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PREFACE SCIENTIFIC COMMITTEE

The Littoral series of conferences are unique in the sense that they bring together scientists, stakeholders and policy makers. As Minister of North Sea in Belgium, I am honored to host the Littoral Conference 2012 in Ostend. Only a decade ago, many people considered that the North Sea policy was of less political importance. I was convinced that marine and maritime policy was of increasing importance and today it is indeed an essential policy. The shipping lanes, together with port activities are dramatically intensified in use. Infrastructures at the seaside, but also in front of the coast and further off shore are being built. Offshore energy production is becoming an intrinsic part of our renewable energy provision. Shipping lanes need to be dredged. Tourism at the coast and at sea is increasing and in the middle of all activities, biological productivity and provision of fish remains of course highly valuable.

Human presence at the coast and at sea affects also species and habitats in a negative or sometimes positive way. Nature conservation at sea becomes therefore an integral part of all economic activities and further policy development. The current conference offers an excellent forum to bring knowledge on potential conflicts and opportunities together. The highlights of this Littoral edition are therefore very well chosen: measuring sustainability, coastal productivity, innovations in coastal infrastructure and coastal nature conservation. The coasts, together with the adjacent marine waters, will continue gaining importance in the future. We have the chance to balance the opportunities in economic development, social welfare and biological conservation of this land-sea interface. The tools we have at hand are integrated coastal zone management (ICZM) and increasingly also marine spatial planning (MSP), as we are moving more and more to coastal and off shore waters. Double and triple use of several marine areas is possible in a sustainable way; reaching the good environmental status as defined in our marine strategies should be our point of reference. Experiments to test the limits of what is possible now and in the future are needed, both for multiple economic use as for combined ecological measures with specific economic activities. Real marine and coastal protected areas should also find their way in ICZM and MSP. The open system of the sea is interesting to further develop human activities but it confronts policy makers also with a huge challenge: how to manage an area that is so connected to what happens outside? As Belgian Minister of North Sea, responsible for 0.5% of the North Sea, I am convinced that both ICZM and even more so MSP must be developed with international collaboration. I believe that Littoral 2012 is a good opportunity to bring together the insights and knowledge to come to a sustainable use of our seas. The time is now.

Johan Vande Lanotte

Belgian Minister of North Sea

Honorary chair of the Scientific Committee of Littoral 2012

PREFACE ORGANISING COMMITTEE

Coasts are of crucial importance in many aspects and at many levels. The economic contribution of coasts is a substantial part of GDP for many countries. The social value of coasts, linked to residency, labour and leisure, is continuously growing. Yet also the importance of coasts for nature, with the diversity of ecosystems and habitats, the enormous productivity and the connectivity function, should by no means be underestimated.

It is clear that in coastal regions all these functions, and the respective users and stakeholders, come together. As the goals are often conflicting, a sound integrated management of coasts is of vital importance. With a growing number of Integrated Coastal Zone Management (ICZM) initiatives, both at local and at international level, the challenge of combining functions in coastal regions has clearly been acknowledged over the past two decades.

However, the reality in which ICZM originally emerged in the early 1990's, has changed dramatically in the past few years. More than ever before, coasts are under increasing demographic pressure. Also the economic developments keep accelerating. With the predicted continuous growth of maritime activities due to globalization, there is no reason to believe this will come to an end soon. Of a more abrupt nature are the global economic and ecologic crisis, of which we only gradually seem to grasp the size and urgency.

It is thus clear that the Integrated Coastal Zone Management of the past two decades will not suffice to organize coastal regions in a sustainable way in the future, given the current grand challenges in economy, sociology and ecology. During the Littoral2012 conference, we want to look forward towards what we see as the coasts of tomorrow: how can policy makers, scientists, practitioners and involved stakeholders work together to shape coasts in such a way that social, economic and ecologic goals are aligned and achievable.

For the organisation of the Littoral2012 conference, a partnership was created between the organisations based in the InnovOcean site: The Flemish Marine Institute, IODE-UNESCO, ESF-Marine Board and the Province of West-Flanders. Also the partners of the Coordination centre on ICZM: the Agency for Nature and Forests, the Agency for Maritime and Coastal Services Coastal Division and the Federal public Service for Public Health, Safety of the Food Chain and the Environment were involved in the organisation of the conference. EUCC and EUROCOAST supported the conference from within their network. The City of Ostend with is rich maritime and cultural heritage offered the ideal location for the conference and give the necessary support to organise this event.

We hope that the abstract book captures all the potential idea's, inspirations, knowledge present at the conference and will further inspire many coastal managers, scientists and stakeholders.

On behalf of the Littoral Conference Organising Committee

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Keynote presentations

ICZM2.0 - A NEW ICZM FOR AN ERA OF UNCERTAINTY

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ICZM is facing a an unprecedented period of uncertainty and vulnerability, resulting not only from external global drivers that are destroying old certainties, but also from intensified policy 'competition' in the coastal space. These problems are compounded by ICZM's own fundamental inadequacies and weaknesses. Paradoxically, ICZM has amassed an armoury of practical tools, scientific techniques and many of the policy instruments it needs, along with long experience. Unfortunately however, ICZM's modern political profile and status is weak, its benefits are ill-defined, and it lacks a clear, simple and transferable process. Simply, the status quo is not an option if ICZM is to survive.

The time has come for a revitalized ICZM – an iCZM2.0 - that is politically robust and legitimate, coherent in its outcomes, and with a clear roadmap of how to achieve them.

The architecture of a new iCZM2.0 model is proposed based on first principles, along with a working 'beta' version in real-time. These principles include: a clear and unambiguous definition of the geographical dimensions of the coastal zone that encompasses both the marine and terrestrial space, along with a recognition of ICZM's status as the overriding policy space within which other instruments operate within the coastal zone. The future iCZM2.0 will also have a legal basis at multiple governance levels - providing a coherent framework for governance and actions. Rather than the current "scattergun" approach, there must be a strategic, hierarchical context of regional, national and local ICZM strategies and plans.

A strong, disciplined outcome-driven iCZM2.0 is proposed to clearly identify and deliver outcomes that are appropriate to the local context and capacities; a simple transferable jargon-free process leading to a shared vision of coastal sustainability.

Sceptics will doubt all this is possible, but a real-time 'beta' example will be presented that meets these prerequisites with a powerful legal basis, one that is currently being developed in one of the world's most complex and challenging regional seas.

ICZM PROTOCOL FOR THE MEDITERRANEAN – A LEGAL FRAME FOR MANAGING COASTAL SYSTEMS

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The Barcelona Convention as the legal framework and its seven specific Protocols complete the legal system for the Mediterranean region. The signing of ICZM Protocol, the 7th Protocol in January 2008 in Madrid marked the fulfilment of six years of dedicated work by all the Parties. By adopting the ICZM Protocol, unique in international legislation, the Mediterranean Action Plan (MAP) demonstrated its will to keep ahead in terms of legal innovation and marine and coastal governance within the regional seas context. The signing also marked therefore the beginning of an intensive process of implementation to ensure that its ambitious objectives for the sustainable development of the Mediterranean coastal zone are achieved. By entering into force of the Protocol 24 March 2011 the period of much more responsible behaviour towards development and protection of Mediterranean coastal zones began, i.e. the activities and evolution of coastal zones that is under human control has now on its legal mirror.

The implementation challenges in front of the Contracting Parties as well as for the MAP Secretariat, its supporting components and all other actors in the region are being spelt out in the draft Action Plan for the implementation of the ICZM Protocol for the Mediterranean. This is a document that sets out a range of actions required in the period 1st January 2012 – 31st December 2019 as priorities in this initial phase of the Protocol implementation.

The ICZM Protocol implementation represents therefore a tremendous challenge. In this respect, the PAP/RAC, mandated to assist the Parties in the implementation of the priorities agreed in the Action Plan, focuses its activities along the major requirements of the Protocol. A plethora of various methodological documents, demonstration projects, tools, training and awareness raising activities are in the core to be delivered.

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Using coastal infrastructure to create a multi-purpose, green and sustainable economy: Aquaculture and the combination with energy supply installations

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The biological, technical and commercial feasibility of aquaculture enterprises are often related to local environmental conditions and an available niche market potential. With regard to its direct economic potential it involves information about fixed and running costs with special focus on the operation and production costs. Projects on the combination of aquaculture ventures with other industrial installations, such as biogas plants, geothermal power stations as well as other concepts have shown that these innovative combinations inherit an economic benefit. This is due primarily to various cost savings as well as using energy for e.g. adjusting the required optimal water temperature for cultivation of marine products. Biogas and geothermal plants have shown the feasibility of such multi-purpose systems and are already in the commercial utilization phase in the cultivation of aquatic species; however, other innovative combinations on a commercial basis are still in their infancy.

A case in point is the potential of combining aquaculture systems with offshore wind farms in order to develop more spatially efficient production systems. Indeed, along the German North Sea coast, the observed high spatial competition of stakeholders has encouraged the idea of integrating various users at the same site. Newcomers – the offshore wind farmers – are already covering large areas, which provide the opportunity to use these areas in a multifunctional way. Open ocean aquaculture in conjunction with the offshore turbines beyond the 12 miles zone is believed to be a promising avenue to decrease possible stakeholder conflicts.

This presentation provides an overview of the potential multi-use concepts. The current state of inter- and transdisciplinary research on a potential implementation on a showcase basis is outlined, covering biological, technical, economic and social/policy aspects as well as an estimation of its future potential.

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CULTURE AND COASTAL TRANSITIONS

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INNOVATIVE HERITAGE

The Netherlands has a rich cultural ánd innovative relationship with the sea.

The continuing need for coastal defence due to rising sea level in past, present and future is important for everyone. Reflections on the past teach us that the great flood of the southern parts of The Netherlands in 1953 instigated 60 years of Delta Works with dikes and dams (so called: 'building against nature'), which have been recently completed. As Emmy Bolsius, director of the governments Coastal affairs of the Delta program recently stated: 'As a result ecology suffered profoundly because of this strong focus on safety. We rigidly cut salt from fresh water and brought water that moved to a standstill. Water quality became low in some areas behind the dikes and dams. Every area of the country has its water problems: there is too much or too little water depending on the season or water is too salty for certain purposes. Salt water intrusion, salt water seepage, too little water in the rivers for freight traffic in dry periods. And on top of it all coastal erosion, the rise of the sea-level , stronger storms that last longer and a dipping country.'

So, we recently made a complete turn around in the way that we now invite the sea as a partner to help shape the coastal protection with the sands we put in front of the shores; we call this Sand Engine, 'building with nature', rather than 'building against nature'. Sand is the future strategy for coastal protection. It contributes to our most innovative heritage and is the newest Dutch export product.

While discovering and conquering the seas elsewhere, the Dutch shore has been the inspiration of our famous and innovative Dutch painters ever since the 17th century. The myth of 'Dutch Light' attracted international artists to the Netherlands, but, as the famous German artist Joseph Beuys stated, the Dutch light lost its extraordinary radiance after the reclamation of large parts of the Zuyder Zee (now called IJsselmeer) in the mid - 1950's. Of great value is to grasp this concept of 'cultural landscape' as a characterization of our coasts.

This strives to make the coast appear natural so that coastal interventions are not directly visible to the casual seaside visitor. Transparency – making this 'man-made' landscape visible and understandable - in the past, present and future is the aim of Satellietgroep. Transparancy contributes to the public and professional awareness of our culture and this particular innovative heritage.

IDENTITY IS FLUID

So, the Netherlands is a country with an innovative historical ánd artistic relationship with the sea. The resilient way of life in the Netherlands has been the inspiration for artists and scientists for centuries. These resilient Dutch people forever compete with the sea, recover from floods, gain lands from the sea, build dikes and invent innovative strategies to survive in our country below sea level.

The offside of this brave Dutch tale is that overall public use of waterfronts is under great pressure. Urban coastal developments seem to neglect the public, social and cultural importance of urban life at these seafronts. These developments show a tendency to focus on strategies that exclude local people and migration movements from the shores and emphasize tourism as a more interesting source of revenues. That may lead to conflicts, estrangements, a loss of heritage and a loss of more informal cultural and economic uses of public coastal space.

