mediterranean, is made of beaches, cliffs, intertidal areas or infrastructures.
2. Physical processes: extreme events and chronic processes are shaping the coast and climate change is affecting the whole system.
3. Ecological processes: in order to maintain and improve ecological functions and coastal landscapes it is important to work with nature and give it space.
4. Socio-economic processes: building shall not be permitted in physically and ecologically sensitive areas, although some soft uses should be permitted. Existing building (cities, historical centers, etc.) and valuable heritage and coastal uses should be not affected by new measures. Special cases should be considered.
5. Legal framework: national, regional and local requirements should be considered as a base for discussion.
6. Stakeholder perception: the opinion of the stakeholder at the local level should be taken into consideration as an essential part of the whole methodology.

In order to identify setback lines for the coastal zone as a policy option, an analysis of the situation should be carried out, in order to give a clear and integrated vision of the situation, using technical tools for the identification of the needs for setbacks from a physical, ecological and landscape point of view. These results are then confronted with the actual situation of the coast, where buildings, legal frameworks and a public perception oon the issue already exists.

In any case a clear formulation of the problem and of the objectives of setback lines should be identified in the beginning of the process, in the framework of a broader ICZM strategy.

The analysis needed to identify SBL should cover the following steps:

Part 1: technical diagnosis

1. Identification of topographic and morphological feature (type of coast)
2. Identification of the significant physical processes in order to combine chronic processes with extreme events.
3. Identification of the ecological processes based on the best available information.
4. Identification of cultural and natural landscape values based on the best available information.

Part 2: Policy analysis and stakeholders involvement

5. Identify infrastructure and recreational activities inside the buffer zone.

6. Identify the actual legal instruments and the costs for the implementation of the new setbacks.
7. Involve stakeholders at the local level in a consensus-building participation process in order to identify management options to protect human activities, nature (ecology) and landscape

The following scheme summarizes these basic ideas:

