Concepts and Science for Coastal Erosion Management

Specific Targeted Research Project

Thematic priority: Forecasting and developing innovative policies for sustainability in the medium and long term

Final Activity Report

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Coordinator Marcel Marchand

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CONSCIENCE

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Instrument: STREP

Thematic priority: Forecasting and developing innovative policies for sustainability in the medium and long term

Final Activity Report

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Introduction

Problem setting

All around Europe coastal managers are confronted with the problem of coastal erosion. One fifth of the EU's coastline is already severely affected, with coastlines retreating by 0.5 up to 2 m per year. Coastal erosion causes significant economic loss, ecological damage and societal problems. Loss of property, infrastructure and beach width annually causes millions of Euros worth of economic damage, loss of valuable coastal habitat and presents significant management issues. At the same time protection is expensive. For example, in France some €20 million is spent each year on mitigation measures and in The Netherlands the annual budget for sand nourishment amounts to some €41 million. Or take the case of Portugal where €500 million has been invested in dune and seafront rehabilitation and hard defence since 1995 along a coastal stretch from the harbour of Aveiro to the resort of Vagueira [1]. Predictions for the effects of climate change suggest that the scale of coastal erosion will increase and therefore there will be knock-on costs for both protection and repair.

Tackling coastal erosion at its roots

There is increasing consensus among coastal practitioners and scientists that we should address the coastal erosion problem at its source. And that is an imbalance in the sediment budgets in the coastal zone. If sand is lost to deeper water, one should not be surprised that this can lead to erosion at the coast. Scientific knowledge of coastal processes is already well-developed. Available models and monitoring systems are becoming more sophisticated. Yet at the same time it is very difficult for coastal managers to put this knowledge into practice. In many countries coastline management is weak or even non-existent. Without clear government policy, lack of sufficient funds and limited public understanding it is hardly surprising that the approach taken to erosion management is primarily through ad hoc arrangements. Such arrangements tend to be temporary in nature and can often prove detrimental to surrounding coastal areas.

The CONSCIENCE Project

Three years after the EU - EUROSION project finished its comprehensive inventory of the problem and mitigating measures, the EU co-funded CONSCIENCE project was started. This Specific Targeted Research Project (STREP) aimed to develop and test the concepts, guidelines and tools for the sustainable management of erosion that were formulated by EUROSION in order to support their effective implementation for the European coasts. The 3 year project was undertaken by a consortium of 8 partners from 7 European countries (Croatia, Ireland, Netherlands, Poland, Romania, Spain and the United Kingdom).

Table 1: the consortium

Participant organisation name	Short name	Type	Country
Deltares (co-ordination)	DELTARES	Res. Institute	Netherlands
EUCC – Mediterranean Centre	EUCC-MC	NGO	Spain
National University of Ireland, Cork	NUIC	University	Ireland
International Centre for Coastal Resources Research	CIIRC	University	Spain
HR Wallingford Ltd	HRW	SME	United Kingdom
GEOECOMAR	GEO	Res. Institute	Romania
Institute of Hydroengineering	IBW-PAN	Res. Institute	Poland
Priority Actions Programme Regional Activity Centre	PAP/RAC	Other	Croatia

The main aim of the project was to provide an operational support structure for coastal managers so that they can implement sustainable methods for the management of erosion. In order to reach this aim, the CONSCIENCE project has therefore the following ***overall objective***:

> *To define and validate through pilot applications a methodology to support the implementation of the concepts of coastal resilience, favourable sediment status, strategic sediment reservoirs and coastal sediment cells for the European coasts. The project will provide a series of guidelines and tools in support of this approach to ensure that it can be effectively assimilated into a sustainable management strategy for erosion.*

Central to the project is the notion that coastal erosion is a result of a sediment imbalance occurring in a *coastal sediment cell*. Linked to this cell, the project analyses the use of three other key concepts, namely i) *coastal resilience*, ii) a *favourable sediment status* of the sediment cell and iii) *strategic sediment reservoir*. CONSCIENCE aims at developing these concepts into measurable standards, which can be used and evaluated in practice for any field situation. Suitable Coastal State Indicators (CSI's) are developed that can link scientific knowledge, measurements and modelling results to these management concepts.

A generic framework is described for coastal erosion management that bridges the gap between scientific knowledge and practical coastal erosion management. The practical applicability and effectiveness of the framework, CSI's, guidelines and tools are tested in 6 different coastal sites (figure 1).

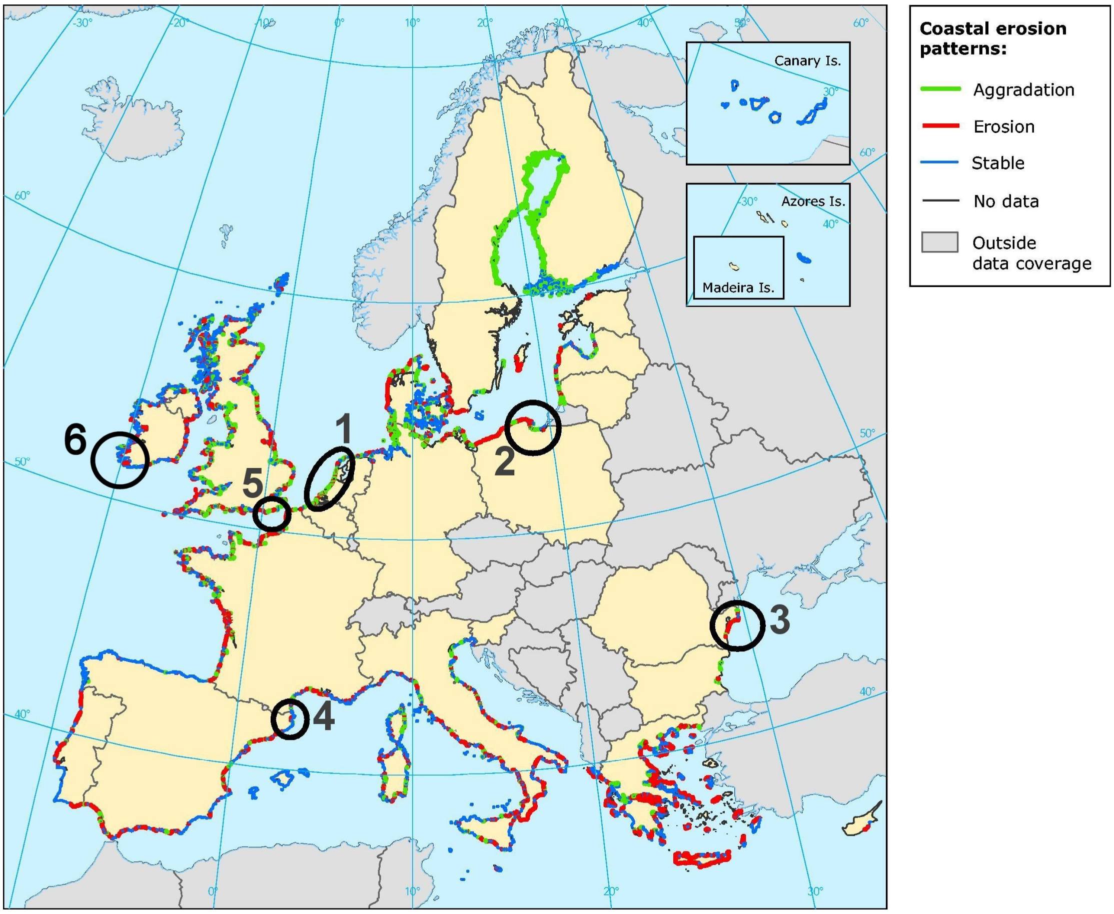

Figure 1: Pilot sites of the CONSCIENCE project (Map source: EUROSION project).
1: Holland coast (the Netherlands), 2: Hel Peninsula (Poland), 3: Danube Delta coast (Romania), 4: Costa Brava (Spain), 5: Pevensey Bay (United Kingdom), 6: Inch Beach (Ireland).

The pilot site studies have finished all their tasks. All pilots have collected and/or compiled data that are required to produce sediment budgets for the identified coastal cells. Model applications have been done to analyse wind and / or sediment transport processes and erosion rates. The Frame of Reference has been used to analyse objectives and steps for coastal erosion management in each of the pilot sites.

It became clear from the project that the coastal erosion concepts as well as the generic frame of reference can provide good guidance for shaping a coastal erosion management policy. However, as the pilot sites show, there is a wide diversity in both physical conditions and societal objectives with regard to coastal erosion that makes generic interpretation and quantification of the concepts difficult. For instance, the delineation of a coastal cell is not only scale dependent, but also relates to geophysical characteristics of the coast and to the strategic objectives for coastline management.

