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"Coastal erosion – Evaluation of the need for action"
Directorate General Environment
European Commission

Living with coastal erosion in Europe: Sediment and Space for Sustainability

Guidelines for implementing local information systems dedicated to coastal erosion management

Executive Summary

17 May 2004

National Institute for Coastal and Marine Management of the Netherlands (RIKZ)
EUCC – The Coastal Union
IGN France International
Autonomous University of Barcelona (UAB)
French Geological Survey (BRGM)
French Institute of Environment (IFEN)
EADS Systems & Defence Electronics

This document briefly summarizes the main outcome of EUROSION Work Package 3, which aimed at developing guidelines local information systems dedicated to coastal erosion management. These guidelines are intended to help regional authorities willing to make a major contribution to coastal erosion management and coastal information sharing. A complete set of EUROSION Guidelines for implementing local information systems can be obtained upon request.

WHAT IS A LOCAL INFORMATION SYSTEM ?

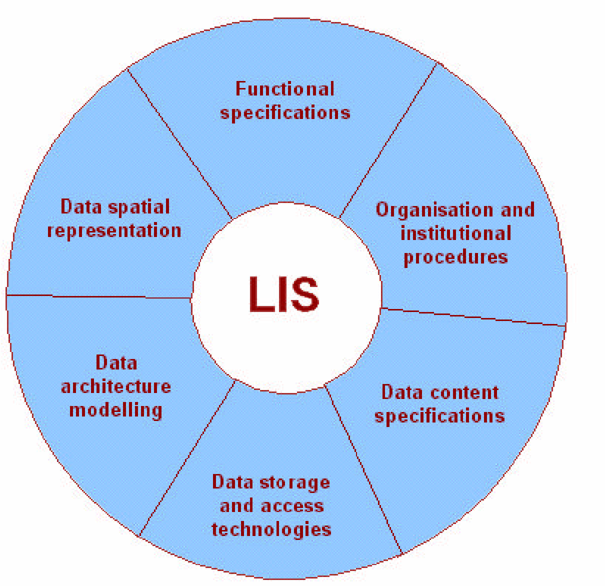
An information system (IS) can be defined as "a set of technological, human, organisational, financial, and information resources organized in such a way to produce, archive, retrieve, modify, process, combine, represent, exchange and/or disseminate information with a view to reach the objectives the system is designed for".

By local information system, and with reference to the above-mentioned definition, we mean that the objectives for which the system has been designed for, relate to a restricted geographical area, ranging from a municipality to a regional entity.

Although a number of other IS definitions tend to put the technology upfront (computer-based), it is worth mentioning that institutional, organisational and political aspects account for the greater share in the success (or failure) of an information system.

WHICH ASPECTS MUST BE TAKEN INTO CONSIDERATION?

Designing, developing, installing and maintaining a local information system (LIS) dedicated to coastal erosion management require taking a wide range of aspects into consideration simultaneously. These aspects may be grouped in six categories as shown in the figure below:



Principles of LIS design, development, installation and maintenance

More precisely:

Functional specifications. Functional specifications aims at clarifying the objectives of the information system. They describe which coastline management decisions are to be supported by the system, as well as their data requirements. To some extent, the functional specifications are the *raison d'être* of the information system.

Organisational and institutional procedures. The design, development, installation and maintenance of any information system require well-tried organisational procedures which aim at ensuring that the system will meet the expectations of the different stakeholders and is implemented within an agreed time schedule and budget constraints.

***Data content specifications*.** Data constitute the fuel of the information system. This section thoroughly describes the typology and nature of data which have been identified by the technical specifications. Besides, this section also provides information on the methods and costs associated to data production.

***Data storage and access technologies*.** This part describes the mechanisms through which information is physically archived and made available to a wide public. It notably describes the standards to be used for exchanging data from one computer to another and for documenting the content, quality and access conditions of the data themselves.

***Data modelling*.** Data modelling is about the architecture and the structure of the data, concentrating on the logical entities and the logical dependencies between these entities. Data modelling is a critical aspect of information system development since the ability of the system to combine and cross-analyse data will depend on it.

***Data spatial representation*.** Data spatial representation deals with the location of physical objects or phenomena described by the data collected and how this location will be characterized. A common way of describing location is to use geographic or cartographic coordinates which refers to a specific geographic reference system and a specific cartographic system. Failure to adopt a standard geographic reference system or a specific cartographic system may result in the impossibility to cross-combine information and represent them consistently on one map.

A. FUNCTIONAL SPECIFICATIONS

The objectives assigned to local information systems may vary considerably from one site to another. In the fields of coastline management however, experience gained from EUROSION pilot sites makes it possible to define these objectives as answers to frequently asked management questions. To a large extent, these management questions are linked to investment decisions, which can be summarized as follows :

- Will my investment be exposed to coastal erosion hazard during its lifetime ?
- Will my investment impact coastal erosion processes ?
- Do the benefits generated by my investment (including the environmental benefits) exceed its costs (including environmental costs) ?

The answers to these questions are far from obvious and generally require a considerable amount of data from different nature and different sources. In line with these three questions, EUROSION proposes the development of local information systems dedicated to three main functionalities.