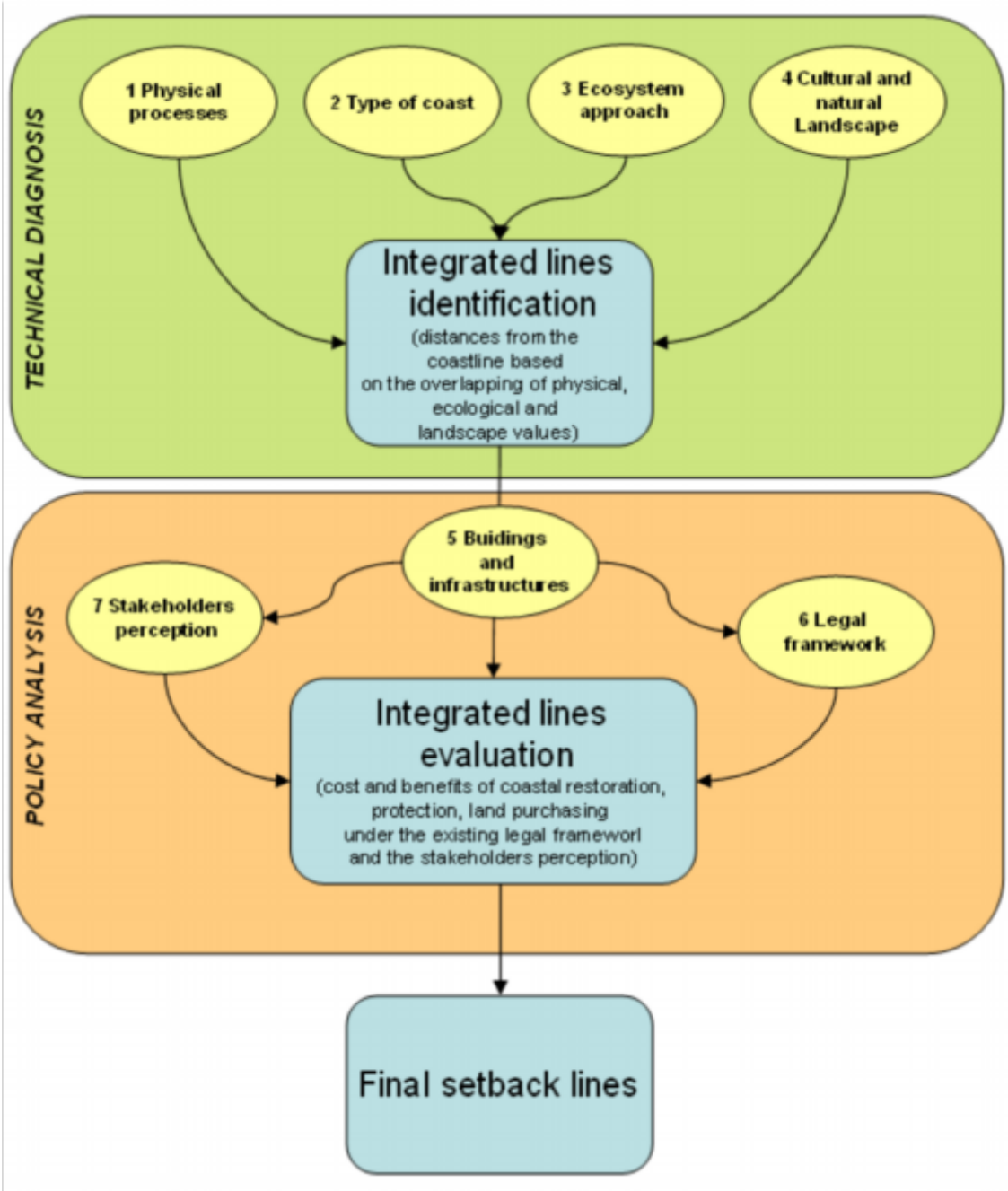

Figure 5. Scheme for setback lines preparation.

4.1 Type of coasts

A basic classification of the types of coast should be based on its physiographic description. In this sense it is possible to identify four types of coastlines which should be treated differently while identifying criteria for the definition of SBL:

Sandy coastline

A sandy coastline is made of beaches and coastal dunes. It ranges from long sandy beach systems (like the ones in the North Sea) to small, gravel pocket beaches in the Mediterranean. Morphodynamics of these systems is strictly related with waves and storms, which shape the profile and which move sand longshore and shape their profile. They are sensitive to small changes in sea level.

Rocky coastline

A rocky coastline is made of high cliffs, low rocky coasts made of different materials. They can be affected by erosion due to extreme events but they are normally not very sensitive to small changes in sea level.

Tidal coastline

A tidal coastline is a coastline made of fine sand or mud which is protected from the direct effect of waves but it is connected to the open sea by tides. The limit of the saline intrusion of sea water into rivers is normally considered as the upper limit of a the tidal coastline.

Infrastructures

An infrastructure is any hard infrastructure which is placed on the coastline or substitute it. If the land behind an infrastructure is suitable for physical planning, special setback line criteria should be defined.

Figure 6. Ttype of coastline, Santander bay, Spain.

4.2 Physical processes

Some specific technological requirement had been already introduced in chapter 3.5. This chapter is focused on the concepts and processes that should be further considered.

Physical processes represent the base for the identification of setbacks. They cover extreme events and chronic processes, including sea level rise. Physical processes affect each type of coastline, depending on their topography and elevation. The area which can be affected by physical processes should be protected from constructions; high economic values in special areas should be in any case considered. The analysis of the physical processes is the base for the identification of setbacks, either for extreme events or for chronic processes.

An extreme event is an event with high or unpredictable return periods when waves and/or wind provoke strictly interconnected processes like the run-up in beaches, overtopping of infrastructures or rocky coast and extended floods. Most of the events are predictable and return periods can be calculated with a certain error. Unpredictability is associated with tsunamis, which should be only considered in high risk areas, even if the probability of the event cannot be calculated. Coastal erosion under heavy storm conditions should be also considered an extreme event. The analysis of the extreme events should include trends in climate change.

Coastal erosion can be also considered as a chronic process in coastal stretches where the sediment balance is negative and an historical coastal regression can be detected. Coastal erosion can be also occur in rocky coasts. Chronic processes also include sea level rise, based on local measurement and long-term projections related with climate change (IPPCC).

The following scheme summarizes the effects of physical processes on different coastal types in relation with the need for setback lines:

Effect: Low med High		Sandy coastline	Rocky coastline	Tidal coastline	Infra structures
Extreme events	Waves				
	Wind (surge)				
Chronic processes	Long shore transport				
	Sea level rise				

Figure 7. Qualitative matrix concerning the relation between the type of coast and the effects of physical processes in relation with the need of setback lines.

A common methodology should be based on minimal requirements, which take into consideration the effect of physical process and its long term evolution.