As the esteemed ethnologist Prof. Dr Gerard Rooijakkers states, identity has 3 locations: in the heart (feeling), in the head (knowledge), in the head of the other person (projection).

Identity also has 3 domains: it is territorial (we connect to spaces as the topographic sense of belonging), it is a construction of the past (we manipulate history and heritage and use rituals to deal with this) and the construction of blood (race, regional or national character, locality).

Arts and science can express the spatial and social qualities - as well as the problems - of our coastal areas, and make them engagingly accessible to the public. These works can transform a destination normally marked by consumption and recreation into a platform for critical communication and serious reflection. This timely reflection of art and culture on spatial transition processes may act as a strong catalyst in generating public and professional awareness and connect contemporary research and new works to historic and future coastal developments.

ART AS STRATEGY FOR CHANGE

Since 2006 Satellietgroep connects arts and science, architecture, film, urban developments and innovative heritage to coastal transitions. We research how the sea and waterways influence cities, people, communities and environments.

We connect to the latest governmental and scientific developments on coastal protection by Deltaprogramma Kust (Coastal affairs of the Delta program) in association with Atelier Kustkwaliteit (Studio on Coastal Quality by the Technical University Delft). Deltaprogramma Kust is the Dutch government's program that aims to protect the Netherlands this century against high water and keep the freshwater supply up to sufficient level. 'The National Perspective for the Coast' will be completed in the beginning of 2013 and it will be the guidelines for the next decades.

Satellietgroep developed a new method, an 'artist in residency program' for research and exchange of local knowledge on a global level. We invite international artists and scientists to jointly develop and present research articulating a cultural, innovative and sustainable significance of the sea and its coasts by doing on-site research, engaging with local communities, collaborating with local experts and connecting to international networks. The results are the production of new works related to coastal transitions and the development of new insights that contribute to future coastal scenarios.

Among our Dutch partners is Trans Artist (a platform for international artist in residence programs), Domein voor Kunstkritiek (Domain for Artcritism) and Reinwardt Academy (AHK, Museology and Heritage).

BADGAST

Satellietgroep programs Badgast, a research based artist in residence program, outdoor Cinema with screenings and Talks at the coast and develops international cultural exchange projects, all concerning the sea. Badgast is located in the middle of the surfing village FAST, the Urban Beach Community at the hinge point of the promenade and harbour in The Hague at Scheveningen. During the residency period new works – both conceptual and documentary - are developed that reflect upon the complex and layered coastal transitions and urban developments. With these works they contribute to the International Contemporary Collection On Coastal Transitions of Satellietgroep to be shared with broader audiences.

NOW WAKES THE SEA (NWTS)

Starting in 2012 Satellietgroep exported the concept and methods of our embedded research based artist in residence program Badgast for the first time abroad. We initiated the project 'Now Wakes The Sea' (NWTS), which involves research based artist in residence programs for artists /architects / filmmakers in coastal transition areas. We focus on countries surrounding the Black Sea and North Sea, encouraging artist to develop new works, to select existing works and to program travelling film festivals for public screenings and debates at venues, on both coasts.

'Now Wakes the Sea' (NWTS) combines architecture, arts and sciences in pursuit of local knowledge on a global level. Artist in residencies are used as a research method. NWTS enables artists to do fieldwork and to work on site with local partners in order to map out, collect and research the current status of coastal transitions and to generate new perspectives. This embedded research contributes to public and professional awareness. Thus, our project brings together different views and opens up dialogue. This new method of artist in residency program connects to the international development of artist residencies as cells of knowledge and as alternative academies.

INTERNATIONAL CONTEMPORARY COLLECTION ON COASTAL TRANSITIONS

In close collaboration with international artists, scientists, curators and guest curators, Satellietgroep develops an 'International Contemporary Collection On Coastal Transitions'. Through exchange projects in The Netherlands and abroad, Satellietgroep interconnects coastal communities.

'ZEESPIEGEL' ('MIRROR ON THE SEA')

One of the results of the program is the free open air photo exhibition 'Zeespiegel - Mirror on the Sea' on the new boulevard of The Hague at Scheveningen. Composed by Satellietgroep with artworks of 25 artists in residence of Badgast, locals en professionals. Contributions about innovative coastal protection, including the Sand Engine, complete the tales about our relationship with the sea and make them accessible to everyone.

Exchange of local knowledge on a global level - Art as strategy for change.

Satellietgroep was founded in 2006 in The Hague, The Netherlands. We have an embedded art and cultural approach in researching how the sea and waterways influence cities, people, communities and environments. We research the pressures placed upon the public, social and cultural use of waterfronts, and develop new concepts and sustainable strategies for a new approach to future sea and coastal urban areas.

ORAL PRESENTATIONS: Coastal management

THE ROLE OF STAKEHOLDERS IN MARINE POLICY AND MANAGEMENT: LESSONS FROM THE PISCES PROJECT

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Our coasts and seas are under growing pressure from the cumulative impacts of uncoordinated human activities and a lack of adequate protection for biodiversity. The EU Marine Strategy Framework Directive (MSFD) has been introduced to improve the environmental status of Europe's seas. It requires Member States to implement marine strategies to manage their waters more sustainably using the ecosystem approach. An essential element of the ecosystem approach, and of successful marine management, is meaningful engagement of stakeholders. Coastal communities and marine sectors most affected by changes in marine systems and by marine policy should be engaged. It is necessary to bring together stakeholders with very different interests and expertise, and from different sectors and disciplines, in order to share knowledge, develop common understanding, and ultimately agree management measures.

PISCES (Partnerships Involving Stakeholders in the Celtic Sea EcoSystem) is a pioneering project involving stakeholders in the development of a practical guide for implementingthe ecosystem approach in the Celtic Sea. PISCES is a ground-breaking project that is truly stakeholder-led and aims to translate EU marine policy into practical outputs for multiple sectors across a multinational area encompassing four countries: the UK, Ireland, France and Spain. This three-year project (2009 – 2012), part-funded by the European Commission LIFE+ programme, is building stakeholder partnerships and involvement through a programme of workshops, training and outreach. Stakeholders include representatives from all major sectors operating in the Celtic Sea (including fishing, aquaculture, renewable energy, shipping, telecommunications, aggregate extraction, ports and tourism) and Government agencies. A participative process, involving the stakeholder representatives from the different sectors of activity in the Celtic Sea, was established for the purpose of identifying realistic and meaningful management principles in line with the goals of the MSFD.Cross-sectoral partnerships resulting in increased understanding and participation are expected to enhance stakeholder incentives to protect the region, develop a sense of stewardship, and ultimately, result in greater compliance with marine legislation.

PISCES stakeholders have made a series of recommendationsto help deliver the ecosystem approach in the Celtic Sea. Recommendations for governments and stakeholders are made on: how stakeholders should be involved in MSFD implementation; a future model for stakeholder engagement;and voluntary actions to deliver sustainable practices. The guide, aimed at policy-makers, sea-users, and marine managers, was launched in late 2012 for application in the Celtic Sea, other EU waters and beyond. The PISCES project's innovative, stakeholder-led approach demonstrates the benefits of stakeholder involvement in helping to foster multi-sector, trans-boundary working based on trust and mutual understanding. Lessons can be applied from PISCES to other areas, other marine policy contexts, and to the process of stakeholder engagement in marine policy implementation and management.

BUILDING LOCAL CAPACITY TO DEVELOP ADAPTATION STRATEGIES TO CLIMATE CHANGE – THE IMCORE PROJECT

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There are a number of challenges in developing effective local adaptation strategies to climate change ranging from lack of public awareness of potential impacts through to lack of capacity and resources in local authorities. IMCORE (Innovative Management for Europe's Changing Coastal Resource), (INTERREG IVB), which ended in April 2012 applied various techniques to overcome these challenges at nine sites across North West Europe.

This entailed identifying the potential impacts of a range of climate change scenarios on coastal sectors (e.g. fisheries and aquaculture, ports and shipping, marine recreation and coastal protection) and subsequently developing an effective response in the form of adaptive management strategies at each site.

The Project actively promoted partnership working between research centres and local authorities and utilized an Expert Couplet Node approach to develop strategies to address local issues in order to avoid the disconnect that can exist between the scientific output and the needs of local government.

The presentation will provide an overview of the project, present reasons why adaptation is necessary and highlight the key challenges encountered whilst developing strategies at the case-study sites. It will showcase some of the innovative techniques employed to overcome these difficulties and the freely available resources generated by the project which are of benefit to all involved in coastal management.

COASTAL COMMUNITIES ADAPTING TO CLIMATE CHANGE: AN EVALUATION OF CAPACITY BUILDING AND ENGAGEMENT IN THE SOLENT, UK

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Associated with the complexity of hazards relating to climate change is the acceleration and dynamism of natural processes; the impacts of which are likely to be keenly felt in the coastal zone where littoral communities may face an increasing risk of coastal erosion, flooding and saline intrusion.Enhanced vulnerability requires solutions, and a more strategic approach to ensure that timely and effective measures are taken, whilst achieving coherence across the different sectors and levels of governance.

With a realisation of the limitations of mitigationas the principal mechanism to manage climate related impacts and their consequences, on a geopolitical scale, the alternative approach of adaptation has started to play a significantly greater role amongst coastal planners and managers. This is now embedded as one of the post 2012 pillars, having been agreed by the Parties to the United Nations Framework Convention on Climate Change (UNFCC) in 2007.

To date, adaptation has been piecemeal in naturewith research showing distinct challenges and barriers to its introduction (Lorenzoni*et al.*, 2007; Gallagher and Calado, 2008). However, the availability of funding has allowed for a number of projects to run over recent years including the Innovative Management for Europe's Changing Coastal Resource (IMCORE); CoastAdapt; and the Coastal Communities 2150 (CC2150) project. Each has elucidated the challenges involved as well as demonstrating novel approaches that might be deemed 'good practice'.

In the UK, DEFRA has also funded a series of fifteen coastal 'Pathfinder' projects, to test new and innovative approaches to planning for coastal change. One of those selected is the Hampshire County Council project entitled 'Coastal Communities Adapting to Change' (CCATCH), which covers the 10 km stretch of coast from Beaulieu to Calshot in the Solent. This estuarine complex is an area of coast likely to be particularly vulnerable to coastal change since it is densely populated, low-lying and highly contested by a range of competing interests. It is also likely to include specific areas defined as Coastal Change Management Areas (CCMAs) that will not be protected by any new measures; hence requiring communities to adapt. As such the objectives of the CCATCH – Beaulieu to CalshotPathfinder *inter alia*have been to engage the local community in all aspects of coastal change; toprovide educational and interpretational opportunities so as to build adaptive capacity; and to enable the development of a shared understanding in order to provide the basis for agreeing joint action in the form of a Local Adaptation Plan. Central to this is the communication of science to enable more effective planning, and to draw conclusions that are horizontally transferrable to other vulnerable areas of the UK coast and beyond.

The project started in 2010 and is now part of a wider CCATCH – *Solent*project that represents Hampshire County Council's contribution to the Environment Agency led project CC2150.An Adaptation Plan has now been produced for the Beaulieu to Calshot Pathfinder and a project evaluation (Gallagher and Inder, 2012) carried out on the basis of the capacity building and engagement process employed. This is now informing the other five 'Priority Areas' as identified as being most 'atrisk' in the Solent.

The research presented in this paper is concerned with the evaluation of the Pathfinder and its outcomes, and will start with a review of the key elements of the Beaulieu to Calshot project. The methods employed to gather data included interviewing the key stakeholders involved in the process as well as the engagement consultants who facilitated it. This was supplemented by a public survey to gauge the project awareness and to interview the project managers of several other coastal adaptation projects, so as to enable a comparison with the work being carried out elsewhere.

The results of the evaluation are presented and are generally supportive of the approach taken and the tools and techniques employed during the Pathfinder. However, they also highlight some clear areas for improvement and consideration. For example, on the basis that the selection of the area and the need for the project has already been established, there is a need to consider the application of stakeholder engagement in relation to the commitment to implement identifiable actions. This should also be considered both at the outset of the project and its duration, but also as a part of a developed on-going network beyond the lifetime of the funding. Engaging such commitment is clearly fundamental to implementing any specific actions identified as part of the Adaptation Plan. In order to agree the Plan, and identify actions, it was also clear that there was a need for specialist skills, and whilst these were available through the Pathfinder, there was a further need to consider the use and interaction of such consultants so as to maximise their effectiveness.