Main achievements

For each of the following objectives the status is briefly summarized in small capitals:

- *Review and consolidate* the existing knowledge and methodologies relevant to the definition and determination of coastal resilience and favourable sediment status (Task 2.1)
  THIS REVIEW HAS FINISHED AND REPORTED AS PART OF DELIVERABLE **D6**: 'ON THE REVIEW OF EXISTING KNOWLEDGE AND METHODS'

- *Review and consolidate* the existing knowledge and methodologies relevant to the identification and delineation of strategic sediment reservoirs and sediment cells (Task 2.1).
  THIS REVIEW HAS FINISHED AND REPORTED AS PART OF DELIVERABLE **D6**: 'ON THE REVIEW OF EXISTING KNOWLEDGE AND METHODS'

- *Provide an inventory* of relevant (emerging) measurement and monitoring techniques and where necessary update the overview of models established by the EUROSION project (Task 5.1).
  THIS INVENTORY HAS FINISHED AND REPORTED AS DELIVERABLE **D1** 'INVENTORY OF COASTAL MONITORING METHODS AND OVERVIEW OF PREDICTIVE MODELS FOR COASTAL EVOLUTION'.

- *Identify possible gaps* including geographical disparities in available knowledge and/or capacities across the EU (Tasks 5.1 and 6.1 – 5).
  REPORT DELIVERABLE **D11**: 'AN ASSESSMENT OF EUROPEAN COASTAL EROSION POLICIES IN RELATION TO ICZM PRINCIPLES'

- *Provide coherent and operational definitions* of the concepts of coastal resilience, favourable sediment status, strategic sediment reservoirs and coastal sediment cells (Task 2.2).
  REPORT DELIVERABLE **D8**: 'REVIEW OF EXISTING KNOWLEDGE AND MANAGEMENT APPROACHES OF COASTAL EROSION'

- *Establish methods and criteria* for the identification and designation of strategic sediment reservoirs (Tasks 4.1 and 3.3)
  THIS OBJECTIVE WAS ADDRESSED IN THE PILOT SITE ACTIVITIES AND DESCRIBED IN DELIVERABLE **D19**.

- *Define the preservation requirements* that shall be applied to strategic sediment reservoirs (Tasks 4.1 and 3.3)
  THIS OBJECTIVE WAS ADDRESSED IN THE PILOT SITE ACTIVITIES AND DESCRIBED IN DELIVERABLE **D19**.

- *Define parameters and thresholds* for coastal resilience and favourable sediment status (Tasks 3.3 and 4.1)
  REPORT DELIVERABLE **D9**: COASTAL PROCESSES AND COASTAL STATE INDICATORS.

- *Develop a harmonised approach* for the identification and delineation of coastal sediment cells, taking into account the wider sedimentary systems including the river basin and marine areas (Task 4.1).
  REPORT DELIVERABLE **D13A** 'CONTROLLING COASTAL EROSION BASED ON THE CONCEPT OF SEDIMENT CELLS'

- *Develop a framework* for sustainable sediment management using the concepts of coastal resilience, coastal sediment cells, favourable sediment status and strategic sediment reservoirs, that have been defined and identified above. The framework will describe the coastal sediment balance in a holistic manner relevant and in a format that is readily understandable to coastal managers (Task 2.2).
  REPORT DELIVERABLE **D7** 'FRAMEWORK FOR COASTAL EROSION MANAGEMENT'

- *Examine the ability* of the methodology to distinguish between different coastal typologies and/or broader areas such as regional seas (Task 2.2).
  THE FRAME OF REFERENCE METHOD HAS BEEN TESTED IN THE PILOT SITES AND REPORTED IN DELIVERABLE **D19**.

- *Improve integrated models* for sedimentation transport and coastal erosion processes and tools for data and model management (Tasks 4.2, 5.2 and 5.3).
  REPORT DELIVERABLE **D13C**: '*MODELLING OF SANDY BEACH AND DUNE EROSION*'. REPORT DELIVERABLE **D13B**: '*MODELLING EROSION OF GRAVEL/SHINGLE BEACHES AND BARRIERS*' .
  REPORT DELIVERABLE **D14**: '*TOOLS FOR DATA MANAGEMENT*'.

- *Test the methodology* for feasibility and validity at a number of test sites covering a cross-section of coastal types and forcing conditions (Tasks 6.1-5).
  THE FRAME OF REFERENCE METHOD HAS BEEN TESTED IN THE PILOT SITES AND REPORTED IN DELIVERABLE **D19**.

- *Develop guidance for implementation*, covering the application of the methodology and monitoring requirements. Guidance should also be provided to facilitate the integration of the concepts into multi-risk management of the coastal zones, planning and environmental assessment (Task 3.4, 5.4).
  WEB BASED GUIDELINES WERE PREPARED AND DOCUMENTED IN DELIVERABLE **D20**.

- *Disseminate the project results* along the project life-time to stakeholders at EU- and national levels (Tasks 7.1 – 4). THE BROCHURE (DELIVERABLE **D4**) HAS BEEN TRANSLATED IN 6 LANGUAGES. THE DISSEMINATION DATABASE HAS BEEN UPDATED (DELIVERABLE **D3**). A WEBSITE HAS BEEN INSTALLED: WWW.CONSCIENCE-EU.NET (DELIVERABLE **D2**). DELIVERABLE **D23** '*CONCISE REPORT FOR POLICY MAKERS*' WAS DISTRIBUTED (2000 COPIES).

Framework for Coastal Erosion Management

A sustainable solution to coastal erosion problems should be based on an understanding of the sediment dynamics, framed in a policy context with explicit objectives and an institutional environment in which each stakeholder has a clear role. The CONSCIENCE project introduces the Frame of Reference (Figure 2) as an aid to formulate this policy. Through this Frame a transparent erosion management policy becomes possible. Also the different Eurosion concepts can be given a suitable place in management.

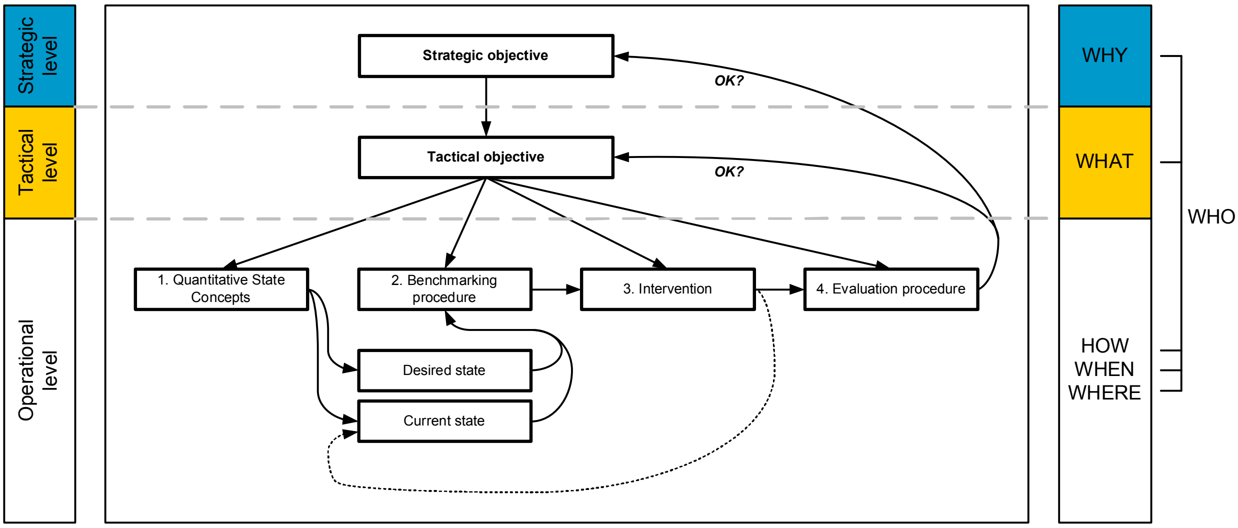

Figure 2: Generic Frame of Reference for coastal management.

The Frame of Reference for policy formulation

Characteristics of the Frame of Reference are the definition of clear objectives at strategic and tactical levels and an operational decision recipe involving four steps. At the highest (policy) level a strategic objective is formulated, determined by the long term vision about desired development of the coast. This vision could be based on generic ideas about sustainable development and should ideally reflect the interdependency of the natural coastal and socioeconomic systems.

At the next level one or more objectives are formulated describing in more detail what has to be carried out in order to achieve the strategic objective. As this implies a choice between different tactics, we call these the tactical objective(s). If, for instance, at a strategic level the objective formulated is 'sustainable development of coastal values and functions', then at the tactical level we have to choose between different options, such as maintaining the coastline at its current position (i.e. not allowing erosion), or allowing a certain variability in coastline position.

Once this tactical objective has been defined, the actual management process regarding interventions can be formulated through four steps, namely:

1. *Quantitative state concept:* a means of quantifying the problem in hand. Coastal state indicators (CSIs) (i.e. specific parameters that play a role in decision making) are relevant at this stage of the process.
2. *Benchmarking process:* a means of assessing whether or not action is required. CSIs are compared to a threshold value at this stage.
3. *Intervention procedure:* A detailed definition of what action is required if the benchmark values are exceeded.