Function 1 - Hazard assessment

Coastal erosion hazard assessment has been identified during the EUROSION study as the first function which would justify investing in a local information system. Depending on the type of coasts, erosion hazard may be relating to the loss of lands, and together with them, the economical assets they support (e.g. cliff retreat or beach lowering), or it may be relating to the flooding of coastal plains either as a direct result of acute dune erosion or as a result of sea defence undermining by chronic coastal erosion. In both cases however, the data requirements identified during EUROSION investigations are the same and can be listed as follows:

- Aerial orthophotographs (alternatively satellite images)
- Current and historic coastline
- Terrestrial elevation
- Near-shore bathymetry (alternatively offshore bathymetry)
- Cross-shore profiles
- Coastline geomorphology
- Coastline geology
- Seafloor sedimentology
- Sediment transport
- Near-shore wave regime
- Offshore wave and wind regime
- Near-shore currents
- Astronomic tide
- Still water level
- Coastal defence works

The following figures provide some examples of the use of information systems to generate maps of coastal erosion hazard.

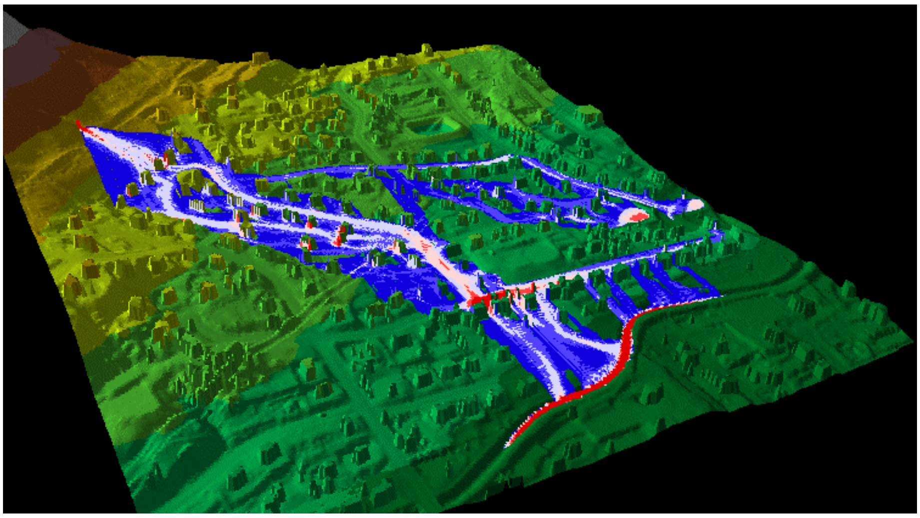
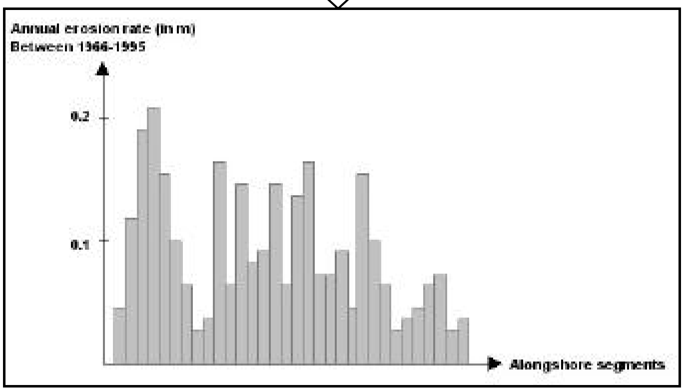


Illustration of an inundation process using a flood simulation model (MIKE Flood) integrated to a coastal information system. Source: Danish Hydraulics Institute (DHI)

1. This photograph depict a segment of the coast of Haute-Normandy (Criel-sur-Mer) which is characterized by highly erodible chalk cliffs. Two coastline positions, respectively from 1966 and 1999, were extracted from orthophotographs. The coastline was then divided into equidistant segments for which the loss of land between 1966 and 1995 was estimated. Here, an equidistance of 100 metres was selected.



2. The loss of lands between 1966 and 1995 is converted into an annual erosion rate for each 100 metre long segment. Annual erosion rates for the entire coastline is reflected into a histogramme as depicted beside.

3. In turn, the erosion rate is used to estimate the future shoreline position by simply multiplying the erosion rate by the number of years considered (e.g. 50 or 100 years in the future)

Illustration of a GIS-based local information system dedicated to cliff retreat monitoring and prediction

Function 2 – Impact assessment

Human activities may impact coastal erosion processes in a variety of ways. In all cases, changes take place whenever one or more of the above mentioned natural causes of coastal erosion are modified. EUROSION proposes to consider the following typology of impacts on coastal erosion processes and impacting projects:

- **Impact 1**: modification of near-shore bathymetry and wave propagation patterns
- **Impact 2**: disruption of long-shore drift currents
- **Impact 3**: removal of sediment from the sediment system
- **Impact 4**: reduction of river debits
- **Impact 5**: reduction of volume of tidal basins
- **Impact 6**: modification of near-shore vegetation
- **Impact 7**: modification of soil weathering properties
- **Impact 8**: modification of Aeolian transport patterns
- **Impact 9**: land subsidence

A wide range of projects is concerned with such modifications. They can be grouped in 6 categories:

- **Category 1**: Land reclamation projects
- **Category 2**: River water regulation works
- **Category 3**: Sediment extraction projects
- **Category 4**: Construction of tourism and leisure facilities
- **Category 5**: Coastal defence works
- **Category 6**: Hydrocarbon and gas mining activities

Table below provides an overview of how above mentioned projects impact coastal erosion processes.