In relation to tools and techniques employed during the Pathfinder, many were considered innovative, but not all were well attended. Local specificity means that the activities selected should best reflect the nature of the area. Finally, one of the key areas identified as a lesson learned relates to the Pathfinder's communication and publicity, with the evaluation identifying scope for improvement in the project website, and its use of local newspapers, TV and radio. Employing a more developed communication strategy would certainly help with public awareness as well as lead to greater engagement with some of the activities.

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MARITIME CLUSTERS: A GOVERNANCE SUCCESS? EVIDENCE FROM THE CAMIS PROJECT

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There is an increasing awareness of the importance of global seas and coasts, with coastal communities dependent on the marine environment for a range of ecological, economic and social services. The pressure on marine environments and their resources poses a stark challenge to the sustainability of many coastal communities. While, as yet, no perfect solution has been identified, what is clear is that responsibility for effective marine governance does not just lie with policy makers (McKinley and Fletcher, 2010; 2012). In order for marine governance to be effective in delivering sustainability, an integrated approach to managing these vital resources must be adopted. In recent years, the marine environment and associated resources have been at the centre of a policy evolution within the EU. Key to this has been the development of the Marine Strategy Framework Directive (MSFD) in 2007 which emphasised the need for a holistic and integrated approach to managing marine resources across Europe. In addition, promotion of the Europe 2020 strategy (European Commission, 2010) designed to maximise employment opportunities, support economic growth and encourage sustainable development must be considered a driving force for policy development. Efforts are underway by Member States to ensure they are meeting the targets set by these EU political drivers in terms of environmental, economic and social sustainability.

In order to successfully deliver on the objectives set out by recent policy, the development of effective and inclusive marine governance is being increasingly prioritised within EU political agendas. In recent years, there has been a marked ‘turn to citizenship’ as policy makers strive to develop more effective and implementable governance strategies (Valencia- Saiz, 2005; Fletcher and Potts, 2007; McKinley and Fletcher, 2010; 2012). While this movement away from top-down management has meant an increase in public involvement in marine governance, it must also include the diverse range of maritime industries whose futures are wholly dependent on the long term sustainability of marine resources. The importance of maritime industries to local, national and global economies is being increasingly recognised (Kildow and McIlgorm, 2010) and, as such, maritime industries must be viewed as an integral component of developing effective and integrated marine governance. Evidence to support this is found in the Maritime Clusters report commissioned by Commission of European Communities (2008), which states that maritime industries are vital to Europe, responsible for between 3-5% of European GDP. This diverse industry provides employment to over 3 million people in coastal communities, generating 40% of total European GDP.

As a European region, the Channel is a vital regional link, connecting the North Atlantic and the North Sea and acting as a transport link between the UK and France. The Channel Arc Manche Region was first recognised as a significant maritime region through the Espace Manche Development Initiative (EMDI) Project (EMDI, 2006). Following on from EMDI, the INTERREG IV A funded Channel Arc Manche Integrated Strategy Project (CAMIS) aims to develop an integrated management and policy strategy for the vibrant maritime industry sector currently present in the region. Although only recently recognised as its own region, the Channel region includes the major cities of Paris and London, and provides a strong connection between the UK and French coasts. The Channel provides the region with key transport links, diverse ecological ecosystems, and a varied cultural heritage, and is an area of real significance for Europe. The project proposes that by developing a common strategy and encouraging Franco-British collaborative relationships, the diverse range of factors influencing the Channel’s coastal communities, social, economic, cultural and environmental, can be considered. Coastal communities play a vital role in regional, national and international society and the security of their future is a key driver of the Channel Arc Manche Integrated Strategy (CAMIS) project.

As part of the CAMIS project, the role of maritime clusters is being evaluated as a mechanism through which coastal communities can undergo sustainable economic growth and development, whilst adhering to the relevant environmental policies and legislation. A cluster can be defined as a geographically linked group of companies and other associated institutions within a particular field (Porter, 1998). They can include a range of members, such as, specialist suppliers, manufacturers, sales providers, government bodies, as well as other institutions such as universities (Porter, 1998). In the context of maritime industries, the development of successful maritime clusters has been shown to have positive impacts on not just the cluster members, but for the wider economy (Policy Research Corporation, 2008). Like all sectors, maritime industries are working to mitigate the impacts of the global recession. It has been the proposition of the CAMIS project that the development of maritime clusters in the Channel Region could be a way of encouraging long term sustainability and encouraging coastal community growth and stability. The benefits of business clusters have long been recognised (Porter, 1998; Holte and Moen, 2010) including: opportunities for group purchasing and training, development of collaborative business relationships, encourage the generation of local supply chains, increased awareness of skills and expertise, reduced costs for businesses and enhanced development and economic growth. However, as with all new initiatives, the work has also highlighted some potential challenges including; a lack of understanding of existing policies and legislation, a perceived cost associated with collaboration and encouraging pro-environmental behaviour, a fear of losing competitive advantage, lack of awareness of the local/ regional skills and expertise, and a reluctance to change (McKinley, 2012).

Given the EU Integrated Maritime Policy (IMP) promotion of maritime clusters, the work being conducted by CAMIS is both timely and necessary. Case studies examining the capacity for regional, sectoral and cross channel maritime clusters have been carried out with a diverse range of stakeholders. Research has been conducted through a series of facilitation workshops and in depth interviews with maritime stakeholders across the region, encompassing a diverse range of maritime industry sectors. To date, the research has shown that there is stakeholder willingness to engage in clustering for the benefit of the region's maritime industries and the communities they support. In particular, the CAMIS project has identified significant interest in the development of a cross border marina cluster, which would serve to engender Franco-British business collaborations, as well as the generation of a regional cluster in the South West of England. However, in order for these to succeed, there needs to be effective communication between and about the cluster, utilisation of existing infrastructure and relationships, and further promotion of the Channel Region as an area of maritime expertise and skill. Maritime stakeholders in the Channel area are keen to ensure they have a voice within their region, and the development of effective clusters, with support from regional policies and governance, will ensure this is realised. This research proposes that the findings of the CAMIS project could be used as a driver for policy change within the maritime industry sector, aiding the realisation of the goals set out by Europe 2020 (EC, 2012) and promoting the European Territorial Cooperation objectives. Through the findings of the CAMIS case studies, examples of best practice in terms of cross channel business development can be used as evidence to support changes in policy which will work to promote maritime clusters as a stabilising tool for coastal communities and their industries.

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ORAL PRESENTATIONS:
Measuring sustainability

MEASURING SUSTAINABILITY IN THEORY AND IN PRACTICE: SECTORAL INTERACTIONS IN THE COASTAL ZONE.

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Major legislative change is taking place in Scotland within the sphere of marine and coastal management, with Scotland's Marine Act (2010) and creation of Marine Scotland as the overarching governing body for Scotland's Seas. Management of Scotland's marine (and coastal) environment will take on new dimensions over the coming years, with emergence of marine spatial planning identified as a powerful tool for managing the marine environment. One of its key uses is its perceived potential to identify and deliver options for the sustainable management of interactions (positive or negative) amongst sectors operating in the marine environment.

A recent survey carried out by the Local Coastal Partnerships in Scotland, on behalf of Marine Scotland, has compiled data on categorising interactions between sectors operating within the coastal regions. The Tay Estuary Forum (TEF) has acquired information on the nature, extent and intensity of perceived interactions among sectors and subsectors within the Tay Estuary and coastline of east-central Scotland, from the River North Esk to Fife Ness, including the Tay Estuary to its tidal limit at Scone and 12 nm seawards of the baseline (Figure 1). Interviews have been carried out with 26 coastal stakeholders from a range of key sectors. The result is a Sectoral Interactions Matrix (SIM), which assigns a colour-coded interaction between two sub-sectors, populating an intersecting grid pattern, based on a template developed during the Clyde Pilot Scottish Sustainable Marine Environment Initiative (SSMEI) in 2008. This allows respondents to gain a mutual, two-way understanding of each other's activities, highlighting areas of overlap, both in terms of competition or conflict, but also opportunities for partnership working. The exercise forces local coastal stakeholders to re-evaluate their inter-sectoral relationships, past, present and future. Thus, the importance of inter-sectoral communication is promoted, further highlighting the essential role currently played by the Local Coastal Partnerships in providing a neutral and inclusive platform for discussion open to all coastal stakeholders (Booth & Duck, 2010).

The term 'managed competition' has emerged as a key phrase from the Sectoral Interactions work. We define this here as "a balanced or neutral state, achieved between sectors (either by voluntary or statutory measures) which may otherwise compete or even conflict with each other". An example of managed competition in practice is described from the northern extremity of the TEF region at Montrose Bay (Figure 1), a 9km long sandy beach-dune system with significant development in the coastal hinterland at its southern end associated with the port town of Montrose (population: 10,845 in 2001 census). Activities at Montrose are used to illustrate some of the issues faced when sectors compete for the same resources, but more importantly, how these challenges can be overcome by providing a foundation of scientific understanding derived from coastal process analyses, modelling and monitoring (Milne *et al*., 2012) to demonstrate the likely impacts of current and proposed activities at the coast and through fostering a culture of stakeholder communication. Thus, 'managed competition' can be utilized to achieve sustainability where two (or more) competing interests meet within the coastal or marine zone. This facilitates evolution from competitive/conflicting interactions to neutral or even positive interactions over time to ensure an optimal balance between the interests of coastal stakeholders can be met and sustained (Figure 2).

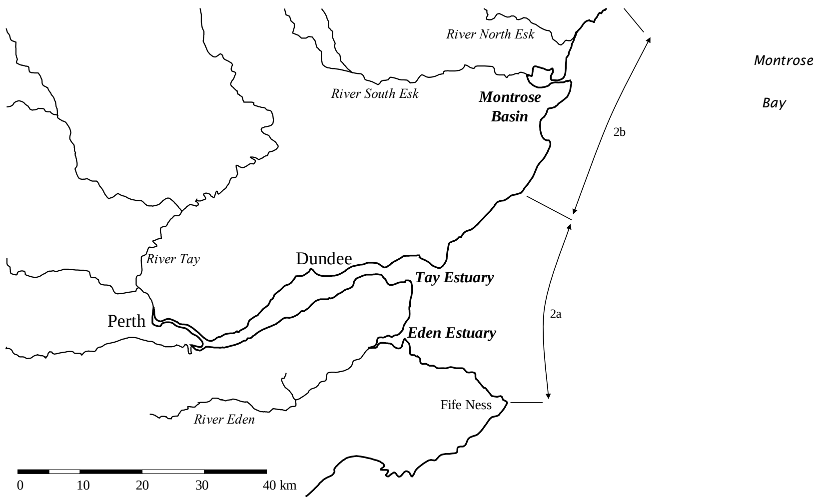

Figure 1: Map of the area covered by the Tay Estuary Forum. The coastline is coincident with Sediment Cells 2a and 2b of HR Wallingford (1997)

Sectoral Interactions Matrices provide a tool by which to monitor changing states of sectoral conflict/competition. It is suggested that changes in the number of neutral or positive interactions in the coastal zone evident in successive SIM exercises represents a powerful measure of the effectiveness of managed competition and thus sustainability at the coast.