These requirements are the following:

1. Identify the maximum erosion during extreme events with a certain return period (e.g. 50 year), with special attention to climate change trends (EXT)
2. Add the sea level rise worst case scenario under IPCC projection. (SLR)
3. Add erosion rates based on scientific and historical information (ERO)
4. Add an uncertainty buffer, typically 10% in civil engineering

The identified distance for physical processes (DPP) is therefore:

DPP = EXT + SLR + ER0 + Uncertainty buffer

These parameters can be calculated by combining statistical analysis of extreme events and numerical modelling of physical processes. Examples of erosion models can be found in the reports *'Modelling erosion of gravel/shingle beaches and barriers'* and *'Modelling of erosion of sandy beaches and dunes'* of the CONSCIENCE project (Van Rijn, 2010a and b).

Typical values for DPP are between 50 and 100 m, but can be extended to kilometers in the case of low land and coastal plains. Significant examples are deltas (Scheldt, Nile, Ebro, Po, etc.). In the case of rocky coasts the DPP can be easily reduced in the absence of erosion and wave overtopping. In any case a precautionary setback line of at least 50 m is advisable.

In special cases, at the local level, water availability, salt water intrusion and soil subsidence should be considered as an added criterion for setbacks.

4.3. Ecological processes and coastal landscape

Ecological processes and coastal landscape preservation and improvement must be included in the criteria for the identification of SBL, taking into consideration the possible effects of climate change. Basic spatial information regarding the importance of the coastal zone from an ecological perspective is collected at the European level through the Nature 2000 Network which covers most of the Marine Protected Areas and Terrestrial Reserves in the coastal zone. These areas are normally under special regimes for development and, in a broad sense, new buildings in these areas should be not permitted. As an example, the delimitation of a Special Area of Conservation in the North of Spain is reported in the next figure.

Figure 8. Delimitation of a Special Area for Conservation of the Natura 2000 Network along the northern coast of Spain.

An important example in this sense is the one of the French *Conservatoire du Littoral*. The Conservatoire is is a public administrative body with the responsibility of conducting appropriate land-use policies for the protection of threatened coastal natural areas. Its main instrument is land acquisition, which is selected with three main criteria: the site is threatened by urbanisation, being divided -up or being made artificial (for example, the infilling of wetlands); the site has deteriorated and needs rapid restoration, the site is closed to the public whereas it should be open to everyone. The Conservatoire has three procedures it can use to acquire land: either by private agreement, by pre-emption in coastal areas defined by the departments or, more rarely, by expropriation on grounds for reasons of public interest The great majority of acquisitions today are made by private agreement Once acquired the land becomes inalienable, meaning that it cannot be resold.

Figure 9. Coastal protected area, *Conservatoire du Littoral*, France.

A similar policy to the French one has been conducted lately also by the Spanish Ministry for the Environment, in order to protect coastal areas from further development in different parts of the Spanish coast. Other similar experiences include the *UK National Trust coastal Policy* and the *Conservatorio delle Coste* of the Sardinia Region.

While including the effects of climate change in the definition of SBL, it is important to identify trends in coastal change and the future space needs for the ecosystems, which can adapt itself through a landwards migration. This is the case, for example, of turtles nesting sites in some parts of the Mediterranean or other functions which are carried out by beach or tidal environments. The trends and shifts in spatial patterns for the systems can be impeded by existing infrastructures as an additional threat to the fragile ecosystems.

Coastal landscape, in a broad sense, should include both natural landscape and transformed landscape in equilibrium with ecosystem which can be considered as a part of the cultural heritage. Coastal landscape should also be assessed and protected, using SBL as a tool for its delimitation.

4.4 Socio-economic processes

The analysis of the socio-economic processes in the coastal zone is way too complex to be analysed in this document. Furthermore, socioeconomic processes are strictly connected to local economies and communities. The idea, in this sense, is that no new building should be permitted if:

1. The area can be directly affected by coastal physical processes, including the effects of climate change.
2. The area has is specially relevant as a coastal ecosystem and coastal landscape and/or it had been recognized as relevant by applying protection measures (land acquisition, protected areas, natural parks, Natura 2000, etc.).

If one of the two conditions applies, a stricter planning and permitting policy should be applied, avoiding constructions and maintaining and protecting ecologically-sound cultural heritage, when it is considered as a major issue by the public. In any case there is a trade-off as to whether or not allow any buildings in an area that is prone to erosion. The rational way of dealing with this is to make a cost benefit assessment, based on the risks involved. A good example can be found in Winckel et al. (2008).