In order to assess the impact of human activities on coastal erosion processes, EUROSION proposes that the following data requirements are taken into consideration in the perspective of local information systems:

- Aerial orthophotographs (alternatively satellite images)
- Current and historic coastline
- Infrastructure
- Hydrography
- Terrestrial elevation
- Near-shore bathymetry (alternatively offshore bathymetry)
- Cross-shore profiles
- Coastline geomorphology
- Coastline geology
- Seafloor sedimentology
- Sediment transport
- Near-shore wave regime
- Offshore wave and wind regime
- Near-shore currents
- Astronomic tide
- Still water level
- Coastal defence works

Typology of projects having an impact on coastal erosion processes

IMPACTS / PROJECTS	Modification of bathymetry and/or wave propagation patterns	Disruption of long-shore currents	Removal of sediment from the sediment system	Reduction of river debits	Reduction of volume of tidal basins	Modification of near-shore vegetation	Modification of soil weathering properties	Modification of Aeolian transport patterns	Land subsidence
Land reclamation									
• Harbour/airport extension	✓	✓			✓				
• Energy production plants (e.g. windfarms)	✓	✓			✓				
• Recreational parks	✓	✓			✓				
River regulation works									
• River damming			✓	✓					
• Irrigation systems				✓					
Sediment dredging									
• Channel dredging for navigation	✓		✓			✓			
• Aggregate extraction for construction	✓		✓			✓			
• Sand extraction for nourishment	✓		✓			✓			
Construction of tourism/leisure facilities									
• Marinas	✓	✓							
• Hotel resorts		✓							
• Recreational parks including golf amenities							✓	✓	
Coastal defence									
• Cross-shore hard defence including groins, breakwaters and jetties	✓	✓	✓						
• Alongshore hard defence including seawalls, bulkheads and revetments		✓	✓						
• Beach nourishment (see sediment extraction)	✓		✓			✓			
Hydrocarbon/gas mining									✓

Function 3 – Cost Benefit analysis

In a significant number of cases, investments relating to shoreline management and/or coastal defence are decided though a poor attention has been paid to social, environmental and economical studies. This has lead to situations where the costs of shoreline management exceed its long-term benefits. To avoid these situations, EUROSION has reviewed a number of considerations which could lay the foundations for further works and research to be undertaken in connection with cost-benefit analysis of shoreline management investments and the development of local information systems.

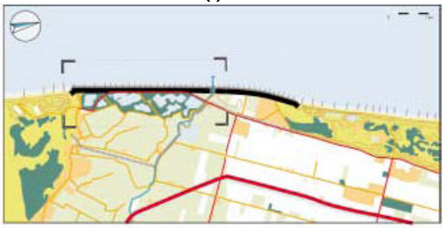
These considerations put the emphasis on the role of the following data requirements :

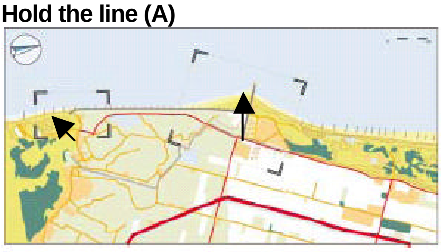
- Infrastructure
- Land cover
- Land cover changes
- Demography
- Areas of high ecological value
- cultural heritage
- Land market value
- Economic registered activities
- fishery and aquaculture concession
- mineral extraction concessions

Next page presents an example of cost-benefit analysis applied to shoreline management and which could benefit from local information systems dedicated to coastline management.

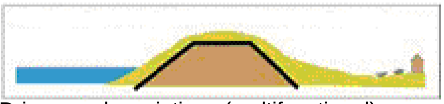
Example Cost-Benefit Analysis: Hondsbossche Sea Dike in the Netherlands

Current Situation (i)


Hold the line (A)


Move Seaward (B)


Move landward (C)


Drive: sandy variations (multifunctional)

The old Hondsbossche Sea Dike or "Hondsbossche zeewering" (1880, length: 5 km) shows currently several problems amongst which sea level rise, increasing erosion, instability and inflexibility (compared to a sandy coastline retreat) and consequently it sticks out by approximately 200m.

3 types of possible solutions are proposed, summarised by hold the line (A), move seaward (B) and move landward (C). Before deciding on measures a balanced cost-benefit analysis has to be made where all interests have to be incorporated. In (A) the current policy will be continued (maintenance with nourishments), in (B) the dike will be dismantled and a dune area will be raised. This alternative is primarily focused at recreational purposes. In (C), the dike will be dismantled without replacing it, an alternative for more ecological value. This example focuses more on the **benefits** of the different options and gives some illustrative approaches. The **costs** can be assessed in the more traditional way:

Costs \ Option	Hold the line (A)	Seaward (B)	Landward (C)
Investment (M €)	137,5	227,4	4,5
Maintenance (M € / 30yr)	20,7	4,0	144,5

The process of qualifying and quantifying the benefits of these separate options was done following a certain method where the distinction was made between three different aspects: (1) Money (economical); (2) Green (Ecological); and (3) Feeling (socio-cultural), after which an integrated approach was made to prioritise the different judgement criteria.

Part of: Benefit Assessment **"Money"**:

Type of benefit	Effect	Assessment method
Returns agriculture	Push out production Change productivity	Market values
Safety perception	Change perception	Contingent Valuation Method
Recreation	Change number of tourists Change perception	Travel cost approach
Fresh water storage / extraction	Production	Market prices
Fishery benefits	Creation breeding ground	Production function method
Economical activity	Mitigated flood damage	Risk assessment
Property value	Change house prices Change number of houses	Hedonic prices Market value

Part of: Benefit Assessment **"Green"**:
Ecological benefits are quantified and assessed according to the envisaged changing aspects of ecological diversity. The table below shows a *relative* scoring which may give an indication of different political visions on nature.