4. *Evaluation procedure:* Impact assessment of the action taken. If the action was not successful it may be necessary to revise the strategic/operational objectives (hence the feedback loops in Figure 2).

Having formulated the strategic and tactical objectives, the operational management is largely a matter for coastal practitioners and experts. In the benchmarking procedure the current state of the coast is compared with the desired state, after which the need for intervention is determined. The procedure describes the kind of information that is needed and how it is collected. Ideally a monitoring programme is in place which enables a pro-active response. Simulation models can be used to predict future coastal behaviour based on historic data.

In order to follow these operational steps, it is evident that we first need tactical and strategic objectives. These cannot be derived by scientists and practitioners alone, since this requires political decisions about the desired development of the coast and how much effort (time and money) society is willing to spend on reaching or maintaining this desired development.

Setting objectives

At the strategic level we have to answer questions regarding the values and functions of our coast. For instance, many coasts contain valuable ecosystems, sometimes explicitly protected through national or European legislation (e.g. Natura 2000). At the same time these coasts are used for recreation, housing, groundwater extraction, agriculture etc. Where the hinterland is low lying, the coast also has a protection function against flooding from sea. Coastal erosion can threaten one or more of these values and functions. Before deciding to act to control erosion, it is advisable first to analyse the relationship between coastal dynamics and the functions of the coast. For instance, a dynamic and sometimes eroding coastline is less of a problem in the absence of built-up areas. Seasonal beach erosion may not be a problem for recreation, if it only happens during the winter storms. In other instances, it may be essential not to tolerate any coastal erosion in case this would lead to significant coastal flooding of built-up areas.

In practice, it appears very difficult to set realistic and unambiguous objectives for coastal erosion management. This already became apparent from the analysis of 60 case studies done by the EUROSION project, which concluded that very few case studies had clearly defined their objectives for coastal erosion management [1]. Developing strategic and tactical objectives should be part of a broader ICZM policy. Using the principles of ICZM is the best way to guarantee a sustainable development policy for coastal erosion, which has the support of all relevant stakeholders.

At the strategic level, objectives are often linked to key policy principles, such as safety and sustainable development. But from a strategic objective it does not directly become clear how to deal with coastal erosion. Therefore, a tactical objective is needed to determine if coastal erosion needs to be controlled or not. For instance, in the UK, the Department for the Environment, Food and Rural Affairs (Defra) has defined the following possible tactical objectives for coastal erosion management:

- Hold the line: maintain or upgrade the level of protection provided by defences;
- Advance the line: build new defences seaward of the existing defence line;
- Managed realignment: allowing retreat of the shoreline, with management to control or limit movement;
- No active intervention: a decision not to invest in providing or maintaining defences.

Table 2 shows the different strategic and tactical objectives found in the 6 CONSCIENCE pilot sites. Note that in some cases these objectives were not officially laid down in policy documents.

Table 2: strategic and tactical objectives for the CONSCIENCE pilot sites

Site	Strategic objectives	Tactical objectives
The Holland coast (the Netherlands)	Safety, sustainable values & functions	Preserve dune strength, hold the line and adapt to sea level rise
Hel Peninsula (Poland)	Preserve the peninsula	Maintain beach width Prevent breaching
Danube Delta (Romania)	Sustainable coastal development	Reduce coastal erosion
Costa Brava (Spain)	Maintain recreational carrying capacity Enhance safety of infrastructure	Maintain beach configuration
Inch Beach (Ireland)	Promote sustainable tourism	Prevent damage to infrastructure
Pevensey Bay (United Kingdom)	Sustainable risk management	Hold the line

Temporal and spatial scales for objectives

It is important to realise that objectives can be made for different time horizons. For instance, providing safety against erosion and flooding due to a storm has a typical time horizon of days: the coast should be strong enough to withstand a storm on any day of the year (and especially during the stormy season). On the other side of the spectrum we may find a time horizon of decades to centuries. For instance if we would like to manage coastal erosion in view of sea level rise and climate change. For each of these temporal scales there is an associated spatial scale: for every day safety we need to zoom in to the condition of the coast up to metres or hundreds of metres. For adaptation to sea level rise we define the coastal cell at the scale of tens to hundreds of kilometres.

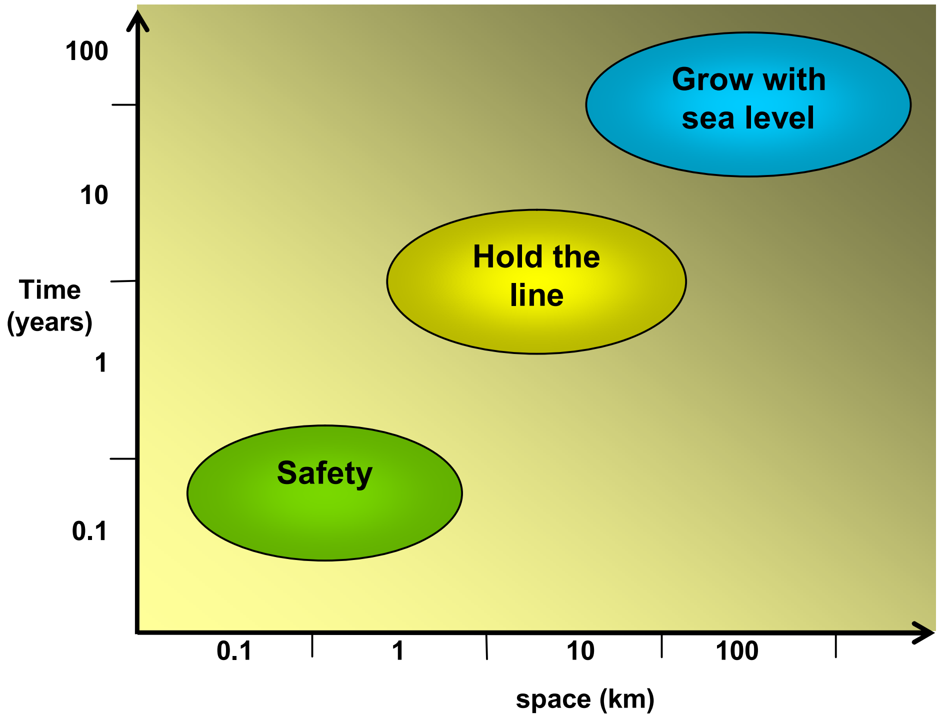

Figure 3. A graphical representation of objectives in time and space

How do the EUROSION concepts fit in?
In many instances, enhancing coastal resilience is an appropriate means to promote sustainability. It should therefore be used as a guiding principle when formulating objectives for coastal management. Good examples of resilient objectives are 'managed realignment' and 'do nothing'. But even an objective such as 'hold the line' could allow for some resilience, for instance by using nourishment to replace losses and maintain a healthy beach. It is often not necessary to demand that at any point in time and place the coastline should be at a pre-defined position. Allowing some flexibility in this criterion would enable the coastline to fluctuate around an average position, which is much more efficient. For example, the Dutch definition of the 'coastline' is related to a *volume* of sand around the mean low water line. This definition allows redistribution of sediment close to the coastline without changing the formal coastline position.

The concepts of coastal sediment cell, strategic sediment reservoir and favourable sediment status are useful for implementation of erosion management at the operational level:
- The coastal sediment cell is the most logical unit to express the sediment situation. Therefore, the coastal cells concept is used in definitions of the quantitative state of the coast.
- Favourable sediment status is an expression of the desired state of our coast and should be used for the benchmarking procedure.
- The strategic sediment reservoir is an essential component of the quantitative state of the coast, and can be used as a sediment supply for nourishments as an intervention measure.

Data, Monitoring and Tools

Monitoring data is vital in developing a picture of the way a beach is evolving. Data helps in developing an understanding of trends and the variation around a trend. A review of different methods of monitoring beaches, covering a range of time and space scales was provided by Sutherland (2010a) which also provides an overview of the models and other tools used to predict beach evolution.

A coastal state indicator (CSI) is a measurable parameter that defines the (desired) state of the coast in order to meet a tactical objective. The major functions of coastal state indicators are to assess the condition of the environment, to monitor trends in conditions over time, to compare across situations, to provide an early warning signal of changes in the environment, to diagnose the cause of an environmental problem, and to anticipate future conditions and trends. Coastal State Indicators should:

- be relevant – there must be a direct conceptual link between the CSI and the coastal function of concern;
- be measurable – ideally using a range of different technologies from the cheap and simple to the expensive and complicated in order that the indicator may be applied in a range of situations with different monitoring policies;
- have a known response to disturbances – that is scientifically based and so reproducible;
- be anticipatory – so that an indicator can be used to prompt action when the indicator reaches a scientifically-derived threshold value;
- be integrative – by combining data and knowledge of processes across the appropriate time-scale and spatial-scale to provide information that is useful to the coastal manager in implementing a policy.