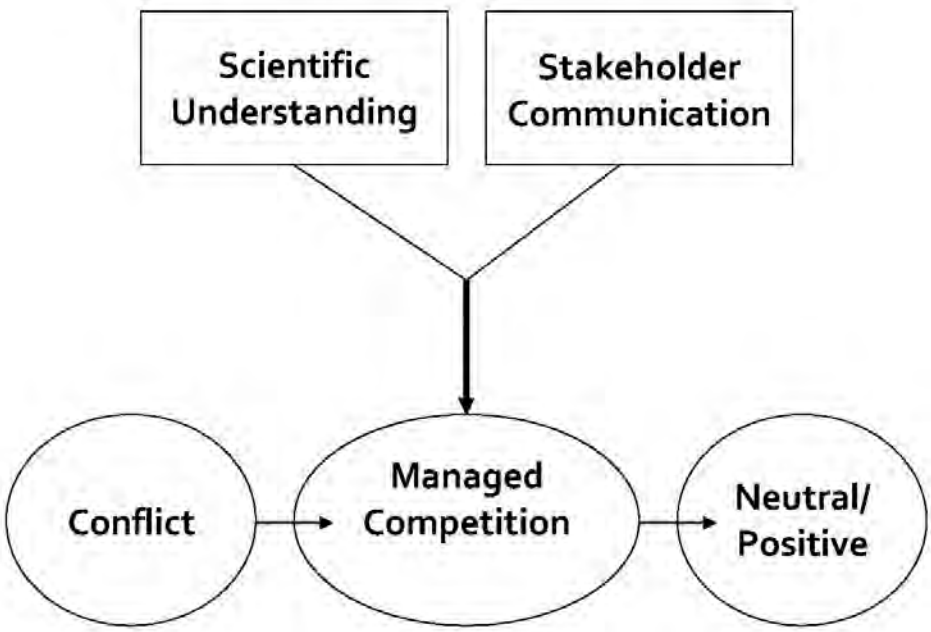

Figure 2: Managed competition as a method to achieve sustainable use of the coast through scientific understanding and stakeholder communication.

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COINS – AN OPERATIONAL INDICATOR SYSTEM FOR INTEGRATED COASTAL ZONE MANAGEMENT

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The coastal areas have been under severe pressure during the last decades. The growing population in the coastal zone and the associated conversion of nature and agriculture land into built-up areas have enhanced the pressure on the coastal zones around the world. The consequences of this development was addressed and recognised at the World Summit in Rio de Janeiro in 1992, where the concept of Integrated Coastal Zone Management (ICZM) was given particular attendance in Agenda 21. The on-going global warming will enhance the pressure – primary due to sea level rise. The European answer to these challenges was two policy documents from the European Commission (2000; 2002) on Integrated Coastal Zone Management. Generally information technology is not considered as being an integrated part of the ICZM process, although technology plays a major role in the practical implementation of the policies and plans decided concerning for example dyke building. GIS played a role in most of the ICZM demonstration projects - mainly in the problem recognition phase and the planning phase (Capobianco, 2003).

However the role of GIS was mainly to produce maps meeting sectoral needs, whereas the full potential offered by a full integration and exchange of information using GIS was not exploited. Nevertheless, the awareness of the importance of informed decision-making is increasing. The EU ICZM Expert Group established a Working Group on Indicators and Data in 2002 to advise it on ways in which Member States, and the European Union as a whole, can assess whether they are moving further towards, or away from, a more sustainable future for their coastal zones. Several indicators have been suggested for monitoring the state of the coast, but the following criteria were used in the selection process: user driven, easy to understand and policy-relevant and scientifically sound. The indicators will allow benchmarking between countries and between regions, and facilitate the evaluation of the effect that their coastal strategies are having on coastal sustainability. The working group agreed on a list of 27 indicators composed of 46 measurements to monitor sustainable development in the coastal zone. The BLAST project on 'Bringing Land And Sea Together' (www.blast-project.eu) has participants from all countries around the North Sea and aims at improving Integrated Coastal Zone Management and Planning as by harmonising terrestrial and sea geographical data and by developing planning and visualisation tools in the context of climate change. The BLAST project is co-financed by the INTERREG IVB North Sea Region Programme.

To support the decision-making process in ICZM we have developed a Coastal Indicator System (COINS) by using the subset sustainability indicators mentioned above, but concentrating on the indicators particularly connected to the impact of climate change. A subset of the indicators is directly or indirectly related to climate change challenge and accordingly relevant for the work carried out in the BLAST project. This subset can be divided into three different groups: A) Control the development of earlier developed coast, B) Protect and enhance natural and cultural diversity, and C) Recognise the threat to coastal zones posed by climate change. The conceptual framework for COINS takes outset in the DPSIR framework developed by the European Environment Agency (2003). Referring to DPSIR framework group A refers to Drivers and Pressures, group B to States, and group C to Impacts.

The indicators implemented in COINS are: 'Demand for property on the coast', 'Area of built-up land', 'Rate of development of undeveloped land', 'Sea level rise and flooding hazard', 'Coastal erosion', 'Natural, human and economic assets at risk', and 'The coastal zone as a resource for renewable energy'.

The data behind the indicator calculations are harmonised land-sea data provided by the BLAST project aiming at more accurate and reliable indicator estimations. All data and indicators have associated metadata in accordance with the European INSPIRE specifications (European Communities, 2007).

Figure 1 and 2 illustrated the functionality of COINS by two indicator examples – both from Northern Jutland. The first example – figure 1 – shows the 'Area of built-up land' expressed as the percentage of built-up land by distance from the coastline. The indicator is estimated for two distance bands – a 1km wide zone representing the coast near areas and a 10km wide zone representing the hinterland. The indicator facilitates the assessment of the urbanisation pressure in the coastal zone compared with the coastal hinterland. The colours range from dark green (low built-up pct.) to orange (high built-up pct.). The narrow orange zone along the North-western coast around Hirtshals shows high built-up ratio in the near coastal zone compared to the hinterland. This is mainly due to high density of summer cottages and other leisure facilities. The second example – figure 2 – illustrates the flooding hazard due to a combined effect of 1 metre sea level rise and 1.6 metre storm surge corresponding to a 100 years event. This is clearly a disaster for Aalborg city – the main city in Northern Jutland with about 200,000 inhabitants for the city including suburbs.

COINS is a web-based application running directly in the browser of the user's computer. The underlying architecture is based on open source components and can therefore be used free of charge. The system is based on the INSPIRE principles European Community, 2007) both in terms of architecture and data. The core components of the system are PostGIS (Obe and Hsu, 2011) and Geoserver, creating INSPIRE compliant geographical services for the application. Background data for the application is provided as services by the appropriated data providers in each country, so that data maintenance and updating is conducted as close to the source as possible, to comply with the data provision instructions from INSPIRE. The application specific indicator data are results of advance geographical analysis, and the results are provided to the application as WMS services hosted by the COINS system.

The user interface is based on OpenLayers (Hazzard, 2011) and GeoEXT providing the user with a desktop GIS experience directly in the browser. Besides the most common map navigation functions, the COINS system is capable of letting the user interact with the system and the data in the application. For each of the indicators, a tool group has been created, enabling the users to visualise the implication of the selected indicators directly in the system, without having any prior GIS knowledge or skills. The indicator data can, free of charge for all users, be downloaded in many common GIS formats, enabling advanced users to download the indicator data and work further with them in the context they wish to apply it to. Finally, the COINS system enables the users to add their own data directly to the web application. This is accomplished by adding user determined WMS services to the application, making the COINS system a very flexible and adaptive system.

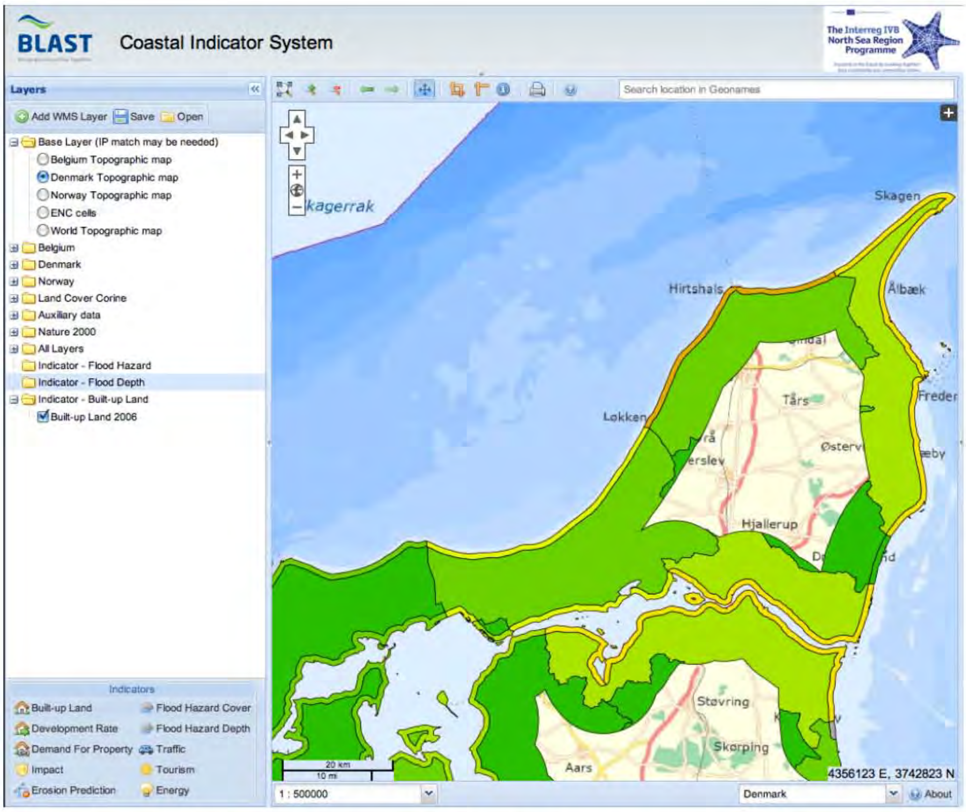

Figure 1. Percentage of built-up land by distance from the coastline.

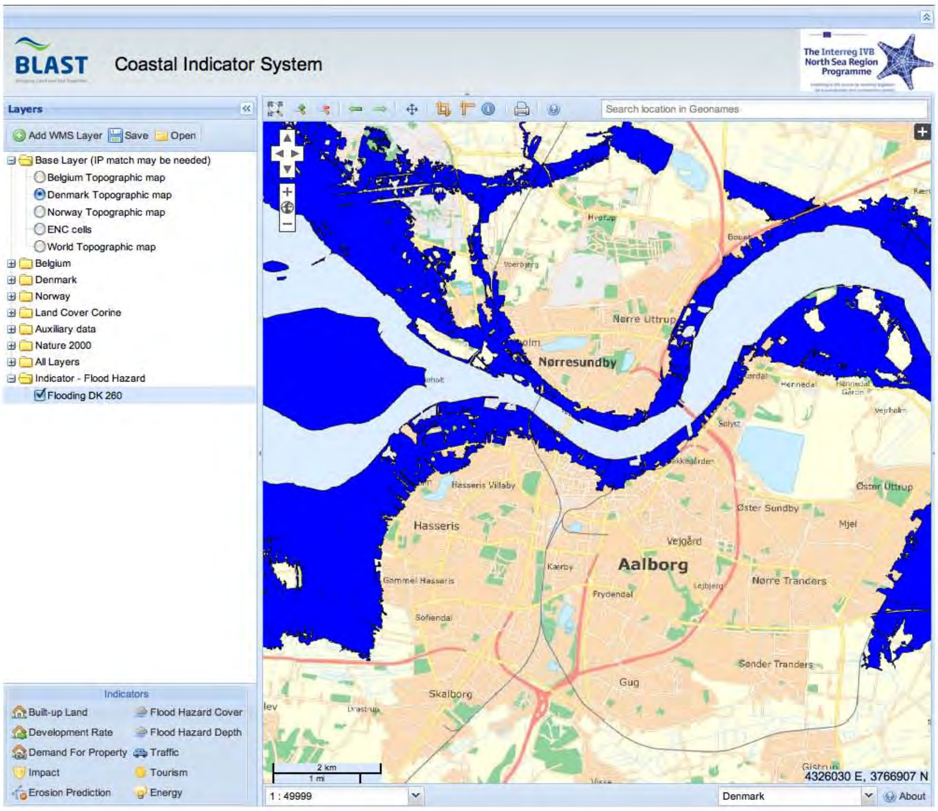

Figure 2. Flooding hazard (shown in blue colour) around the city of Aalborg.

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SUSTAINABLE COASTAL DEVELOPMENT, DUTCH EXPERIENCES AND VISION

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The province of Zuid-Holland has high ambitions to develop its coastal region in an effective, climate proof and sustainable manner. In provincial policy-documents a broad interpretation of sustainability is used: people, planet, profit; or more specific: social, ecologic, economic.