4.5 Administrative processes and stakeholders involvement

The administrative processes for the identification and implementation of setback lines should start with the identification of an institution in charge in each member state. The institution in charge is normally a regional or national organization. Such organization should be involved from the beginning in the whole process from:

- The identification of setbacks for physical processes.
- The identification of setbacks for ecological processes.
- The identification of conflicts with socioeconomic activities and private interests.
- The negotiation process at the local level through the involvement of the key stakeholders.

It is therefore fundamental to use the information which had been produced in the technical phase as a base for further discussion with local stakeholders. A modification of the basic physical and ecological setback lines can be expected as a part of the negotiation process.

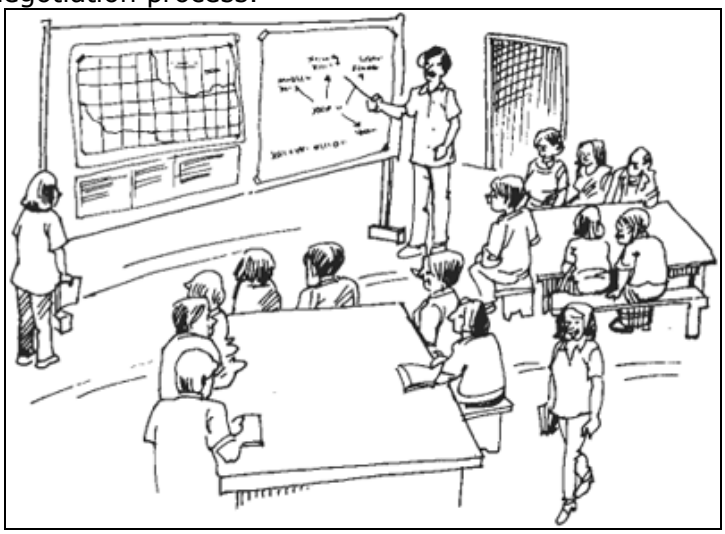

Figure 10 Stakeholder involvement workshop.

4.6 Spatial information

Set back lines for the coastal zone represent spatial information which is useful for management purposes. It is obvious that this kind of information should be prepared, collected, stored and distributed under the common framework for SDI in Europe, the INSPIRE initiative, which sets the standards and requirements for spatial data and metadata management in Europe. Other initiative at the European level already exist, which can support future work on SBL, i.e. Corine, Eurosion. These EU initiative actually give a strong methodological impulse to spatial data use and management at the European level, but their scale, not below 1:100.000, is not sufficient to solve a complex issue such SBL data, which are normally stored in 1:1000 scale.

5 CONCLUSIONS

The results of the preliminary study carried out shows that setback lines cannot be based on physical processes only. The generic application of an arbitrary distance from the coastline (e.g. 100m from high water line) ignores the diversity of coastal characteristics and physical processes. However, it could be the starting point for the definition of a more appropriate setback line based on scientific knowledge and local perception. Arbitrary distances should be only applied when more specific information is not yet available.

The use of setback lines is basically a trade off between coastal development on the one hand and prevention of an unacceptable risk due to coastal erosion on the other. Many investors are either unaware of the risk, or do not think they are liable for any possible damage. Often only the commercial potential is included in the investment decision to build close to the sea while the risk is entirely disregarded. Regional and national governments should however maintain a broader perspective of the issue, including the long term risks and the need for coastal resilience. This requires an assessment of the risk from coastal erosion as well as a procedure how to incorporate this risk into an economic cost-benefit analysis. Furthermore, also ecological values and social motives, such as public access to the beach, can be included in the rationale for defining set-back lines.

The preliminary analysis of the legal frameworks and policies of the EC and of the Member States shows a lack of a common methodology for SBL at the European level, even though the Protocol on ICZM of the Barcelona Convention had been signed with a clear reference to SBL. The development of a Common Framework for SBL should be considered by the Commission as a part of the European cohesion policy and as an initiative which could foster the implementation of the Mediterranean ICZM Protocol in the European Member States (Spain, France, Italy, Slovenia, Greece, Malta, Cyprus). This step can be the base also for further work at the Mediterranean level under international cooperation programmes for coastal safety and environmental protection.

This Common Framework should be based on a methodology that uses scientific knowledge of natural processes, information on ecological and landscape values and an analysis of the costs of implementation under local circumstances. This information should be combined with the perceptions and views of stakeholders at the local level in a process of open communication and discussion. The outcome of this participatory process should be finally used to decide on a setback line that is scientific valid, socio-economic defendable and broadly acceptable by the public. Pilots sites along the European coast should be used to test the methodology.

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