CONSCIENCE has developed the use of Coastal State Indicators in coastal erosion management and tested their application at a number of pilot sites. Table 3 shows the CSIs used in the different pilot sites of the project. It should be noted that these are not the only suitable CSIs that could be used or developed for coastal erosion.

Table 3 Grouped Coastal State Indicators

CSI	Quantity represented	Pilot Site
Dune strength	Standard of protection (SoP) for storm	Dutch coast
Barrier width	Standard of protection for storm	Pevensey
Total barrier volume	Standard of protection for storm	Pevensey
Backshore width	Standard of protection for storm	Black Sea
Dune zone width	Standard of protection for storm	Black Sea
Dune zone height	Standard of protection for storm	Black Sea
Momentary coastline	Position & boundary condition for SoP	Dutch coast
Beach width	Boundary condition for SoP of hard defence	Costa Brava
Barrier crest position	Position	Pevensey
Shoreline position	Position	Black Sea
Shoreline position	Position	Hel Peninsula
Coastline position	Perception of safety	Inch Beach
Coastal foundation	Growth with sea level rise	Dutch coast
Shoreface volume	Flood and coastal erosion risk	Hel Peninsula
Coastal slope	Flood and coastal erosion risk	Black Sea

There are regular measurements and use of the coastal state indicators at three of the sites considered (Holland coast, Costa Brava Bays and Pevensey Bay). At all three sites extensive studies into the behaviour of the beach (such as its response to storms) have been undertaken, which led to the choice of appropriate coastal state indicators, the setting of threshold values for intervention and the choice of a means of intervening.

At the other three sites, there are fewer routine surveys and fewer quantitative studies of the response of the beaches have been undertaken. The relevant coastal state indicators are starting to be derived, but have not been fully developed to link policy to response through the use of thresholds. Coastal state indicators are not routinely used by the coastal managers at these sites.

This experience suggests that the effective use of coastal state indicators for coastal erosion requires there to be knowledge of the state and behaviour of a coastal system to be able to identify the relevant coastal state indicator to meet the tactical objective set by policy makers. There will often be more than one option for implementing a tactical objective and the choice of option will influence the choice of coastal state indicator. This process relies on site-specific studies to define the best option, the relevant coastal state indicators and appropriate thresholds that should prompt intervention.

However, this requires a policy framework that sets strategic and tactical objectives for coastal erosion, as the coastal state indicators are used to assess how well objectives are being met. In countries where there is an effective policy framework this tends to be at a national level. The setting of operational and tactical objectives for coastal management is a pre-requisite for the implementation stage that uses coastal state indicators.

The successful application of coastal state indicators in the management of coastal erosion requires

- a management policy, which defines the strategic objective;
- a tactical objective that determines whether coastal erosion needs to be controlled, or not;
- knowledge of the state of the coastal system and understanding of the key processes of erosion and accretion;
- coastal state indicators that link the knowledge of erosion processes to the tactical objective;
- locally determined threshold values for the coastal state indicators;
- routine monitoring, to calculate values of the coastal state indicators;
- a range of measures for intervening, should a threshold value be crossed; and
- periodic assessment of the implementation and of the tactical and strategic objectives.

The different pilot sites have demonstrated how tactical objectives at different scales and for different purposes (recreation as well as coastal erosion) can be implemented using coastal state indicators. At their best, coastal state indicators integrate site-specific knowledge and study results with repeated measured data to provide coastal managers with information that they can act on to manage their beaches in an adaptive manner.

Coastal State Indicators can be measured in different ways. Methods vary between simple low cost monitoring systems, such as using the traditional theodolite to advanced technologies, using airborne radar and laser equipment. For instance, in the Pevensey case, the information for the CSIs is obtained by mounting a GPS system on a quad bike and driving along breaks in the profile.

In light of the above, CONSCIENCE has produced an inventory of innovative monitoring methods and has updated the overview of models developed in EUROSION. Table 4 gives a list of the methods which have been described and illustrates the variety of methods available. Some of these methods are quite cheap, others require expensive equipment or are costly to operate, such as airborne methods. Each method has its advantages and disadvantages. It is therefore essential to establish what the data will be used for (see box for guidance). A survey programme may, therefore, be based on a conceptual (or numerical) model of coastal hazards or risks. For example, exposed sites with a high risk or flooding or coastal erosion may be surveyed at a closer intervals and more often than a hard rock coastline with a strategy of no active intervention.

Monitoring guidance

The key points for monitoring guidance include:

- Establish what the data is to be used for. A wide range of data could be used in coastal management, including data on wind, waves, tides, beach sediment, offshore bathymetry, coastal profiles, geomorphological features, coastal defences, beach nourishment or recycling. All will cost money to collect and that cost should be justified;
- Establish a reliable system of ground control points or permanent markers that can be used by all surveying groups, whatever technique they are using;
- Explicitly state the datum system to be used;
- Establish a clear set of guidelines for the surveys, including tolerances and national or international standards to be met (such as ISO or British Standards) and guidance on when to survey (with respect to the months, the spring-neap tidal cycle and the occurrence of storms).
- Develop a data management system that will allow the data to be stored, accessed, analysed and represented.

Table 4 Coastal monitoring methods

Monitoring type	Explanation	Examples
Small scale		
Linear arrays of point sensors	Measurement of the depth of scour under all conditions	Tell Tail scour monitoring system
Underwater acoustic measurements of the seabed	An acoustic backscatter device can be used to detect the level of the seabed and give information about sediment in suspension in situations where the seabed and instrument are fully submerged.	Autonomous Sand Ripple Profiler (ASRP)
Measurements of emerged toe levels	There are a number of techniques that can be used to measure emerged coastal defence structure toe levels at a point every low tide.	Argus video system Counting the number of steps above the beach level at access points
Measurements of mixing depth	The seabed mixing depth is the maximum depth below the seabed where sediment motion occurs	Stack of numbered aluminium disks of known height
Medium scale		
Cross-shore profile surveys and topographic surveys	Beach profiles and topographic surveys are typically collected using a large range of methods	Theodolite Kinematic GPS (e.g. mounted on a quad bike) Laser scanning systems Repeated digital photography (Argus) X-band radar
Large-scale		
Mapping of tidelines or shorelines	The position of the shoreline or tidelines (i.e. location of some representation of high water level and low water level) is commonly marked on maps. Different editions of the same map series, sometimes stretching back more than 100 years, can be used to determine long term changes to the position of the shoreline.	Orthorectified aerial or satellite photos Topographic LIDAR Bathymetric LIDAR Synthetic Aperture Radar (SAR) Bathymetric surveys from ships

Erosion Modelling

A considerable amount of research has been carried out over the least 20 years to develop predictive numerical models of coastal evolution covering periods of up to 20 years or more. These models are based on representations of physical processes and typically include forcing by waves and/or currents, a response in terms of sediment transport and a morphology-updating module. However, there are still major gaps in our understanding of long-term morphological behaviour which mean that modelling results are subject to a considerable degree of uncertainty. Their use requires a high level of specialised knowledge of science, engineering and management.

Modelling erosion of sandy beaches and dunes

As part of the CONSCIENCE project, a study has been made of scaling laws, experimental and mathematical modelling of beach and dune erosion under storm events. The mathematical model results have been used to develop a simple dune erosion rule, specifying dune erosion volumes and dune recession values.

Also a detailed sensitivity study was executed which revealed that the two most influential parameters are the storm surge level (above mean sea level) and the bed material diameter. Dune erosion increases with increasing storm surge level (SSL) and with decreasing bed material diameter (d_{50}). The wave period also has a marked influence. Dune erosion increases with increasing wave period. The wave spectrum has no significant effect on dune erosion.

The mathematical model results have been used to develop a new dune erosion rule (DUNERULE-model). This dune erosion rule estimates the dune erosion with respect to a base Reference Case, which represents a storm of 5 hours duration with a constant wave height of 7.6 m (period of 12 s; normal to coast), bed material diameter of 0.225 mm and storm surge level of +5 m (above mean sea level). The computed dune erosion (above SSL) of the base Reference Case is 170 m^3/m (much lower than the erosion volume of 300 m^3/m based on Deltaflume experiments). The most influential parameters are the storm surge level (SSL) and bed material diameter (d_{50}). Dune erosion decreases for smaller storm surge levels, smaller wave heights, smaller wave periods, shorter storm duration and coarser sand. The new dune erosion rule is most valid for dune erosion under major storms, but also yields realistic results for minor storm events based on a comparison with measured data from USA-beaches.