Score \ Option	Hold the line (A)	Seaward (B)	Landward (C)
Ecosystem diversity	0,12	0,31	0,46
Species diversity	0,21	0,21	0,22
Natural quality	0,16	0,50	0,73

Part of: Benefit Assessment **"Feeling"**:
The researcher involved in the *ex ante* assessment of socio / cultural benefits of certain management options may follow the following steps: (1) Reviewing of existing literature regarding comparable cases; (2) Examination of existing maps on the different reference topics and gathers information on notes, municipal guides and internet sites; (3) Makes an inventory of different stakeholders and their interests; (4) Consults one or more boards of stakeholders for advise on the necessary steps towards decision, supported by expert opinions; and (5) Bundles the obtained information and requests additional research on sensitive topics.

Focus on the latter two:
A simple method to quantify feeling is to let the stakeholders give a score of 100 to their main project goal, and percentages of 100 to other project goals, this to make the differences between stakeholders transparent: In the table below for 2 groups (G1 and G2):

Project goals	Most preferable outcome	Least preferable outcome	Rough weights	
			G1	G2
Preserving safety culture	Responsibility government	Appear to be left to nature	100	100
Increase tourism	Unique identity	No distinction with others	60	60
Increase amenity	Keeping polders	Removing polders	60	30
"Authentic" nature	Recovery sea inlet	No sea inlet	0	60
Limiting lasting congestion	No intensive constructions	Intensive constructions	20	20
Keeping flexibility	Lasting options	No options	20	20

The next step is to score the project goals relative to the 3 different management options by the groups, e.g. from 0 to 1. Multiplying the two scorings a weighed total score can be achieved.

The final step involves an **integrated assessment** of the three aspects on the three management options to get a complete overview of the project. This is essential for both the presentation and communication towards stakeholders and local citizens. Also, this overview is needed to give the decision – and policy makers some grip to balance the respective management options between the aspects of Money, Green and Feeling (Source: Baten van Water, zoute case studies, 2002 – in Dutch).

B. ORGANISATIONAL AND INSTITUTIONAL PROCEDURES

Political, institutional and organisational arrangements appear to be among the most critical factors when designing and implementing an information system. These arrangements express the willingness of a group of stakeholders to put their information resources on a common platform, and therefore guaranty its sustainability. In a sense, these arrangements define a "coastal information governance strategy" which will set the institutional basis for the design, implementation and operational functioning of local information systems. This governance strategy needs to be formally endorsed by all involved stakeholders in order to ensure commitment and responsibility division.

EUROSION proposes to build such coastal governance strategies upon 9 principles which are:

- *Principle 1* - a lead authority working in partnership with a wide range of local to national stakeholders;
- *Principle 2* – a commitment to share relevant information (or data);
- *Principle 3* - use a well-documented web-based information system using internationally recognised standards;
- *Principle 4* - institutions retain responsibility for their own data including quality, timeliness and for its dissemination;
- *Principle 5* - the information system should be based on relevant and reliable data;
- *Principle 6* - adequate training;
- *Principle 7* - cost sharing by all partners;
- *Principle 8* - the system is reviewed periodically;
- *Principle 9* – regular review of the strategy realisation and performance

Moreover, there is a need to adopt a project-wise approach to make sure that the information system is implemented according to pre-established terms of reference and that its implementation receives appropriate guidance from the partner institutions.

This has lead the EUROSION project to propose a manual of procedures, to be formally amended and approved by all stakeholders, providing clear insight in the different phases of development, expected input and responsibility of each involved stakeholder, their interdependence and the obtained end result of the specific phase. The phases, responsibilities and results may vary along the process due to unforeseen changes, political choices or newly obtained knowledge, so flexibility is an essential element.

OUTLINES FOR A "LIS" MANUAL OF PROCEDURES

I.1. Feasibility and pre-design study
- I.1.1. Designation/recruitment of a LIS project manager
- I.1.2. User need requirement survey
- I.1.3. Inventory of existing sources of information available at the local level
- I.1.4. Elaboration of specific technical specifications for the LIS
- I.1.5. Assessment of implementation costs

I.2. Implementation
- I.2.1. Kick-off meeting with all stakeholders
- I.2.2. Adaptation of EUROSION prototype to match the requirements of the feasibility and
- I.2.3. Implementation and test phase
- I.2.4. Training
- I.2.5. Marketing

I.3. Management and maintenance
- I.3.1. Submission and resignation procedures
- I.3.2. Arbitration procedures in case of a conflict
- I.3.3. Annual budget planning procedures
- I.3.4. Access rights management procedures
- I.3.5. Forum management procedures
- I.3.6. Data quality control procedures
- I.3.7. Training procedures
- I.3.8. Documentation procedures

C. DATA CONTENT SPECIFICATIONS

The scope of this section is to review which datasets will contribute to answer critical questions for coastline management. These critical management questions have already been discussed earlier in this document.