Measuring success in terms of sustainability is quite common on local-level and project-level. Zuid-Holland's coastal resorts received quality awards for their efforts in sustainable tourism. Every major project intervention in the coast is accompanied by monitoring and evaluation programs. On a regional level (for the coastal region of the province) however, it's more difficult to measure changes in sustainability. In a recent try-out with the scoring methodology of the "Sustainability Development Indicators" of the InterregIVb project SUSTAIN it turned out to be in particular difficult to find economic data specific for the coastal region. Data are mostly aggregated to regions where the coast is only a part of. The lack of specific economic data for the coast motivated the policy makers involved in the National Deltaprogramme, to start a research project on the "Power of the Coastal economics". Thisresearch reveals that most specific coastal economic sectors are dropping behind the national economic development, that the coastal population is older and that labour participation is lower than the average in the Netherlands. These are rather worrying figures for a region that the province regards as their "golden edge". Interventions are needed to keep the coast attractive!

Awareness of the situation is extra urgent because there are some essential changes coming into the Dutch coastal development policy. Until recently, coastal safety has been the dominant and determining factor in the Dutch approach to coastal development. This approach has led to specific, typical technical Dutch planning strategies for the coast. These strategies may be logical to the Dutch, but can obstruct views on other possible developments. And the question is how tenable the strategies are in the new situation.

In Zuid-Holland safety works include the nourishment of the coast by artificially raising huge amounts of sand both under water along the coastline, as well as on the beach, forming new rows of dunes. A recent innovative method is the realisation of the so-called Sand Motor: a manmade peninsula of sand, which will disperse along the coast for the coming 20 years, reinforcing the coast in a more or less natural way. This shift to working with nature rather than against it, is a new and important perspective for the Dutch coastal development. The Sand Motor represents a new way of looking at coastal defence methods where the interests of water safety are combined with those of ecology, landscape and recreation.

A secondchange in the Dutch coastal practice between past and future is that within a few years the major safety works will have been completed. Water safety of course continues to be an essential aspect in planning the Dutch coast, especially in the light of climate change and rising sea levels. However, till 2050 there are no new radical plans for major safety projects that will alter spatial conditions along the coast. Coastal protection will consist mainly of maintenance and management. This maintenance and management guarantees safety, but does not automatically address the demand for more space for recreation, better-equipped seaside resorts, nature reserves, etcetera, in the coastal zone.

In the densely populated province of Zuid-Holland a better integrated coastal design is required to improve the social, economic and ecological climate. Integrated designs should look at how the coast and coastal zone can increase its value, by a higher spatial quality in terms of landscape, ecology, economy, exploitation, tourism, cultural heritage, energy, and etcetera. In the quest to new designs and strategies the province involves professionals as well as citizens and local stakeholders.

An example of the professional involvement is the international coastal design workshop that Zuid-Holland initiated in June 2012 to explore different approaches of the coast and coastal zone with less emphasis on safety. The assumption was that examples of coastal development in other European countries could be beneficial to the Dutch coast. Will they lead to other, refreshing insights in a sustainable future of the Dutch coast? Will they lead to a higher standard or other form of spatial quality? What can Zuid-Holland learn from other regions and countries? Can the coastal strategies be redeveloped to higher standards by examples of other European practices with a different cultural background? The workshop delivered suggestions for new designs and refreshing insights about the strengths and weaknesses of the coast of Zuid-Holland. The relative cold climate hinders competition with warmer region for the number of international visitors. Surprisingly a lot of the current local strategies to build more of the same apartments, shops and marinas are pursuing exactly this competition. A more fruitful approach would be to strengthen still existing qualities like the quiet long stretch of the sandy coastline, the contrasts between the resorts and the natural areas and the natural areas.

In sub-regions of the coast a more bottom up orientated approach is going on. With citizens and local stakeholders, a common vision on green infrastructure and a business model for eco-system services in the dune and coastal area are being developed (Green Infrastructure for Tomorrow- Together - GIFT-T, INTERREG IVB-programme). Involving local knowledge and activating the energy of the local communities is essential for new successful strategies on a sustainable coastal development.

TRANSNATIONAL MAPPING OF COASTAL AND MARITIME USES AND FUNCTIONS: TOWARDS A MARITIME SPATIAL TYPOLOGY

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Within the Wadden Sea Region an innovative GIS-based transnational Planning Portal maps both existing and planned anthropogenic activities as well as protection needs and functions. The Planning Portal has a trans-boundary focus on coastal and off-shore areas in the Netherlands, Germany and Denmark. It contains a wide range of uses, facilities and protection demands and is designed to meet the information needs of integrated management and marine spatial planning. The intensity not only of infrastructure projects but also the different national planning approaches are made visible by this application. A tool like this provides the basis for an assessment of the present state of development of clusters of maritime industries and of future development opportunities associated with the different European Seas. In turn this informs the definition of the spatial distribution of different types of maritime/coastal regions and is the basis for a development of an associated maritime/coastal typology.It is showed that the approach to classifying maritime regions with different categories as developed within the ESPON project ESaTDORcan be applied to all of Europe'sregional seas.

DECYDE: A PARTICIPATORY METHOD FOR "MEASURING" SUSTAINABILITY THROUGH A FRIENDLY, FLEXIBLE AND ADJUSTABLE [SELF-ASSESSMENT?] TOOL

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The concept:

DeCyDe is a practical method that can be implemented to give a "number" to a problem or an issue, i.e. to have a measure, to understand the size or the scale of a state/condition, especially in cases where everything is subjective or difficult to quantify. The DeCyDe approach is in line with the trend of public policies to move from a purely conceptual and theoretical view to a more pragmatic approach, based on empirical evidence. When talking about decision support, the important questions are "who are the Decision Makers" and "what are their competences". If a sophisticated and complex to users decision support system, aims to support decision makers who do not have high academic competences, then it should be expected that the system will not be used. This is the most common problem of the Decision Support Systems: in their majority they are complicated and difficult to use, resulting in decision makers who increasingly rely on their intuition and judgment and even interests.

The above issues were the challenges which led to the development of DeCYDe, a method that integrates logical processes, established scientific knowledge and real local data, together with local knowledge and experience and a high degree of participation. More than 10 years of implementing and improving simple decision support methods in real cases, led to the development of DeCyDe, a clear method and a friendly decision support tool, flexible to accommodate different kinds of decision problems when multiple decision alternatives exist. It offers a framework that supports the decision makers and the stakeholders to understand and justify the main issues that are involved in the process of decision and the trade-offs between different decision alternatives. At the same time it gives them the chance to a real participation, i.e. to incorporate their views, evaluations and perspectives in the process.

DeCyDe incorporates principles from multi-criteria analysis, from public policies approaches, from vocational training structures (eg LitusGo structure) and even basic logic principles from Fuzzy theory (the theory of graded concepts, where everything is a matter of degree). It is a spreadsheet oriented decision support method including a flexible and easy to use tool.

The structure of the DeCyDe method:

DeCyDe is structured in three preparatory, self-contained and interrelated steps and in a final stage where the actual decision support work is done. The preparatory steps are self-contained because they can be used *per se*, each step giving specific results. They are interrelated since when put together they lead to the final stage, where the decision is supported, based on facts and data not to perception and intuition. However, the first step, the data base, is necessary for the consistent development of the other steps:

Step1: The Data Base

Usually a major problem in decision making is the lack of consistent data or the low quality of existing data. The Data Base of DeCyDe is built specifically and dedicated for every case that the method is implemented, taking into account the above mentioned data problems. This step forms actually the baseline work, the product of the identification of the problem and the gap analysis of the needs and the parameters that are involved in the specific decision process. The Data Base provides the set of "core" data that are needed in order to guarantee the unbiased character of the results of the decision process. It is very usual that the decision makers believe something which is not the reality but rather their perception. This set of core data is organized in a way that supports the decision makers to picture the real image of the existing situation and understand the problem through numbers.

Step 2: The setting of of criteria/ parameters

This is the part of the method where each case under examination, is structured and modeled. Step 2 of DeCyDe consists of two parts:

Part 1: Addressing the multiple dimensions and/or perspectives of each case. It is important to define the key set of criteria/parameters that are involved in the decision making process. This is achieved through a participatory process, where the experts/consultants suggest a rather large set of parameters/criteria which is the result of their research. The decision makers and stakeholder are asked to go through them during dedicated structured meetings/ workshops, discuss and decide on the "core" set that is going to be implemented in order to support their decision. This is a highly participatory process that incorporates a simple approach, i.e. the availability of data, the definition of the problem and the perception of the decision makers and the stakeholders. It is important to have a robust baseline study, a good set of data (the result of step 1) and a trained facilitator/expert who is not imposing decisions, but supports the process and has a good knowledge of the examined case, of the data and of local/ case specific characteristics. It has to be clear and provide the decision actors with the reasoning that the aim is to solve the problem, to get a concrete result to support the decision to be made than to attempt to model a system mathematically.

Part 2: The "Scoring" of the criteria/parameters. The scoring of each criterion/parameter is achieved through given ranges of values. The "scoring through ranges" approach converts state-of-the-coast indicators into sustainability indicators. This is because the score attributed immediately gives a reference value and relevance instead of just a snap-shot single figure which stands for nothing but itself.

The ranges of values are mainly defined, based on European Union Directives and when these do not cover the specific parameters, limits provided by International Bodies are used. Local/ National regulations are also considered. The approach to score through ranges instead of using precise values, provides the method with flexibility: even data which could not be specifically identified and have a level of being imprecise or give an approximation, can be used if identified within a range, and thus they are descriptive for the method and can be taken into consideration and contribute with a certain score. It is usual to skip parameters/criteria when their precise value cannot be reached. With this approach of scoring through ranges, all key parameters/criteria are incorporated in the decision process.

Step 3: The Weighting

This is the final step of DeCyDe. The criteria are organized in matrices, based on Saaty's concept of comparing couples. The number of matrices, i.e. the number of levels that will be incorporated in the decision support method is defined in step 2, when the key parameters/ criteria are decided. Well structured workshops are organized, with the participation of the decision makers and the stakeholders that have already participated in step 2. The facilitator explains the process on how to compare the importance level between couples of parameters/criteria. The matrices are presented in a spreadsheet form and they need to be ready and programmed in order to have direct results the moment the weight/ importance between a couple of parameters/criteria is agreed among the participants. Through this step a high level of participation is achieved. By increasing the level of actual participation, and by enhancing conversation among conflicting interests, DeCyDe achieves consensus building among the group of decision actors (decision makers and stakeholders) that are involved in the process. They get into a discussion that eventually leads them to a common perception or at least common understanding.

Final stage:

When all three steps are completed, the spreadsheet tool is the ready to be operated further: the decision makers can predict how the existing situation can be changed if, for example, they want to change the score of one or more parameters/criteria. That means that they can easily check what will happen to the entire set of criteria/ parameters should they invest resources to support the change of score and thus the range, of that certain parameter. Or they can forecast what will happen if they change the importance among the different parameters/criteria, i.e. change their policy. Through this exercise, the decision makers can evaluate and assess a large range of concepts, of actions, of policies. They have a “number” that gives them their “score” each time they would take a decision, based on real data of the existing situation. They have the chance to anticipate the impacts of their decisions, identify the pros and cons of different options and discuss them among the entire group of decision actors: and eventually, they can reach an optimized decision. As mentioned before, since this decision is taken through a participatory process, with the consensus of the decision actors, they are all committed to support the implementation of their decision. This is one important issue: promoting the implementation of decisions through the consensus of decision actors.

Case study: implementation of DeCyDe in SUSTAIN project

DeCyDe was modified to accommodate the needs of the Interreg IVC project SUSTAIN. SUSTAIN aims, among others, to provide Local Coastal Authorities and Local Coastal Decision makers with a tool that can help them assess whether their decisions, policies and actions will lead to a sustainable future. In other words, the question was how to “measure” sustainability and how to “track” the changes, improvements or not, and give them a “number” which could be comparable in time.