Modelling erosion of gravel beaches

Two models (process-based CROSMOR2008-model and parametric SHINGLE-model) have been used to simulate the cross-shore swash bar formation under low wave conditions and gravel barrier erosion under high wave conditions (storm events). The SHINGLE-model is a parametric profile model based on shape functions. The process-based CROSMOR-model describes the propagation and transformation of individual waves (wave by wave approach) along the cross-shore profile using a probabilistic approach by solving the wave energy equation for each individual wave. The detailed swash processes in the swash zone are not explicitly modelled but are represented in a schematized way by introducing a time-averaged effective swash velocity in a small zone just seaward of the last grid point. The swash velocity is of the order of 1 to 1.5 m/s. The deposition (or erosion) profile in the swash zone is assumed to have a triangular shape.

Test results of the Deltaflume and GWK experiments have been used to calibrate the CROSMOR-model for gravel and shingle slopes. Qualitatively the results are in reasonable agreement with the measured values. A swash bar of the right order of magnitude is generated above the waterline in both experiments, but the computed swash bars are too smooth whereas the measured swash bars have a distinct triangular shape and are positioned at a higher level on the slope. Simular results are obtained for the other large-scale laboratory tests.

To demonstrate the applicability of the process-based CROSMOR-model for prototype shingle barriers, the model has been applied to a real field case (Pevensey Bay, UK) and a schematized field case. The SHINGLE model of HRWallingford has also been applied to the field case of Pevensey Bay. Various storm cases are considered representing events with a returrn interval of 1 to 400 years and an extreme event with a return interval of 10000 years. The CROSMOR-model results and the SHINGLE-model results show rather good agreement of computed erosion values for the storm case with the largest offshore wave height of 6 m. The SHINGLE-model predicts a relatively large build-up of the crest. The agreement of computed profiles for the other storm cases with smaller offshore wave heights is less good.

The CROSMOR-model has also been applied to a schematized field case with a relatively steep nearshore slope. Wave-induced longshore velocities are relatively large for oblique wave approach along the steep slope. The longshore current velocity has a maximum of 3 m/s for an offshore wave angle of 15^o and 4 m/s for an angle of 30^o, just landward of the toe of the beach slope. The longshore transport increases strongly in the nearshore zone and is maximum at the location where the longshore velocity is maximum (around 0 m depth line). The computed longshore transport rates vary roughly between 5 m^3/day and 9000 m^3/day (including pores) for offshore wave heights between 1 and 8 m. About 80% of the longshore transport occurs in the surf zone landward of the -6 m depth contour and about 70% landward of the -4 m depth line.

Using models to define setback lines
Physical processes are the basis for the identification of setback lines. They can cover *extreme events* and *chronic processes*, including sea level rise. Physical processes affect each type of coastline, depending on their topography and elevation.

For beach-dune complexes our knowledge of the effect of storms is rather well developed. For instance large-scale experiments have been done in a flume facility. These experiments provided benchmarks for models that can predict erosion levels during extreme events. Sensitivity studies show that the two most important factors are the storm surge level (above mean sea level) and the bed material diameter. Dune erosion increases with increasing storm surge level and with decreasing bed material diameter. The wave period also has a marked influence. Dune erosion increases with increasing wave period.

Figure 4 depicts the dune erosion area (above the storm surge level) after 5 hours as a function of sediment size and storm surge level based on the cross-shore model of Van Rijn. What the figure shows is that dune erosion is very much dependent on the diameter of the sediment. Dune erosion rates are largest for relatively fine sediments and reduce rapidly for coarser sediments. Dune erosion of gravel (1 mm) is only 15% of that of fine sand (0.15 mm). What the figure also shows is that for a fine sandy dune 10 m high a severe storm will produce an erosion rate in the order of 30 m. With this kind of model output, risk lines can be developed such as those shown in figure 4. For example, a North Sea storm with a surge level of 5 m above mean sea level has a return period of about 10,000 years (so on average once in 10,000 years). The return period of a surge level of only 2 m is 1 year; so, on average once every year. The computed dune erosion values are of the order of 20 m^3/m for a surge level of 1 m and up to 300 m^3/m for a large surge level of 5 m. To withstand an extreme event with surge level of 5 m above mean sea level, the dune row fronting the sea should have a minimum width in the order of 50 m.

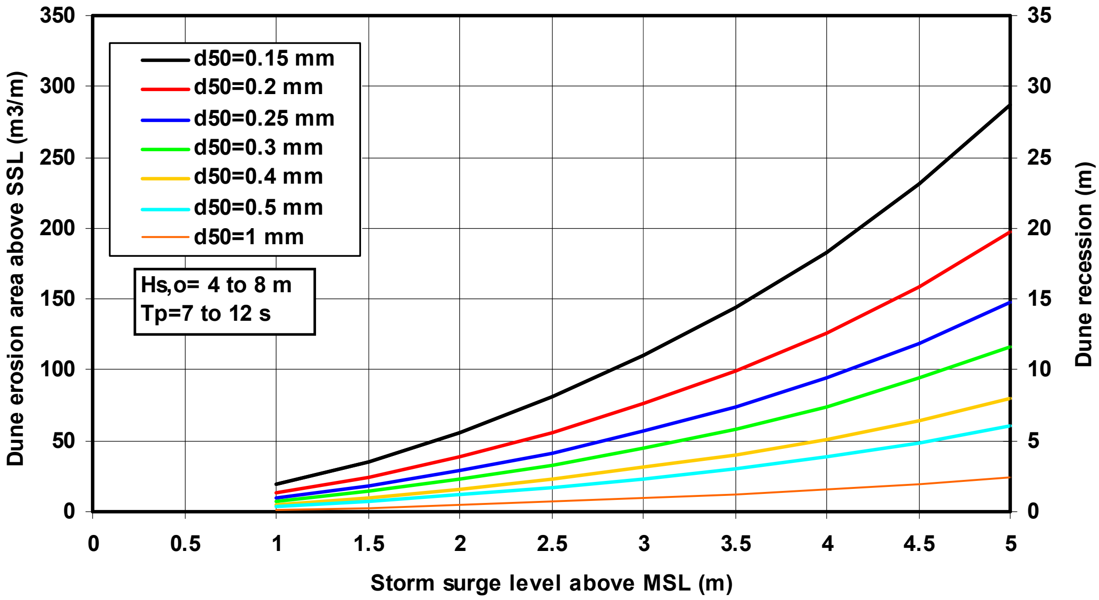

Figure 4. ***Dune erosion after 5 hours of a storm event as a function of sediment size and storm surge level. Dune recession based on dune height of 10 m above SSL***

We can also estimate whether or not the beach/dune complex will recover from chronic erosion. In 'normal' conditions with two or three events per year and surge levels between 1 and 2 m per year, the total annual dune erosion may be as large as 50 m^3/m/year along sandy North Sea coasts. Most of the eroded dune sand will be deposited on the beach from where it can be returned to the dune front by wind-induced forces or carried away by cross-shore and longshore currents. Dune accretion at the dune front due to wind effects is in the order of 10 to 20 m^3/m/year and is generally not sufficient to compensate dune erosion on the annual time scale. Thus, dune erosion generally leads to a permanent loss of sand which can only be compensated by artificial nourishment or dune reinforcement of the order of 50 m^3/m/year.

Beach erosion during minor storm events with surge levels below 1 m is of the order of 10 to 20 m^3/m per event. Beach build-up during daily fair-weather waves is in the order of 1 to 2 m^3/m/day. Thus, beach erosion can easily be compensated for by natural processes on a time scale of weeks.

Case studies in pilot sites across Europe

In *Conscience* we have applied the developed frame of reference to manage erosion-related problems at six contrasting field sites covering different spatial and time scales (Fig. 1 and Fig. 5).

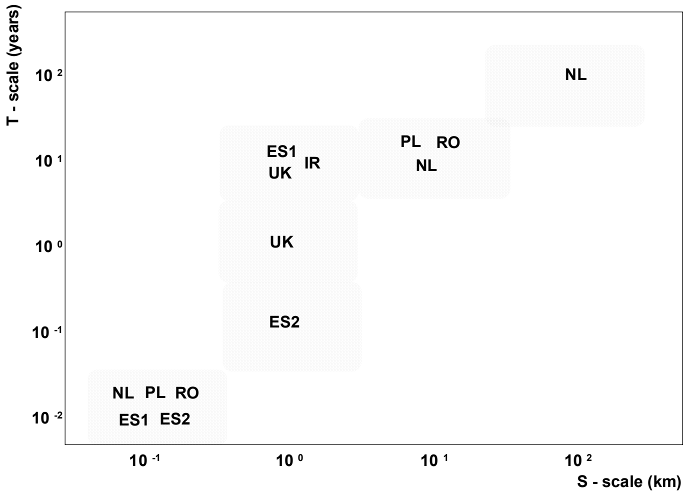

Figure 5. Conscience case studies in the S-T plane.

They include the whole of the **Netherlands coast** as representative of a country where coastal resilience is an essential requirement even for the survival of large parts of the country. Because of that it has a well developed legal and administrative structure to control coastal evolution and to assess any performed interventions.