On the basis of the review of past and ongoing experiences in coastline management conducted Europe-wide in the framework of EUROSION, 31 relevant datasets or "reference topics" that we have organised in 9 topic groups have been identified. These reference topic groups and topics include:

Reference topic group 1 – Administrative boundaries

- Reference topic 1.1 - terrestrial boundaries
- Reference topic 1.2 - maritime boundaries

Reference topic group 2 - Topography

- Reference topic 2.1 – Aerial photographs / orthophotographs
- Reference topic 2.2 –Satellite images
- Reference topic 2.3 - Current and historic coastline
- Reference topic 2.4 - Infrastructure
- Reference topic 2.5 - Hydrography
- Reference topic 2.6 - Terrestrial elevation
- Reference topic 2.7 - Near-shore bathymetry
- Reference topic 2.8 - Offshore bathymetry
- Reference topic 2.9 - Cross-shore profiles

Reference topic group 3 –Geomorphology, geology and sedimentology

- Reference topic 3.1 - Coastline geomorphology
- Reference topic 3.2 - Coastline geology
- Reference topic 3.3 - Seafloor sedimentology
- Reference topic 3.4 - Sediment transport
- Reference topic 3.5 - Sediment-dwelling (benthic) infauna

Reference topic group 4 - Hydrodynamics

- Reference topic 4.1 - Near-shore wave regime
- Reference topic 4.2 - Offshore wave and wind regime
- Reference topic 4.3 - Near-shore currents
- Reference topic 4.4 - Astronomic tide
- Reference topic 4.5 - Still water level

Reference topic group 5 - Land cover

- Reference topic 5.1 - Land cover
- Reference topic 5.2 - Land cover changes

Reference topic group 6 – Demography

- Reference topic 6.1 - Demography

Reference topic group 7 - Heritage

- Reference topic 7.1 - Areas of high ecological value
- Reference topic 7.2 - cultural heritage

Reference topic group 8 – Economic assets

- Reference topic 8.1 - Land market value
- Reference topic 8.2 - Economic registered activities
- Reference topic 8.3 - fishery and aquaculture concession
- Reference topic 8.3 - mineral extraction concessions

Reference topic group 9 – Coastal defence

- Reference topic 9.1 - coastal defence works

D. DATA STORAGE AND ACCESS TECHNOLOGIES

The purpose of this section is to describe the common requirements related to the technology used to make the data and information accessible. Besides requirements of the data and information (format, metadata, coordinates etc.) the technical specifications used allow broad access, requiring soft and hardware standards. These requirements are intended for system architects, database designers, and software developers who will implement these requirements in different LIS applications, and can be summarised as follows:

- ***Storage***. The data present need to be stored into a physical place, supported by a hardware platform and into a professional (relational) database in order to provide a consistent structured methodology for standard compliance and long term knowledge embedding. The storage of data is in principle best guaranteed at the location to which the main usage is to this data given, ensuring continuation and long-term homogenous information. Server capacity, backups and the stability need specific definition for both storage and access.

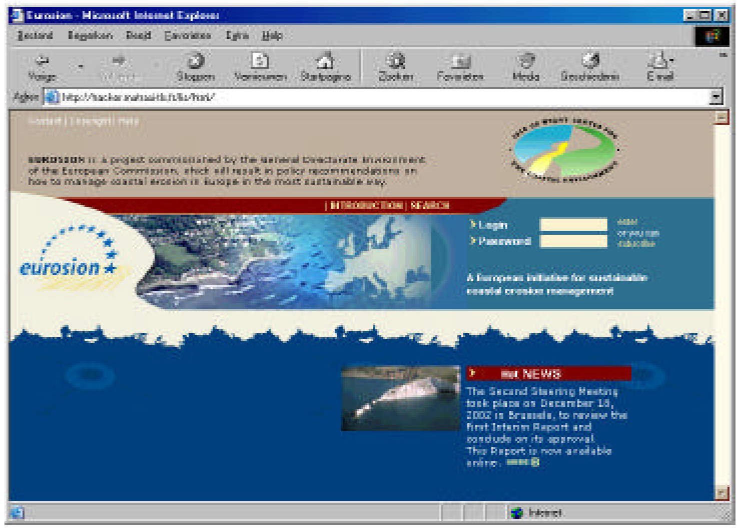
- ***Access***. Wide access to data (and information) to stakeholders (involved in risk mapping) can be facilitated through Internet technology; access requires limited effort, can be monitored and restricted if required. Distributed technologies allowing access to local internet sites ensure provision of timely information leaving the storage at the place of origin. Means to define the exact information required can be done through querying the database. Existing technologies to facilitate the web-access are FTP-sites, websites allowing querying at the proper site, portals connecting multiple distributed databases and information systems (CoastBase, others…) and common used Internet search engines (google, yahoo etc.). The services to be provided need to encompass effective searching, viewing downloading, data transformation, and presence of metadata.

- ***Security***. Firewalls, specific user identification and passwords can improve the proper use of the information

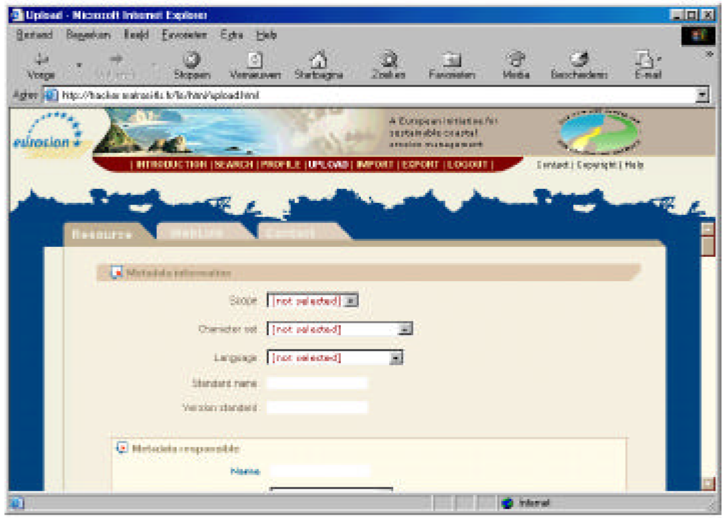
- ***Maintenance***. System maintenance at the information holder site includes regular hardware and software investments. Licences for all kind of applications.