The multi-functionality and complexity of coastal zones gives rise to several conflicting functions and much ambiguity in coastal zone management. The SUSTAIN group formulated/ modeled coastal zone systems through 42 parameters/ indicators: the SUSTAIN sustainability indicators. ISOTECH’s working group (the DeCyDe developers) took the SUSTAIN set of indicators and (a) drafted a list of data and their format/ units, that should be provided from each SUSTAIN partner in order to run DeCyDe in each partner’s area (b) gave ranges to each parameter/ indicator in order to proceed with the “scoring” (b) set up the decision support spreadsheet with the weighting matrices. The SUSTAIN partners have implemented the DeCyDe tool during the project. The complete structure of the DeCyDe method, as it was implemented in the SUSTAIN project, will be presented during the Littoral 2012 Conference.

Conclusion

DeCyDe is a method that aims to facilitate decision makers and decision actors in the decision process and at the same time sets their actual participation as a prerequisite for the success of the method. It provides them with a friendly to use and rapid implementation tool, respecting thus their time limitations (which is one of the major problems of participation in decision support systems). DeCyDe was developed based on a wide range of concepts, techniques and principles, targeted towards a transparent and effective decision support method, which can provide the decision actors with a tool of high sensitivity and robustness in assessing different options and impacts of decisions. DeCyDe is characterized by flexibility and adaptivity: it is a multi – task/ multi-purpose/ multi-use decision support method.

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LOCAL ECOLOGICAL FISHERIES KNOWLEDGE IN SUPPORT OF SUSTAINABLE DECISION-MAKING THROUGH MARINE SPATIAL PLANNING

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The paper will report research results of "LECOFISH" (http://www.lecofish.be). Data on the distribution of fishery activities and fish species in the Belgian Part of the North Sea (BPNS) are very limited. Studies on biological valuation of the BPNS confirmed that certain spatial information is only fragmentary available, such as on epibenthos, macrobenthos and demersal fish species. Due to the large grid of ICES boxes and the fact that these data do not sufficiently provide spatial information for small coastal regions, sustainable management of fisheries combined with nature conservation often lacks sufficient information.

Starting from the assumption that we lack sufficient small scale fisheries data for sustainable fisheries and nature management, LECOFISH gathered fisheries data through local ecological knowledge (LEK) of fishermen, commercial and recreational, during a period covering the last 50 years.The Belgian coastal zone, including the territorial sea and exclusive economic zone(3,600 km^2) is the case study area.LECOFISH made use of interviews and oral mapping of fishermen. The overall objective of LECOFISH was: 1. to gather data through LEK to improve our knowledge of local ecosystems and fisheries in the Belgian coastal zone and to further analyze spatial and temporal distribution of fishery activities and fish abundance; 2. tocompare LEK data with available Scientific Ecological Knowledge (SEK) data in order to assess the scientific value of LEK as a tool to fill in fishery data gaps (validation process); 3. to discuss LEK and SEK results with stakeholders (fishermen, officials from the fisheries administration, fishery scientists); 4. to explain changes in fishery activities and fish species shifts during the past 50 years; 5. to develop spatial maps with information of fishing (where, what and why) that are useful for marine spatial planning.After having explained the methodology used, the results of the above mentionedobjectives will be reportedin a paper presentation with focus on three commercial fish species(cod, sole and shrimps) as an example for further decision-making. Finally, spatial fisheries and fish distribution maps in their historical perspective can be used in support of marine spatial planning and sustainable management of fisheries and nature conservation.

MEASURING SUSTAINABILITY

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SUMMARY

Increasingly, humankind is attempting to move towards a sustainable future. Unfortunately, communities do not have a means of adequately measuring whether it is reaching that goal or not. This paper sets out an indicator-based methodology which would allow a numerical value to be attributed to the efforts of Authorities to determine if they were reaching their strategic sustainability goals. It was developed in the ERDF-funded INTERREG IVC project SUSTAIN.

This goal was achieved by the selection of relevant, scoreable indicators that had available data. Indicators were chosen to cover 22 distinct Issues within the four recognisable pillars of sustainability i.e. Governance, Economics, Environmental Quality and Social Well-being. Innovation was introduced through the use of a checklist for Governance, as opposed to traditional indicators which are notoriously difficult to measure, and the combination of a set of Core Indicators together with Optional Indicators to reflect local needs and specificities.

Data for the relevant indicators is fed into a newly developed policy tool, DeCyDe. This is a user-friendly, spreadsheet tool which serves as a self-assessment to determine, numerically, whether an authority is moving towards a sustainable end-point. It is done through highly participatory workshops where discussion about the Issues, Indicators and data is as important as the numerical value obtained.

The only problems to this approach, common to any methodology based upon indicators, are the time needed to find the relevant data and the sometimes lack of data. However, whilst nothing can be done about the former problem, the latter is minimised since DeCyDe is flexible and robust enough to cope with less-than-perfect or absent data.

Together, the Sustain Indicator Set and DeCyDe tool constitute a friendly to use rapid implementation, self-assessment tool. It respects the time limitations of policy-makers and other stakeholders.

A Methodological Framework

Sustainability is more of a generalised concept than a fundamental truth. It does not have defined parameters that can be scientifically determined. Neither is it constant but continuously changing. Indicators that are applied to determine sustainability today rarely take this into account and, paradoxically, use data that has been precisely measured. Many of the indicators are very specific and many measure parameters which are beyond the sphere of influence of regional/local authorities. A pre-requisite for any determination at local or regional Authority level, is a framework in which the Indicators and their scoring can be placed. This framework, by necessity, needs to be based in policy and in implementable instruments e.g. legislation. Therefore, a step-wise methodological process has been developed which takes us from the starting point to the expected end point in a logical and cyclical manner. The framework incorporates the European strategic goals for sustainable development and integrated coastal zone management, as well as the most relevant issues in those domains. Having agreed strategic goals and targets, policy-makers can measure the relevant indicators from various data-bases. The framework explicitly addresses the selection criteria for indicators and has allowed the analysis of international, national and local indicators in order for the SUSTAIN indicators to be chosen by a group of involved stakeholders.

The SUSTAIN Sustainable Development Indicator Set

The Indicator Set has been deliberately based on indicators that are already in common usage and ones that, according to EU legislation, should be regularly monitored. New indicators, although possibly more relevant to sustainability have not been introduced if there is no data-base from which to measure them.

SUSTAIN offers two sets of Indicators differing from the more traditional approach of applying a fixed, standard indicator set. One of the sets, the CORE indicators, should be used by all Authorities seeking to measure their level of sustainability. They are considered to cover essential aspects of sustainability. They can be used with a number of OPTIONAL indicators which reflect local/regional specificities. They have been robustly selected using criteria such as relevance to sustainability, availability of data and their ability to be scored.

These indicators represent the four pillars of sustainability i.e. governance, environment, economics and social well-being. In order to show their relevance to sustainability the different indicators have been grouped into a number of Issues. In total there are **22 key, core Issues** broken down as follows:

Governance	5 issues
Economics	4 issues
Environmental Quality	8 issues
Social-Wellbeing	5 issues

a. The Governance Issues and indicators

These indicators are used to measure the consistent management, cohesive policies, guidance, processes and decisions for the wise use of the coast. Traditionally, indicators to measure governance have proven to be very difficult to define. Therefore, SUSTAIN has used a new approach which poses a series of grouped questions (each regarded as an indicator) which require only a positive or negative response (with a don't know' option). They have been structured into 5 groups of indicators:

i. Policies/ strategies for sustainability
ii. Monitoring tools for sustainability
iii. Human resources/capacity building
iv. Implementation of good management practices
v. Stakeholder involvement/public participation.

b. Economic performance Issues and indicators

These indicators have been chosen to show whether a vigorous and sustainable coastal economy is being promoted and supported. Four key, Core Issues have been identified which are deemed to be important for the economic contribution of sustainability in coastal zones:

i. Economic Opportunity
ii. Fisheries and Aquaculture
iii. Land Use
iv. Tourism
v. Transportation

A further three Optional Issues have been identified:

vi. Economic Performance (1 optional indicator)

vii. Energy & Climate Change (1 optional indicator)
viii. Fisheries and Aquaculture (1 optional indicator).

c. Environmental Quality performance Issues and Indicators

These indicators have been selected to demonstrate the availability of sustainable environmental practices and the way they are promoted. Eight core issues have been identified as important in a Pan-European context. They are:

i. Air Pollution
ii. Biodiversity and Natural Resources Management
iii. Change at the coast
iv. Energy & Climate Change
v. Land Use
vi. Public Health and Safety
vii. Waste Management
viii. Water resources and Pollution

Further one Optional Issues have been identified:

ix. Fisheries and Aquaculture (1 optional indicator).

d. Social Well-being performance Issues and indicators

The indicators for social well-being have been chosen to promote social unity and durability. Five core issues have been selected, being:

i. Demography
ii. Equity
iii. Education and training
iv. Local and cultural Identity
v. Public Health and Safety

Applying the DeCyDe scoring methodology

DeCyDe is a practical method that can be implemented to give a numerical value to an individual indicator. It is also an approach which is in line with the trend of public policies to move from a purely conceptual and theoretical view to a more pragmatic approach, based upon observed data. It incorporates principles from multi-criteria analysis, from public policy approaches, from vocational training structures and basic logic principles. It is spreadsheet-oriented. DeCyDe is structured in three preparatory, self-contained and inter-related steps and a final stage where the actual decision-support work is done. The preparatory steps are self-contained because they can be used per se, each step giving specific results. They are interrelated since when put together they lead to the final stage, where the decision is supported, based on facts and data and not to perception and intuition. DeCyDe has been built specifically, and dedicated, for each core and optional Sustain indicator. Determining the values of each indicator actually forms the baseline work. The information provides a set of essential data that is needed in order to guarantee the unbiased character of the results of the decision process. The scoring of each indicator is achieved through a given ranges of values. The "scoring through ranges" approach converts state-of-the-coast indicators into sustainability indicators. This is because the score attributed immediately gives a reference value and relevance instead of just a snap-shot single figure which stands for nothing but itself. The value of each indicator when found is simply entered into the relevant cell in the spreadsheet and the score attributed. As each score is entered, the overall scores alter automatically. The issues and the pillars under which the indicators fall are then organised in matrices (based on the concept of comparing couples). When the various weighting for the Issues and Pillars are entered into the relevant cells, the spreadsheet automatically calculates the overall score of all the indicators used. This is given as a single numerical value.When these three steps have been completed, the spreadsheet tool can be operated further: DeCyDe allows decision makers to predict how the existing situation can be changed if, for example, they want to change the score of one or more Issues. That means that they can easily predict what will happen should they invest resources to support the change of score and thus the range, of a given indicator e.g. by increasing resources in waste management recycling by moving them from aquaculture production. Alternatively, they can forecast what will happen if they change the importance among the four main pillars e.g. putting more resources into Economics and less in Environmental Quality through a change in their policy.

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IMPROVING SUPPORT OF COASTAL INFORMATION SYSTEMS TO ICZM

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In 2011, the European Commission launched a review of the EU ICZM Recommendation (2002/413/EC) with a view to a follow-up proposal; an impact assessment was therefore conducted to explore the need and options for future EU action and to assess related potential social, economic and environmental consequences (http://ec.europa.eu/environment/iczm/ia.htm). This activities implied a wide variety of initiatives aiming to provide input to the Recommendation review, e.g.: an on-line public consultation; a public hearing event; Member State reports on progress in ICZM implementation; the OURCOAST project gathering and disseminating case studies and practical examples of coastal management practice in Europe; studies to inform the impact assessment, including the study "Options for coastal information systems".

One of the main challenges in the implementation of ICZM is the integration of different sources of knowledge and different types of information in order to better understand coastal processes and dynamics and to develop scenarios for better evaluate, and manage properly, the possible impacts deriving from different coastal uses (Meiner, 2010). Within this framework, gathering and proper structuring of relevant data, transparent and ready available information to decision makers and stakeholders, adequate communication to citizens, information sharing, effective and concrete use of data and information in policy and decision making are all key elements to support and implement integrated planning and management of coastal zones (Rodriguez et al., 2009; O'Dea et al., 2011; Wright et al., 2011). The diffusion, further development (including innovation) and actual use of coastal information systems (CISs) can therefore concretely improve the implementation of ICZM in Europe; indeed this is one of the strategic objective of EU ICZM related policies. The study "Options for coastal information systems", funded by the European Commission[1], aimed to contribute to this overall goal, in particular by the identification of the key structuring requirements and related policy options for CISs that may significantly improve their support to ICZM implementation through scientifically-based data, functions, tools and mechanisms.