The Dutch coast in the Southern North Sea is exposed to medium to energetic waves and strong tidal wave-induced currents. Three different scales are being considered nowadays explicitly for the coastal zone management in the Netherlands. It is important to realize that each scale is analysed in terms of a key variable and that is applied at given temporal and spatial scales. The shortest scale, associated to several days and several metres, is analysed in terms of the residual strength of the dune field. The main variable considered is the residual dune volume after the action of a wave storm. The next scale is that associated to a basal coast line at a temporal scale of years and a spatial scale of kilometres. The main variable considered is the basal coastline or coastline of reference. It corresponds to the coastline position in the year 1990, against which "momentary" or present coastlines are being compared. The last scale considered is that of the coastal foundation, which corresponds to the inner shelf at depths below 20m and it is associated to a temporal scale of decades or centuries and a spatial scale of decades or hundreds of kilometres.

The second field case corresponds to part of the **Hel Peninsula** in the Baltic Sea (Poland). The studied cell is located between a harbour on the Western side and the end of the peninsula on the Eastern side. The sediment transport pattern has been defined considering that the harbour acts as the Western barrier and the end of the spit as the Eastern barrier. In the budget both the cross shore transport and artificial nourishment have been considered.

More than 20 profiles have been analysed in terms of bathymetry and prevailing hydrodynamic conditions along the coast for the period between 2004 and 2008. The resulting sediment transport rates have been calculated using state of the art formulations and the observed changes in bathymetry. This Polish coast line represents a typical coastal situation where there is prevailing erosion after the construction of a barrier, in this case a harbour. It corresponds to a site in which there are low to medium energy waves and a limited tidal range. There is some field information available although not long enough to provide a robust basis for long term conclusions.

The third field case corresponds to a stretch of deltaic coast in the **Danube delta** in Romania. It goes from the Sulina jetties to the Sahalin spit and benefits from the discharge of a river near the beginning of the spit, located on the western side of the Black Sea coast. There are two sources of sediment identified as strategic reservoirs. The first one is the area where sediments are blocked by the jetties at the Northern part of the stretch. The second one consists of the sediments dredged from the channel giving access to the river. There are 14 points which have been defined to control coastal evolution, calculating sediment transport and shoreline dynamics at each of them. There are limited observations available and a number of wave fields have been obtained using a wave model (SWAN) and the available synoptic fields. The calculated transport rates have been based on the "CERC" and "Bijker" formulations.

This coast represents an interesting case of subsiding beach, located in a delta which is partially retreating. It also offers the possibility to consider various management options given the low to medium level of human pressure acting on that coast. However, there are some requirements as, for instance, the accreting spit whose sand cannot be used for nourishment, since it is a protected area. It also corresponds to a coast with micro tidal range and low energetic waves.

The **Costa Brava** case corresponds to two pocket beaches which, feature, in one case, a net budget in equilibrium and, in the other case show a net loss at the southern boundary. These two cases are the Lloret de Mar and the Blanes Costa Brava beaches. The Lloret de Mar beach corresponds to a pocket beach located between two natural rock capes. The sediment budget is in near equilibrium since the two capes are considered to act as total barriers for the engineering (up to 25 years) timescale. The beach is subject to oscillations in plan and partially also in profile due to the prevailing wind-wave conditions. The second Costa Brava beach, that of Blanes, is located between the Blanes harbour which acts as a total barrier on the Northern side of the beach and the Tordera river mouth which acts as a sediment (deltaic protuberance) dynamic barrier at the Southern end of the cell. The sediment transport at this Southern barrier has been estimated in 30.000m^3 per year. The beach is therefore suffering a net erosion which results in various types of conflicts particularly in the Southern most part of this beach.

For this case as for any other beach analysis we must consider the available beach width and the expected incident waves (and thus transport patterns) to assess the corresponding risk. This risk may go up to dangerous levels in areas not protected by neither of the two barriers and subject to large enough wave heights. The advanced knowledge on which parts of the beach are experiencing higher risks should allow an interactive management of the beach, transferring sediment from areas with a surplus, near on the barriers, to areas close- by but experiencing a beach width below the established threshold.

The **Pevensey shingle barrier beach** is located in Pevensey bay in the South East coast of England. There are a number of groins in various states of maintenance and a number of nourishment operations have been performed as described in the corresponding paper. It is worthwhile mentioning that the analysis of transport conditions has included the joint probability distribution of wind generated waves and storm surges from which the barrier cross sectional area as a function of return periods has been obtained. The minimum or threshold conditions have been assigned to the area measured in 2003. This probabilistic approach is well in line with the CONSCIENCE Frame of Reference in the sense that it makes explicit the need to predict (decide) in the face of uncertainty.

The Pevensey Bay corresponds to a case where the human settlements and the value of the hinterland require a coastline stability which is at odds with the natural dynamic character of the beach, reflecting intense cross-and-long-shore transports. The shingle dynamics illustrate the difficulties in predicting sediment transport for such sediment fractions. It also illustrates the difficulty of establishing cell boundaries which in this case are not so straightforward to establish as in some of the former cases.

Finally **Inch and Rosbehy Strands**, Dingle Bay, Kerry (Ireland) comprise large barrier-dune systems, linked to dissipative shorefaces and a high energy tidal delta system. Inch is c. 5.5 km in length, orientated N-S and receives direct Atlantic swell waves from the west to the shoreface. The dunes systems reach up to 30m in height and comprise a complex of transverse and active parabolic dunes. Rosbehy is a simpler, narrower system directly south of Inch and on the south side of the tidal delta that separates the 2 systems.

Analysis of existing data suggests that Inch only suffers large scale erosions (100's of metres) during extreme conditions. The main issue from the management standpoint is protection of infrastructure / safety of life and it would appear that the problem is being addressed. However this is an ad-hoc response and is not part of any coastal erosion management policy (nationally or locally).

Extensive descriptions of each case study have been given in papers, which will be published in a special issue of the Elsevier journal *Ocean & Coastal Management*. A list of the papers to be included in the issue is given below (Table 5)

Table 5. List of Contents of Conscience Special Issue of Ocean & Coastal Management journal.

#	Title	Authors
Paper 1	The *Conscience* framework	M. Marchand, A. Sanchez-Arcilla, J. Gault & J. Sutherland
Paper 2	The role of coastal erosion science for management of dynamic coastlines	A. Sanchez-Arcilla & J. Jimenez
Paper 3	Implementation of coastal erosion management in the Netherlands	J. P.M. Mulder, S. Hommes & E. M. Horstman
Paper 4	A scientifically-driven approach for the management of coastal erosion along the Hel peninsula (Poland)	W. Sulisz & M. Paprota
Paper 5	Dealing with erosion along the Danube Delta coast (Romania)	A. Stănică, S. Dan, J. A. Jiménez, G. V. Ungureanu
Paper 6	The management of Pevensey shingle barrier (UK)	J. Sutherland & I. Thomas
Paper 7	Erosion management in Inch beach (Ireland)	Gault, J, O'Hagan, A.M., Cummins, V., Murphy J. Vial, T.
Paper 8	Managing erosion-induced problems in NW Mediterranean urban beaches (Spain)	J. A. Jiménez, V. Gracia, H. I. Valdemoro, E. Tonatiuh Mendoza & A. Sánchez-Arcilla
Paper 9	The role of coastal setbacks in eroding coastlines	M. Sano, A. Stanica, M. Marchand, I. Trumbic
Paper 10	Managing coastal evolution in a more sustainable manner. The Conscience approach	A. Sánchez-Arcilla & J. A. Jiménez

Dissemination and use

Exploitable knowledge and its use
Not applicable

Dissemination of knowledge

CONSCIENCE website
The website http://www.conscience-eu.net (Deliverable 2) has been operational since March 2007, and it will be three years more after the project end. The project web-site contains all the project documents, reports, pilot site descriptions as well as the guidelines for erosion management.

During the end phase of the project the website was restructured, putting the emphasis on the results of the CONSCIENCE project. The central part of the website are the "Guidelines for sustainable erosion management" – a step-by-step user-friendly guidance to facilitate the application of and integration of the methodology into planning and management of coastal erosion with example links to the pilot sites descriptions. Next to that all project documents, including the concise report are available online for download. Further, translations in 5 European languages of the project Brochure are made available for download.

The website was launched in March 2007 and was visited 38865 times up to April 2010. The statistics show a growing tendency in the average number for visits. In 2007 the average number of visits per month was 194. In 2008 it was 617, in 2009 it was 1466 and in the first four months of 2010 it was 2881.

The CONSCIENCE website will be maintained 3 years after the project completion in order to ensure a long-term accessibility to project results.

Promotion material
Printed information material on CONSCIENCE has served two purposes: firstly, to briefly inform the targeted communities about CONSCIENCE, its mission and objectives, and raise awareness on the users and partners of the project, secondly, to raise the interest in the project and promote the URL of CONSCIENCE for further in-depth information. As various partners have been involved in publishing information about the project, it was important to agree on some standard visual elements (CONSCIENCE colours, fonts and the logotype) to create name familiarity and a typical, recognisable CONSCIENCE identity.