- ***Interface***. Common interfaces used for data access, allowing google-like free text search as well as advanced access through search form, glossaries and maps. The use of multilingual thesaurus has been identified as a strong requirements by non-English users.

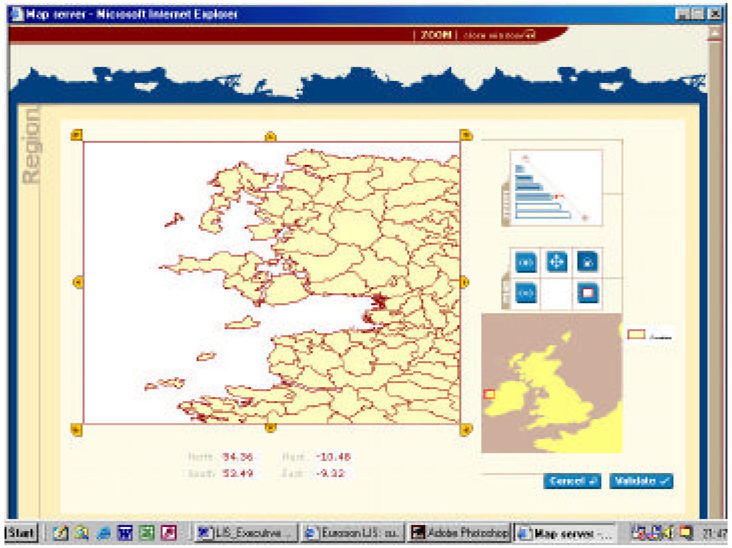
In the course of EUROSION a prototype of data storage and access technologies implementing the above-mentioned requirements has been developed and can be obtained upon request. This prototype has been built upon the CoastBase technologies. The following pictures present screenshots of this prototype.



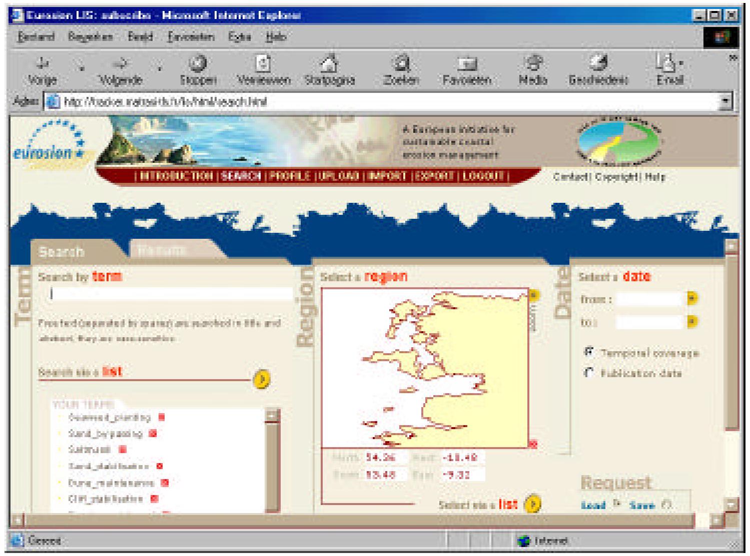
1. The home page of LIS can be customized for each region willing to implement its own LIS. In this example, the home page has been customized to fulfil the expectation of the Isle of Wight County. Visitors can only access a few functionalities (e.g. search). Only authorised user may access the full range of functionalities through a login name and a password.



2. Authorised users can (in particular) upload new datasets in the system. Uploading new datasets requires filling in a complete metadata formulaire compliant with ISO 19115. Each user is responsible for the quality and the maintenance of data he/she uploads.



3. Both geo-coding of uploaded datasets and research of information is performed using a mapserver. This tool makes it possible to navigate on a map (with the possibility to zoom in and zoom out) and to capture the rectangular coordinates (latitude, longitude) of the dataset bounding box. A bounding box defines the geographical extent of a particular dataset (here approximately the county Mayo).

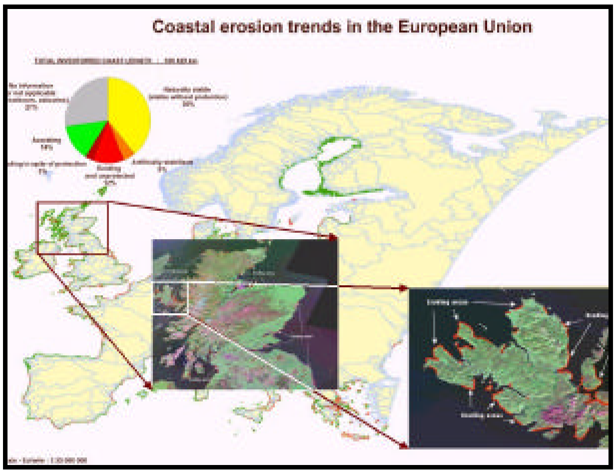


4. Beside research by geographic location, search may also be performed on the basis of free text or a thesaurus. A thesaurus facilitates storage and retrieval of datasets by describing the datasets with a standardized set of keywords. Research can also be performed by date.