As a first step, the study analysed forty CIS illustrative cases, representing different levels of application (local, sub-national, national, transnational and regional sea one), regional seas and CIS' typologies. Based on the gained results, twelve cases were further in-depth analysed through direct interviews of main involved actors (users and/or developers), including among the others the Venice CIS case study. This case, similarly to the others, was selected since respond to the following criteria: (i) covers a wide range of ICZM information dimensions and sectors; (ii) provides good illustrative examples of integration among data and information related to different ICZM sectors and dimensions; (iii) provides good illustrative examples of ICZM knowledge and/or process related functionalities; (iv) is integrated with other tools, (v) is directly linked to an on-going ICZM process. The analysed Venice CIS is actually a system of different (on-line and off-line) tools (GIS, databases, models and DSS), used to manage and analyse an incredibly rich and wide amount of information about the Venice Lagoon. The CIS support the activity of the Venice Water Authority, i.e. the body responsible for the safeguarding of Venice and its lagoon. Within this unique scope, different tools are used to support different activities, including: studies, planning, project design, realisation of interventions and monitoring. Currently, data and tools are being used to develop a new Web-based CIS to support the operation of mobile gates protecting Venice from high water events and more in general to promote sustainable management of Venice lagoon.

Main conclusions of the CISs' overview and in-depth analysis can be summarised in the following points:

- For the great majority of analysed CISs the area of interest is mainly defined by administrative boundaries rather by the adoption of an ecosystem-based approach;
- Territory and environmental data are properly considered in CISs, while social and in particular economic and governance data are rather limited;
- Other data gaps or weaknesses are related to: (i) historical series, generally limited to a small number of specific issues, (ii) climate change related data, (iii) 3D data;
- Almost half of the analysed CISs provides basic ICZM knowledge and process related functionalities, as for example: availability of geo-spatial data, operation at different spatial scale, support to problem understanding and structuring;
- More advanced ICZM functions are much less available, such as: ICZM indicators and indexes, climate change related functions, stakeholder involvement and participation, vision building and scenario development, support to adaptive planning and management;
- Tools enabling an appropriate e-participation in ICZM (i.e. e-forum, geo-tagging, platform for participated GIS, wiki-like tools, etc.) are still not much diffused (20% of the cases).

The CISs' analysis showed that the problem to be addressed – improving CISs' support to ICZM – is a twofold problem: (i) underuse or improper use of existing CISs within the ICZM process at various scales, (ii) existence of weakness and gaps to be addressed through the development of new CIS' features to further improve their use within the ICZM process at various scales.

Based on the above results, the second step of the study identified main policy requirements of CISs to improve their support to ICZM. Policy requirements refer to all CIS' components including in particular: contents (data, information and related structuring), on-line functions and tools related to different target users (expert and non-expert), CIS' scope in relation to different users (decision and policy making, coast management and planning, stakeholder participation, etc.), and management and operation mechanisms. Contents and function requirements can mainly act on the design and development of new CISs features thus principally addressing the second aspect of the identified problem, while scope and mechanisms requirements can also determine significant improvement in the use of already existing functions, thus strengthening their positive effects on the ICZM process (first aspect of the problem).

Identified requirements were then aggregated to formulate policy options, whose specific objectives are:

- Increase the use of CISs in providing full support to implement the key ICZM principles, in particular as defined by the Recommendation 2002/413/EC;
- Provide support (through data, functions and management mechanisms) to the on-going integration process between ICZM and MSP, and more in general between ICZM and close related policies (including in particular the EU policy on climate change adaptation);
- Simplify the use of coastal information systems in order to make easier and more immediate their support to the ICZM decision making.

In relation to the identified problems and objectives, the study identified three policy options. i.e. integrated and homogenous sets of the key policy requirements. Firstly a "baseline scenario" was defined, to set a reference benchmark for the impact assessment of the policy options. In the specific context of the study, the baseline scenario was defined as the scenario not including the implementation of new policy requirements for CISs and implying the fulfilment of already set legislative requirements, in particular related to implementation of the INSPIRE Directive. The formulated policy options can be summarised as follow:

- P1 – Improving data and information base;

  P1 policy option deals with the principal identified data and information gaps. The final goal is the support to the creation of wider CISs able to address the various sectors and integrated aspects of the ICZM holistic approach as well as its long-term perspective, thus improving the current main contents gaps characterising the baseline scenario (in particular in relation to social, economic and governance data). The implementation of the P1 policy option mainly relies on the integration within

CISs of already existing data and information, still not included in the system, rather than on the acquisition of new data or the realisation of new studies.

- P2 – Improving and innovating functions and tools;
  P2 policy option mainly aims to improve the availability of functionalities and tools directly supporting ICZM decision makers and coastal planners and managers, as well as to increase stakeholders' involvement and participation in the ICZM process. The implementation of this option will significantly evolve the current state of the art (baseline scenario) in relation to interactive tools (for ICZM decision making and stakeholder involvement) available on-line.
- P3 – Enhancing cooperation;
  P3 policy option mainly aims to enhance cooperation among different subjects involved in the CISs implementation and management and more in general in the ICZM process, thus improving the CISs support to this latter. The P3 policy option is implemented through the following principal specific issues: (i) progressive shift towards the adoption of an ecosystem-based approach in the definition of the CIS's context and geographic area of application; (ii) strict link and cooperation between the structure responsible for the CIS management and operation and the structure responsible for the implementation of the ICZM process, (iii) improvement of the use of protocols facilitating geo-spatial data sharing, implying cooperation among different data producers and managers. P3 focus is mainly on the reinforcement of coordination mechanisms that can enhance the CIS usefulness in promoting and implementing ICZM principles.

Policy options were then assessed (third step) in terms of direct (or primary) and indirect (or derived) impacts (EC, 2009). Direct impacts are those related to effects directly determined by a CIS policy option on key issues of ICZM implementation in Europe or to the use and the operation of the coastal information systems. Indirect (economic, social and environmental) impacts are those directly or indirectly deriving from direct ones. All the three options represent a significant step forward compared to the baseline scenario, since they include new requirements to be implemented in the CISs, contributing to further increase the support to the ICZM process. The impact assessment showed that the three policy options can be conceptually distributed along a gradient. P3 represents the most ambitious policy option, in terms of economic and human resources likely required for its implementation, but also in terms of expected direct and indirect benefits. P2 is in a relative medium position, while P1 is characterised by a relative lower level of ambition.
The full implementation of the P3 option would require an effort (to upgrade about the 64% of existing CISs) that is 1.6 greater than the one required by the full implementation of the P1 option (corresponding to 41% of CISs to be upgraded); P3 expected effort is also greater than P2 one (56% of CISs to be upgraded). The following rough schematisation of policy ambition and implementation challenge can be therefore defined: P3 > P2 > P1. However, the implementation of all the three policy options still requires relevant efforts.
Significant differences exist among the various European regions in relation to the current implementation level of the three policy options and the related expected benefits and effort needed for their further improvement. The analysis showed the greatest challenges in general are related to: (i) the P3 option implementation in all the regions with relatively minor relevance for the North Sea and (ii) the Black Sea region for all the three policy options, where however there are significant on-going initiatives that will probably improve the current situation.
In terms of policy instruments for the implementation of the different option the following main considerations were provided by the study:

- P1 policy option includes essential requirements to improve the CISs' capacity in supporting the ICZM process and can be therefore considered as a necessary (or basic) step to improve CIS' support to ICZM. In this perspective, this policy option could be incorporated in an EU binding legislative framework (i.e. EU Directive) defining obligations for the ICZM implementation, also in relation to the CISs further improvement. A strict link with the INSPIRE Directive is also essential for the P1 policy option implementation.
- An EU binding legislative framework could also fit with the second policy option (P2), which also includes some essential requirements for the improvement of the CISs support to the ICZM process (i.e. the development of new tools to better support

ICZM decision making and stakeholders' participation). However, P2 could be more efficiently implemented through the Recommendation policy instrument that enables a higher level of flexibility.

- The implementations of the P3 policy option (focusing on enhanced cooperation) can be likely more efficiently supported through incentives, e.g. a policy programme providing a common framework for and financial support to projects and studies dealing with P3 key issues. The higher costs related to the P3 policy option also suggest to avoid the adoption of a strictly binding approach for the implementation of this policy and to prefer a more flexible and progressive mechanism.

As a final conclusion, the study suggested to adopt a two phase approach. The first four-five years phase would focus on P1 and P2 policy options (to be implemented through an EU Directive and/or an EU Recommendation). The first phase should not totally neglect the P3 option; whenever opportunities arise this should be promoted through a dedicated policy programme, even if the major focus would be on P1 and P2, and its implementation monitored to correctly depict the occurring progresses. An interim and final evaluation of the first phase results will be useful to prepare the second phase that would specifically focus on the implementation of the P3 option. This evaluation will be also useful to fine-tune the policy instrument to be used to successfully implement the P3 option in the second phase, i.e. the continuation of an incentives-based policy programme and/or the development of another policy instrument (e.g. a specific EU Recommendation).

[1]Disclaimer: "This abstract does not necessarily represent the opinion of the European Commission"

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MEASURING SUSTAINABILITY – A GERMAN CASE STUDY

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Within the project SUSTAIN a universal tool to help deliver sustainability on Europe's coasts has been developed with the involvement of 12 EU countries. This new tool is based on easily measurable indicators and is applicable to all European coastal regions. Together with a weighting and preference system it allows coastal municipalities not only to measure the present state of sustainability but also to develop a future sustainability vision as well as a development strategy. We present a full application exercise in the German Baltic seaside resort Warnemünde, with the exemplary involvement of stakeholder groups. We critically evaluate results and benefits and show how the system can be linked to the existing QualityCoast destination labeling and award system.

ORAL PRESENTATIONS: Nature Conservation

PREVENTING EROSION OF TIDAL FLATS: A LARGE SCALE EXPERIMENT

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The largest Dutch National Park, the Eastern Scheldt, is an inter-tidal area with a dynamic equilibrium between the tidal flats and the dimensions of the tidal channels. This dynamic equilibrium depends on the tidal range and the current velocities in the estuary. In 1987 the Eastern Scheldt Works have been completed. The Eastern Scheldt Storm Surge barrier ensures safety, but also has a downside. Soon after completion it was found that the barrier has a detrimental effect on the development of inter-tidal flats in the area. The current velocities and the tidal prism decreased and the dynamic equilibrium between the flats and the gullies has been disturbed. The disturbance induces a deficit of sediment in the gullies and causes erosion of the tidal flats. The erosion of the tidal flats results in a decrease of the areal of tidal flats of approximately 50 hectares per year. It is expected that in 2050 half of the tidal flats will be lost due to erosion and that in 2100 merely 1,500 of the present 10,000 hectares will remain.

The loss of area of inter-tidal flats has negative impacts on dike safety and nature. Dike safety is affected, because the wave attenuation effect of the shoals disappears. Nature is affected because major forage sites for protected bird species disappear. Moreover, resting and nursing places for seals disappear. Preservation of these food and resting places in the best way possible, is one of the most important Natura 2000 conservation in the Netherlands.

Preservation of the tidal areal requires tremendous nourishment quantities. The Dutch Ministry of Infrastructure and the Environment investigates, under the program 'MIRT 2010-2014 Sand Demand' alternatives for conserving the tidal flats. One of the possible alternatives is the construction of sand retaining structures at the edge of the flats which possibly reduce the erosion speed and therefore reduce the required nourishment quantities.

The erosion of tidal flats (with or without sand retaining structures) is a complex process and difficult to predict. Knowledge about effectiveness (in terms of decreasing erosion rate), constructability, lifetime and the costs of retaining structures is limited. To understand the mechanisms and effects on nature a large scale experiment is set up in the Schelphoek, a bay on the northern shore of the Eastern Scheldt. The large scale experiment comprises a surface of 13ha, which is divided into an area with replenishment only and an area including the construction of sand traps.