A **project brochure** (**Deliverable 4)** was published and widely disseminated (circulation 3000 copies, re-print of 1000 copies in September 2008). It is a full colour print, with attractive design and a good balance of text and visual elements. This document contains a brief introduction to the project, its origins and objectives, framework for research development, details on how to get involve and the partnership. All CONSCIENCE partners have distributed this information tool during conferences, meetings and for mailings (see Annex 3). The objective was to increase knowledge about the project initiatives, gain the interest of a growing community, and get potential end-users involved in the project development. In addition and since there were various countries represented in the project consortium, it was agreed that translations and ready-to print files were be made available for download through the website in project partner languages: Spanish, Dutch, Croatian, Romanian, and Polish.

Additionally, a **project poster** (**Deliverable 2)** was prepared in format A1, printed and distributed to CONSCIENCE partners by EUCC- Mediterranean Centre. It aims at drawing the attention of conference participants to the project and encouraging them to visit the website and get involved in the process. An updated poster was prepared to, including the envisaged project results, and it was presented at the international MEDCOAST conference in November 2009.

In addition, newsletter articles, reports and other publications have been developed by all partners. Several in-house publications of the partners provided convenient fora for information dissemination. The EUCC quarterly magazine *Coastline*, EUCC Coastal News (monthly electronic newsletter and its Dutch and German language versions, with almost 5000 subscribers) and the EUCC Euro-Mediterranean newsletter (quarterly electronic newsletter in English, Spanish and French) have already proven to be successful dissemination tools for similar projects in the past as the reader feedback shows.

Several articles have been disseminated through the EUCC Mediterranean News C&M E-News electronic newsletter during the project duration: announcement of the start of the project (http://www.eucc.net/en/news/CN07-03.pdf) and progress information about project development (http://www.eucc.net/en/news/CN07-06.pdf), and workshops and visits to local sites (http://www.eucc.net/en/news/CN09-02.pdf). The CONSCIENCE project has been also highlighted through the quarterly EUCC Euro-Mediterranean e-Newsletter (http://www.eucc.net/medcentre/newsletter/index.htm):

- June 2007: project kick off
- October 2007: project progress
- July 2009: project workshop
- September 2009: editorial by the project leader, Marcel Marchand

Moreover, an announcement was sent on 19th March 2010 to the mailing list of this newsletter to inform about the project final event.

Further, partners have also disseminated project information through their newsletters and networks such as :
- Link from HR Wallingford web pages at
http://www.hrwallingford.co.uk/index.aspx?facets=projects&hrwsector=Coasts
- CMRC, Cork (Ireland) quarterly newsletter - Issues available online at
http://cmrc.ucc.ie/pages/news/cmrcnews10_auwi2006_web.pdf;
http://cmrc.ucc.ie/pages/news/NewsletterVol12_Spring2008.pdf
The CMRC website contains details of the project and provides a link to the overall project website which provides an insight to interested browsers and a conduit to more information on the project site. http://cmrc.ucc.ie/pages/research_project_page.php?project_code=conscience.

Project results deliverables
Among the project results deliverables, it is important to highlight the **Concise report for policy makers (D23)** as a powerful mean to inform about the project and, more important, to give a first insight about the project findings. This short, attractive and colourful publication is aimed mainly, but not only, to policy makers. It provides a first insight of project findings, giving the possibility to know in-depth via the website. Two thousand copies have been printed and will be widely disseminated through the dissemination database of contacts (D3) and through the own network of contacts and institutions and at the occasion of relevant meetings and events, listed at Annex 3 and 4.

Networking
Each partner disseminates information on CONSCIENCE within his or her organisation and the organisation's networks. These actions are implemented during staff and board meetings within organisations, at international project team meetings, and similar

occasions. The aim of networking activities is to raise awareness about the project and receive feed-back on its development.

Co-ordination with related initiatives

For an efficient dissemination of CONSCIENCE and its further development, it has been important to co-ordinate efforts with similar programmes and strategic information initiatives. One way of fostering such co-ordination has been keeping them updated on project progress and using every possibility for direct exchange of information and discussion. Therefore a list of key initiatives and organizations were listed and linked on the project website – see http://www.conscience-eu.net/links/index.htm. This list has progressively been updated.

Action Plan

Mechanism	Activity	CONSCIENCE partner responsible	Time schedule
Project Web Portal (D2)	Register domain name at www.conscience-eu.net , draft and upload initial CONSCIENCE project information, including definition of visual identity elements of CONSCIENCE project such as logo	**EUCC**, Deltares	Done
	Collection of material, photos from study sites & comments	**EUCC**, ALL	Done
	Encouraging partners to submit updated information on progress of their work package, editing this information, filling in information gaps	**EUCC**	Ongoing and this will be promoted by EUCC during the following 3 years while the website will be online
	Monitoring number and profile of visitors	**EUCC**	Every year
	Submitting information for the website	All	Continuously
	Maintenance of website for 3 years after project completion	EUCC / CoastInfo subcontract	2010 - 2013
Project Brochure (D4)	Draft, print and distribute to partners first Brochure (circulation: 3000)	**EUCC**	Done (month 4)
Project Poster (D4)	A1 format Draft, print, and distribute to partners	**EUCC**	Done (month 6)
Dissemination Database (D3)	Preparation of draft list of contacts for dissemination, including all levels of stakeholders and End-users advisory group.	**EUCC**	Done (month 6)
	Collection of additions, corrections from partners	ALL	Ongoing
Conferences and exhibitions	Preparing list of potential events for project presentation, and/or exhibition of poster	**EUCC**, and all partners	See Annex 3
Collection of articles in publications (D21)	Identifying opportunities, submitting articles, collection of published articles and feedback through the dissemination activities	**EUCC** and all partners	e.g. Coastline magazine: end 2008, 2009
Concise report for policy makers (D23)	Final report based on collection of all partners contributions	**Deltares**	Done

Promotion targets and results achieved

Specific targets to be reached until the end of the project 36 months period were listed at the first version of this dissemination plan:

- at least 3000 website visitors,
- at least 5000 professionals learned about CONSCIENCE via brochure and web-based activities (incl. E-news articles of EUCC),
- dissemination activities reached a substantial percentage of the target audience as defined by the Plan
- at least 5 presentations at national and international expert meetings were given about or with reference to CONSCIENCE.

These targets have been largely accomplished, we can assert that the expected results over the project life have been achieved: CONSCIENCE is well known among coastal erosion experts and coastal managers and policy makers throughout Europe; CONSCIENCE printed information material and web-based mechanisms have reached the main coastal erosion research, policy-makers and practitioners.

This final Dissemination plan, coming at the final phase of the project, provides more opportunities for disseminating CONSCIENCE, which will therefore upgrade the degree of results achievement.

The way forward: project results dissemination and future initiatives

The dissemination of project results

The main CONSCIENCE findings came at the end of the project and therefore there dissemination falls largely beyond the project life. This is the reason of the existence of this chapter: provide the means and occasions to widely spread the CONSCIENCE results.

As for the means, once the target audience is aware of the project, it is time to focus on the use of project results. Thus, the project partners will disseminate:

- ✓ The project website, which will be active three years after the project completion. This will be the project gateway of results.

- ✓ The central part of the website are the "Guidelines for sustainable erosion management" – a step-by-step user-friendly guidance to facilitate the application of and integration of the methodology into planning and management of coastal erosion with example links to the pilot sites descriptions.

- ✓ Project documents for download section provides access to all public documents, including the Concise report are available online for download. Further, translations in 5 European languages of the project Brochure are made available for download.

Foreseen further project development

Future science-policy project initiatives

The "CONSCIENCE concise report for policy makers" concludes with some recommendations at different policy levels within Europe. More than recommendations, it sets orientations for of future implementation needs of the CONSCIENCE project results as well as it application of the coastal erosion concepts defined by EUROSION.

At the EU level, several suggestions have been formulated:

- ✓ *Promoting the use of the Inspire Directive to support the standardized delineation of coastal sediment cells by incorporating key input datasets required for such delineation into Spatial Data Infrastructure standards being established under the terms of the Directive.*

- ✓ *Promoting the designation of strategic sediment reservoirs in marine planning by Member States under the Marine Strategy Framework Directive and in the spirit of the Soil Strategy.* In fact, this Directive gives room to coastal erosion to be considered. A future interesting and necessary initiative would be to search for strategic sediment reservoirs, check the possibilities of exploitation (comprising the environmental impact assessment) and set the procedures and protocols to do so. To this regard, there have been some successful local and regional initiatives to identify these reservoirs (e.g. Tuscany Region).