<u>Screenshot of the LIS prototype developed in the framework of EUROSION</u>

Up-scaling and down-scaling possibilities

Besides the importance of proper access to information another relevant component is the possibility to aggregate information from local level to European scale and reverse. Three main reasons for this were identified, firstly validation and representation purposes of European scale geographical information 'at the ground'. Secondly the potential European semantic network at the local, benefiting from the INSPIRE initiative and principles supports the growing of an operational Europe covering distributed network. This network aims at feeding the information updating and feedback processes. Thirdly co-operation and commitment between authorities actuating at different levels is enhanced when concretising the information sharing and fluxes through such network. A summary is given and an attempt to come to determination of the benefits of such network.



EUROSION identified 20 data groups layers and examined the up and down scaling potential. These layers are divided in four main groups.
For each of the data group layers the potential for upscaling from the local level towards European scale and the reverse downscaling process is described.
The physical environment includes: Shoreline, Wave regime, Wind regime, Sea level, Bathymetry, Foreshore Characteristics, Sediment transport, Terrestrial elevation, Geology and Geomorphology and historical events.
Legal and policy data groups consist of: Land use, Protected areas, Remarkable boundaries and land ownership.
Socio Economical layers: Population, Land cover, Infrastructure, Economic activities and Market value.
Technical measures: Coastal management operations

Standardisation of key datasets required for delimiting coastal sediment cells

In line with the recommendations on assessment of hazards, environmental impacts and cost benefit analysis coastal sediment cells are deemed to constitute the units for managing coastal erosion. However, experience in Europe has shown that the delineation of coastal sediment cells is a far from trivial task and suffers from a lack of consistency Europe-wide. Efforts should be undertaken to increase the consistency of coastal sediment cell delineation throughout Europe notably by standardizing the production of key input datasets for such delineation.
The INSPIRE initiative distinguished priority common basic data, needed to be harmonized and shared. These include the first three EUROSION key data sets, while the two other recommended data sets are included in the second level of priority INSPIRE data sets. These datasets are:

EUROSION recommended key data sets	INSPIRE data
1. The coastline. 2. Coastal elevation and bathymetry.	Elevation including terrestrial elevation, bathymetry and coastline (Annex I)
3. Hydrography.	Hydrograpy/water catchments (Annex I)
4. Nearshore wave regime.	Meteorological spatial features (Annex II)
5. Astronomical tides.	Oceanic spatial features (Annex II)

Potential benefits of semantic European linkage

Benefit 1: Low-cost update of the EUROSION database and exposure assessment.

Experience has shown that the production of Europe-wide database – such as EUROSION - often results from one-time investments, little attention being given afterwards to updating mechanisms. Yet, it is highly predictable that the long-term cost of continuous data updating is far below the cost of replacing the whole database with a new one once it is completely obsolete. In that sense, Local Information Systems offer major opportunity to update these Europe-wide database at low cost since each local partner would be in charge of updating the small part of the database corresponding to its own region and would send its contribution back to the institution in charge of maintaining the Europe-wide database. One may argue that the Europe-wide database would then be updated in a piecemeal way; however we estimate that the negative effects of this piecemeal updating process could be attenuated by the implementation of "updating" standards to be respected by each LIS and a adequate documentation of the final product. In particular, such a process would make it possible to update some of EUROSION database layers which cannot benefit from economies of scale. These layers include notably:

- the coastline geomorphology
- the coastline geology
- the coastline evolutionary trends
- the presence of defence works
- the budget spent on coastal defences

Benefit 2: Provision of baseline data to regional authorities

If some regions already benefit from a huge amount of data, the situation can be quite different from one region to another. In particular, the experience of EUROSION has shown that some of the EUROSION database layers may be of relevance for regional authorities even if at a 1:100,000 scale. This is the case in particular for data on land cover (CORINE Land Cover), which combined with population data known at the municipal level, can provide a finer estimation of municipal population at risk along the risk (see for example the methodology developed by EUROSION for indicator 11 – population within the radius of influence of coastal erosion). Another example is given by the provision of data on offshore wave and wind regime (provided by EUROSION) which in turn can be transformed into near-shore wave and wind regime after combination with bathymetry and wave transformation models. These are clear illustrations that the availability of Europe-wide data may turn quite useful for certain local or regional applications.

Benefit 3: Ensure interoperability and comparability of local data

A number of applications require that data – though local – have a consistent structure and format Europe-wide. The conclusions of EUROSION, which recommend the establishment of a European map of coastal sediment cells, illustrate this requirement. The delineation of coastal sediment cell indeed requires that a consistent methodology based on same-structure data is adopted. Failure to do so will inevitably result in coastal sediment cell overlapping or coverage gaps, which in turn may biaise coastal sediment management planning process and related responsibilities. By "forcing" the local data to fit within a specific Europe-wide structure, the opportunities offered by the cross-combination of local data increase (as illustrated in the case of coastal sediment cell) and exchange of experience and methodologies become more efficient.

Future development

Further efforts need to be undertaken to:

A) Demonstrate the mutual benefits at the various administrative levels.
B) Develop a Europe-wide methodology for delineating coastal sediment cell boundaries on the basis of the key datasets.

Specific attention shall be given to the identification of sediment sources, sinks and circulation patterns. Characteristics and differences between the European Regional Seas need to be taken into account in this process. Both combining of existing and developing technologies and operational services (e.g. through GMES projects) should contribute to this process.

The challenge to meet such European standardisation benefiting at all administrative levels needs to be demonstrated through practical experience within a coastal sediment cell.

E. DATA ARCHTECTURE MODELLING

The purpose of this section is to establish common requirements for modelling and documenting the architecture of data meant to be integrated into an “exemplary” local information system dedicated to coastline management. These requirements are intended for system architects, database designers, and software developers who will implement these requirements in different spatial data applications (e.g. GIS). These requirements facilitate: (i) interchange of data among data providers and users, (ii) maintenance operations to the information system, and (iii) further improvements to the information system.