- ✓ *Promoting the use of setback lines in urban areas by Member States under the Thematic Strategy on the Urban Environment.* The setback lines issue is also considered by the approved Protocol on ICZM in the Mediterranean region, though not yet entered into force. It is a difficult but challenging issue to put into practice and some pilot initiatives could show the benefits of using setback lines regarding coastal erosion management.

- ✓ *Promoting a consistent approach to the monitoring of coastal erosion, which will require cooperation between adjoining coastal Member States.* At this respect, a cross-border cooperation project could be implemented where the two sides would agree on a monitoring methodology. The INTERREG programme seems an excellent framework to implement such an initiative.

- ✓ At the national and regional level, mostly depending on the size of the country, CONSCIENCE suggests using the four basic steps of the Frame of Reference (defining the quantitative state, benchmarking, intervention and evaluation) for implementing suitable measures to live with coastal erosion. This is probably the most important direction of the future development of CONSCIENCE. To this regard, some projects could be started at locations, others than the project study sites. Regarding the funding of these initiatives, INTERREG IV B and or C could serve as a good framework for several regions to work jointly towards a better coastal erosion management. Of course, national funding should also been made available at this respect.

Keep on liaising with related initiatives

Besides these project ideas, CONSCIENCE partners will promote that their findings are well taking into consideration by other related projects. At this respect and at this moment, we would like to emphasize some initiatives which will be contacted, debriefed and documents made available:

- ✓ **COASTANCE** - Regional action strategies for coastal zone adaptation to climate change. COASTANCE is the development of a cooperative work initiated by a group of Mediterranean regions in 2001 through the INTERREG IIIB Beachmed project, extended through the INTERREG IIC Beachmed-e. This new project integrates them and offers new governance tools for all European administrations levels dealing with coastal management. COASTANCE is using innovative techniques to produce ICZM action plans, by making use of the "good practices" developed by several European projects (Interreg IIIB & IIIC-RFO). Concrete results (submersion forecast systems, specific strategic plans of ICZM, and managers training) will be used by European, national and regional administration as governance and public policy tools.

- ✓ **PEGASO,** funded under the 7th Framework Programme (People for Ecosystem Based Governance in Assessing Sustainable Development of Ocean and Coast). The main objective of PEGASO is to build on existing capacities and develop common novel approaches to support integrated policies for the coastal, marine and maritime realms of the Mediterranean and Black Sea Basins in ways that are consistent with and relevant to the implementation of the ICZM Protocol for the Mediterranean. PEGASO is consistent with the frameworks of the Barcelona and Bucharest Conventions which seek to achieve a coordinated approach to sustainable resource management and development, and to protect these regional seas and the quality of life of their peoples. It also continues ICZM efforts, supporting new marine and maritime policies**.**

- ✓ **ANCORIM** – Atlantic Network for Coastal Risks Management (co-financed by INTERREG programme in the framework of the European Territorial Cooperation – 'Atlantic Space') INTERREG - A). A networking initiative between public Authorities and scientific actors to strengthen the prevention and management of coastal risks in the Atlantic area. Composed by 15 partners from 4 European countries (France, Ireland, Portugal, Spain), representing 8 regions. Three thematic issues are being addressed: shoreline mobility and erosion, quality of water and coastal economic activities; It will run until April 2012.

- ✓ **IMCORE -** Innovative Management for Europe's Changing Coastal Resource. This project aims to address the need to increase capacity to respond to the Ecological, Social and Economic impacts of climate by developing a methodology and templates to aid Coastal Managers across NW Europe in developing the required adaptive strategies. Funded under the INTERREG IVB programme (www.nweurope.eu), the €6m IMCORE project is being led by the Coastal & Marine Resources Centre in University College Cork (also a partner in the CONSCIENCE project) until its end in 2011.

- ✓ **Asset Performance Tools.** This project is funded by the UK Environment Agency to develop guidance, tools and techniques to support the risk-based inspection and analysis of flood and coastal defence assets, which include beaches. CONSCIENCE tools, such as the frame of reference applied to Pevensey Bay, will be considered as the basis for the monitoring of beaches and potentially other assets.

- ✓ The Irish partner CMRC has also promoted the project as part of other ongoing links with allied projects most notably under **CoastAdapt** (INTERREG 4B - Northern Periphery Programme funded) and **IMCORE**

(INTERREG – 4B North West Europe). http://coastadapt.org, www.imcore.eu

Publishable results
Not applicable

Event **Title, place**	**Date**	**CONSCIENCE** **Responsible partner**	**Dissemination activities foreseen**	**Results**
	2007			
ICZM Expert Workshop – BSERP (Black Sea Ecosystem Recovery Programme):		GEOECOMAR	Oral presentation	30 Black Sea national ICZM experts learn about the project (Bulgaria, Georgia, Romania, Russia, Turkey, Ukraine
International Conference on Management and Restoration of Coastal Dunes, Santander, Spain	3rd – 5th October	EUCC	CONSCIENCE poster display and/or Brochure distribution	Appr. 150 participants learnt about the project
COASTGIS'07 Santander, Spain	8th- 10th October	EUCC	CONSCIENCE poster display and/or Brochure distribution	Appr. 100 participants learnt about the project
Polish-German seminar	October	IBW PAN	Brochure distribution	
ENCORA conference on EUROPEAN ACTION PLANS	5th – 7th December	EUCC	Brochure distribution	ENCORA network teams relevant for CONSCIENCE learn about the project
	2008			
The Littoral Challenge Dialogue Action, Lille, France	16th – 18th January	EUCC	Brochure distribution	Appr. 100 participants learnt about the project

Event Title, place	Date	CONSCIENCE Responsible partner	Dissemination activities foreseen	Results
Annual Conference Netherlands Centre for Coastal Research	27th - 28th March	DELFT		80 scientists learned about project
Annual Workshop of CONSCIENCE project, Constantia, Romania	14th-18th April	National Institute for Marine Geology and Geo-ecology (GEOECOMAR) others partners present -	Project, presentation and Brochure distribution at local site	15 scientists and end-users learned about project
ST. FERGUS SYMPOSIUM , Aberdeen Scotland	20th – 22nd May	EUCC	Leaflet distribution, presentation includes reference to CONSCIENCE	Appr. 40 participants learnt about the project
POCOAST – 1st International Workshop of the Portuguese Network of Coastal Research, Porto, Portugal	26-28th MAY	EUCC	Poster presentation, & Brochure distribution	Appr. 100 participants learnt about the project
International Conference on Coastal Engineering (ICCE 2008), Hamburg, Germany	31 Aug – 5 September	CIIRC		> 200
The Black Sea Day	31 October, 2008	National Institute for Marine Geology and Geo-ecology (GEOECOMAR)	Brochure distribution, and project presentation	

Event Title, place	Date	CONSCIENCE Responsible partner	Dissemination activities foreseen	Results
Littoral 2008 Conference, Venice, Italy	26th – 28th November	DELFT, EUCC, others	Brochure distribution and project presentation	
	2009			
10th International Coastal Symposium, ICS 2009	13th –18th April	EUCC, others	Brochure distribution	
3rd CONSCIENCE Annual workshop in Cork, Ireland	27th -29th April	CMRC		The field-trips in Kerry and Eastbourne provided the CONSCIENCE consortium the opportunity to meet with end-users (local authorities / local authority contractors) in situ to appreciate first hand the issues and local solutions
CONSCIENCE PSC 6 Meeting in Eastbourne, England	28th – 29th September	HR Wallingford Ltd		The field-trips in Kerry and Eastbourne provided the CONSCIENCE consortium the opportunity to meet with end-users (local authorities / local authority contractors) in situ to appreciate first hand the issues and local solutions
I International Workshop on Integrated Coastal Zone Management, Vilanova i la Geltrú/Sitges, Spain	1st -2nd October	EUCC	Brochure distribution	Appr. 100 participants learnt about the project
EUCC France field workshop, Brittany, France	15th – 16th October	EUCC	Brochure distribution and presentation of foreseen project results and products	Appr. 40 participants learnt about the project

Event Title, place	Date	CONSCIENCE Responsible partner	Dissemination activities foreseen	Results
MEDCOAST 09 - 9th International Conference on the Mediterranean Coastal Environment, Sochi, Russia	10th -14th November	EUCC	Poster presentation, abstract published and brochure distribution	> 200
	2010			
CONSCIENCE Final Event at ICCCM'10, Estoril, Portugal	12th April	All partners	Presentations on project achievements and results, including the view from external end-users	Appr. 40 participants learnt and discussed about the project results
ICCCM'10, Estoril, Portugal	12th – 14th April	All PARTNERS and END-USERS	Presentation of scientific papers related to project	Appr. 250 participants learnt about the project
3rd European Maritime Day Conference, Gijón, Spain	18th – 21st May	EUCC	Dissemination of the concise report for policy makers and brochures, poster exhibition	
EUCC France Workshop: European Maritime Day, Biarritz, France	20th May	EUCC	Dissemination of the concise report for policy makers	