To avoid confusion, these requirements do not impose or prescribe any particular architecture of the data themselves. Instead, they are meant to codify and formalise the various elements and steps – including for example terminology, modelling language, and documentation - which are needed to develop and implement a data architecture.

Finally, these requirements should be implemented for each Reference Topic meant to become part of the coastal information system. Reference Topics for coastal information system are listed in the section *Data content requirements*. Once implemented for each Reference Topic, these elements form a standard hereafter referred as a “Reference Topic Standard”. This means that in line with the rest of the documents, 31 reference topic standards should be developed in order to build a coastal information system meant to answer the critical questions asked in section A..

EUROSION proposes that data modelling in connection with the establishment of coastal information system are based upon the following requirements:

- Data modelling is undertaken on the basis of ISO/TC211 standards, and are described in accordance to the reference model ISO 19101:2002. The terminology used during the data modelling process should comply with the requirements of ISO 19101:2002 and, in particular with the standard ISO 19104 - Terminology.

- The Unified Modelling Language (UML) is used as the schema modelling language to define data interchange formats. Each of the 31 reference topic standards shall include an integrated application schema expressed in the UML according to ISO 19109, Rules for application schema, and its normative references. The application schema will specify, as appropriate, the feature types, attribute types, attribute domain, feature relationships, spatial representation, data organization, and metadata that define the information content of a data set.

- Each of the Reference topic standards shall contain, as appropriate, documentation of all features, attributes, and relationships and their definitions. A data dictionary table shall be used to describe the characteristics of the UML model diagrams.

- The standard for metadata, to be established in the framework of a coastal information system should comply with ISO 19115, Geographic information – Metadata. ISO 19115 includes a minimal set of metadata that is highly recommended to follow. This minimal set is provided hereafter:

ISO Elements
dataset title **(M)**
dataset reference date **(M)**
dataset abstract **(M)**
metadata point of contact **(M)**
metadata date stamp **(M)**
dataset language **(M)**
dataset topic category **(M)**
geographic location (bounding box or identifier) **(C)**
dataset character set **(C)**
metadata language **(C)**
metadata character set **(C)**
metadata standard name **(rO)**
metadata standard version **(rO)**
spatial representation type **(rO)**

distribution format **(rO)**
dataset point of contact **(rO)**
lineage **(rO)**
online resource **(rO)**
reference system **(rO)**
dataset spatial resolution **(rO)**
metadata file identifier **(rO)**
extent (vertical) **(rO)**
extent (temporal) **(rO)**
Dataset purpose **(O)**
Dataset progress **(O)**
Dataset Maintenance and Update Frequency **(O)**
Access Constraints **(O)**
Use Constraints **(O)**
Keywords **(O)**
Dataset originator **(O)**
Currentness Reference **(O)**

C *- conditional*
M *- mandatory*
O *- optional*
rO *– recommended optional*

Minimum set of metadata elements

- Data modeller refers to national spatial data infrastructures which have defined permanent feature identifiers. A permanent feature identifier is an attribute attached to an object of the real world (e.g. roads, river, administrative units) which is common to several GIS application. In that sense, using permanent identifiers makes it possible to combine data from different applications. It is of the utmost importance that during the design of the coastal information system, the data modeller is knowledgeable of these features which have a permanent identifiers established by national authoritative standards. The management of a common or "permanent" feature identity needs to be undertaken within the community with permission granted to certain participant organisations to create or adjudicate these identities.

F. DATA SPATIAL REPRESENTATION

The Earth is a very complex shape. Its surface is disturbed by mountain ranges and deep oceans. In order to map its geography, a reference system or model is needed which will allow such topographic irregularities to be recorded and any single point on the Earth to be located unambiguously. The problem is that a variety of reference systems exist, particularly in Europe, with the consequence that when combining or integrating data from different providers into a GIS, the various themes (inputs) are not in accurate alignment. To overcome these shortcomings, which may considerably undermine the overall quality of coastal applications, it is recommended that a number of standards are adopted by the various authorities willing to implement such coastal information systems. This section explains in detail the need for adopting common spatial reference systems.

- ***Geographical extent of the coastal information system*.** EUROSION strongly recommends to implement coastal information systems at the level of coastal administrative regions extended to the boundaries of coastal sediment cells overlapping with the region's extent. A coastal sediment cell can be defined as a length of coastline and associated near-shore areas where movement of sediments is largely self contained. Sediment cells are separated from each other by rivers and sometimes by large promontories where the direction of longshore drift is changing; the length of sediment cells may be very small (less than a kilometre) or very large (100 km).

- ***Coordinate reference system*.** In line with the resolutions of European mapping agencies and the European Commission, EUROSION recommends the adoption of ETRS89 for producing and archiving spatial data on European coastal zones. In that respect, it is worth mentioning that some institutions, such as the International Association of Geodesy (IAG) or Eurogeographics (www.eurogeographics.org) which federates the national mapping agencies in the European Union, provide the methodology and the parameters needed (7 parameters) to convert coordinates from any coordinate systems into the system ETRS89.

- ***Vertical Reference System***. In line with the resolution of IAG and the European Commission, EUROSION recommends the adoption of EVRF 2000 as the vertical reference system for altitude related to spatial data in the European coastal zones. EVRF 2000 is characterised by :
  - the datum of “Normaal Amsterdams Peil” (NAP)
  - gravity potential differences with respect to NAP or equivalent normal heights,