The main goal of the experiment is to determine whether or not the sand retaining structures are effective in decreasing the erosion rate and therefore are capable of extending the lifetime of the tidal flat. Other intended results of the experiment are to determine the time of recolonisation of benthos and the development of the shape of the tidal flat due to the sand retaining structures.

The pilot was constructed October till December 2011 and the morphological, hydraulic and ecological development has been monitored closely since. The first results of the experiment are expected soon.

The costs for conservation are high and therefore new solutions have to be found. The Schelphoek experiment is an example of a search for an effective solution for conserving nature in coastal areas in an efficient and practical manner.

THE CONSERVATION OF BELGIAN MARINE NATURA 2000 SITES: THE FIRST STEPS INTO A BRAVE NEW WORLD?

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I. The designation of the first marine protected areas in the Belgian part of the North Sea

In Belgium the legal basis for the designation and management of Natura 2000 sites is the 1999 Law on the protection of the marine environment under Belgian jurisdiction (as amended in 2005) (see Cliquet et al. 2008). After a rather difficult and lengthy process (see Bogaert et al. 2008), five Natura 2000 sites were designated in 2005 by Belgian Royal Decree. Three sites were designated as Special Protection Areas (SPAs) under the Birds Directive. Two sites (Trapegeer-Stroombank and Vlakte van de Raan) were designated as Special Areas of Conservation (SACs) under the Habitats Directive. The two Habitats Directive sites were both included on the List of Community Importance by 2008. The designation of one site, Vlakte van de Raan, was annulled by the Belgian Council of State in 2008, following a complaint by an electricity company, which had plans to build a windmill offshore park in that area. The environmental and building permit for the construction, which had been granted before the designation of the site as a Natura 2000 site, had afterwards been abrogated by the Belgian government. However, the site is still included on the Community List and therefore needs to be designated again at the national level.
In 2009 a scientific report on the designation of additional SACs in the marine environment was ordered by the federal government. Two proposals were made in this document: a substantial extension of the existing SAC Trapegeer Stroombank and the (re)designation of the Vlakte van de Raan. The policy summary by the federal government of this scientific report only dealt with the first area (Trapegeer-Stroombank). The extended site was included in the Community List in 2011. The area, which would become the largest protected site in the Belgian part of the North Sea, is to be formally designated by national legislation.

II. The establishment of a regulatory framework with several loopholes

Regarding the conservation of the SPAs/SACs, the Law on the marine environment (as amended in 2005), provides that, by Royal Decree, harmful activities can be restricted or forbidden within the sites. By virtue of the designation Decree of 2005, the following activities are prohibited: all building activities, industrial activities and activities of commercial and advertising enterprises. In the SAC Trapegeer-Stroombank, the dumping of dredged material and inert materials of natural origin is also forbidden. In SPA 1 and SPA 2, common tern, sandwich tern, little gull and great crested grebe are protected. During winter, helicopter flights at altitudes of less than 500 ft, the passage of high speed vessels and offshore water sports are forbidden. Furthermore, an appropriate assessment has to be made of all new plans and projects that are likely to have a significant effect on the site in view of the site's conservation objectives. A new plan or project can only be allowed if it does not adversely affect the integrity of the site concerned. In case of a negative assessment, the plan or project can only be allowed under certain strict conditions as provided in the Royal Decree (which implements Article 6, § 4 of the EU Habitats Directive).

At first sight the protection regime seems to be quite severe. Yet, the possibility of regulating harmful activities and interventions is excluded for certain activities mentioned in the Law (such as fishing, dredging, etc.). The reasoning behind this legal provision is connected with a certain view on the division of competences between the federal and Flemish level for the North Sea. It is reasoned that, as some of these activities belong to

Flemish competences, they cannot be regulated by the federal government, which is only competent for marine nature conservation. This complicates the establishment of conservation objectives and management measures and might impede the favourable conservation status of the habitats and species for which the sites have been designated. Indeed, several of the so-called 'Flemish activities', such as fisheries and dredging, can cause a significant deterioration of the habitats and/or species present in the protected areas.

The above mentioned measures show the idea underlying designation at that time: the designated areas had to be protected against the potential impact of future activities. Hence, current activities within the sites were not perceived as a threat to reaching the objectives. Yet one - rather 'soft' - instrument was introduced to tackle possible harmful ongoing activities. For all the protected sites, voluntary user agreements can be concluded with user groups. Agreements have already been concluded with organizations of the water sports recreation sector. Those agreements mainly emphasize the distribution of information on the protected areas by the water sports organizations to their members. Moreover they recommend some measures for the protection of the marine environment (e.g. the recommendations not to fish close to wrecks, to avoid damage to the sea bed when dropping anchor, to respect fauna and flora at sea).

Lastly, the regulatory framework requires the formulation of a policy plan within three years after the designation of each site. In 2009 the Minister responsible for the marine environment approved the first policy plan for the marine protected areas in the Belgian part of the North Sea. The plan contains a description of the sites, a description of the different uses and an overview of existing measures and user agreements. Finally the plan suggests 14 measures. The measures include different issues, such as communication about the sites, setting up of advisory commissions and the setting up of a monitoring programme. Most of the proposed measures however lack a detailed and concrete character and are still in the planning phase. For instance, an agreement will be concluded with the competent Flemish authority to stop the negative effects of beam trawl fishing. Also, new proposals for the redesignation of the SPAs will be made. The plan does not mention the redesignation of the Vlakte van de Raan as an SAC.

III. Important legal challenges around the corner?

In the past ten years some important steps for the establishment of a marine network of protected areas in the Belgian part of the North Sea have been taken. However, as the situation is today, the conservation and protection regime for the Natura 2000 sites, which is part of the Belgian regulatory framework, is not sufficient to comply with the requirements of the Birds and Habitats Directives (see Cliquet & Decleer 2007; Bogaert et al. 2009).

The federal administration, dealing with marine nature conservation, was aware of this and ordered a study on the legal problems in the existing legislation, as well as proposals for amendments. This study was concluded in February 2012(Schoukens et al. 2012). This paper gives an overview of some of the findings of the study. It focuses more specifically on the issue of human activities with a possible effect on Natura 2000 sites. Based on the obligations of the Birds and Habitats Directives, the case law of the European Court of Justice, guidelines by the Commission and legislation in other European countries, the study proposes a management regime for the Nature 2000 sites that seeks a balance between nature conservation and human activities.

One of the most important legal problems that was identified in the existing law is the lack of a clear implementation of Article 6, §1 and §2 of the Habitats Directive. Article 6, §1 of the Habitats Directive requires that Member States establish the necessary conservation measures which correspond to the ecological requirements of the habitats or species listed on the sites. Article 6, § 2 of the Habitats Directive requires Member States to take appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated. Moreover, according to case law of the European Court of Justice, it is not permissible to exclude certain activities from the obligations of article 6, § 2 of the Habitats Directive in advance. This makes clear that the general exemption of several 'Flemish' activities from the federal protection regime is contradictory to the approach of the Habitats Directive. As fisheries are a Flemish competence, limitation of fisheries could be done by the Flemish government, but a Flemish legal framework that aims at regulating fisheries in marine Natura 2000 sites is absent. Also, the lack of a clear framework for the establishment of conservation objectives and measures seems contradictory to article 6, §1 and §2 of the Habitats Directive. Especially for existing harmful activities, the establishment of specific conservation plans seems indispensable.

But also with respect to the obligation to carry out an appropriate assessment for harmful plans and programs, the study concludes that the existing regime lacks consistency and appears to be in contradiction with the European framework. The present regime provides no clear limitation of its scope of application. After all, one gets the impression that only larger infrastructural projects and/or plans should be subject to an appropriate assessment, whereas smaller interventions seem to be exempted from this regime. On several occasions, the Court of Justice stated that such an approach is not allowed in the light of article 6, §3 of the Habitats Directive, as it does not allow tackling the cumulative effects which might be linked with these interventions. The study recommends the establishment of a so called 'Natura 2000'-permit, which should be able to close all loopholes in the existing permitting regimes.

It remains to be seen to what extent the conclusions of the study will be implemented during the next reform of the regulatory regime for the Natura 2000-sites in the Belgian part of the North Sea. Nonetheless, taking into account the many deficiencies of the existing framework, providing a more clear legal and regulatory framework on the conservation and the protection of the Natura 2000 sites in the Belgian marine environment will enhance legal certainties and could prove a model for a balance between nature conservation in the marine environment and the different human activities within this environment.

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COASTAL AND MARINE ENVIRONMENTS IN BAHRAIN: ANTHROPOGENIC IMPACTS AND CONSERVATION MEASURES

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The Arabian Gulf is a semi-enclosed sea situated in the subtropical zone and characterized by low precipitation and high aridity. Biota in the Arabian Gulf inhabits one of the harshest marine environments due to marked fluctuations in sea temperatures and high salinities. Additional anthropogenic effects could arguably be critical for biodiversity and abundance of marine organisms inhabiting the naturally stressed environment of the Arabian Gulf, which is considered among the highest anthropogenically impacted regions in the world. Coastal development associated with intensive dredging and reclamation is increasingly contributing to the degradation of marine ecosystems. Pollutants inputs affecting coastal and marine environments of the Arabian Gulf include domestic sewage, brine waste waters, and effluents from petroleum and petrochemical industries.

This paper identifies valued ecosystem components (VECs) and their ecological goods and services in Bahrain, characterizes existing anthropogenic impacts influencing coastal and marine environments, and proposes measures that may contribute to the conservation of coastal and marine habitats in Bahrain.

Despite the limited land area of Bahrain, waters surrounding its islands support several VECs such as seagrass beds, coral reefs, mangrove swamps, and mud flats that provide important ecological goods and services. Seagrass beds are highly productive ecosystems that characterized by important ecological and economic functions. They provide food sources and nursery grounds for turtles, dugongs, shrimps and a variety of economically important marine organisms. Coral reefs are characterized by both biological diversity and high levels of productivity. They provide a variety of ecological services such as renewable sources of seafood, maintenance of genetic, biological and habitat diversity, recreational values, and economical benefits such as utilizing destructive reefs for creating land. Mangrove swamps are ecologically important coastal ecosystems that provide food, shelter and nursery areas for a variety of terrestrial and marine fauna.

However, these ecosystems are intensively subjected to human disturbance either by direct physical damage or by deterioration of the water quality resulting from increasing levels of pollution. The main anthropogenic impacts in Bahrain are reclamation and dredging, industrial and sewage effluents, hypersaline water discharge from desalination plants, and oil pollution.

Preserving and conserving genetic, species, habitat biodiversity in the marine environments are immediate priorities. Several measures could be applied to protect the biodiversity in Bahrain. Marine protected areas are widely recognized as an effective mean of protecting biodiversity. Several coastal and marine protected areas have been established in Bahrain. However, their effectiveness is restricted due to the lack of management plans.

Further integration of biodiversity into environmental impact assessment system in Bahrain is needed. This is of crucial importance as coastal and marine environments are the prime target for most developmental projects in Bahrain. Considering effects of dredging and reclamation on marine biodiversity in EIA studies and suggesting measures to avoid or reduce adverse impacts could contribute to conserve the sensitive and productive habitats in Bahrain.

Legal instruments and higher level environmental policies in Bahrain are contributing to preventing environmental degradation and conserving biodiversity. Incorporating biodiversity assessment into the legal system and implementing the Bahraini National

Biodiversity Strategy and Action Plan may contribute significantly into the enforcement of biodiversity conservation.

Monitoring and scientific research are integral part of any effort to reduce the loss of biodiversity. Developing necessary plans and mechanisms for population and habitat conservation require adequate knowledge and description of species. This could be achieved by promoting taxonomic research in the Arabian Gulf.

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ARTWEI – ACTION FOR THE REINFORCEMENT OF THE TRANSITIONAL WATERS' ENVIRONMENTAL INTEGRITY – A SOUTH BALTIC CROSS-BORDER COOPERATION PROJECT

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The term 'transitional waters' was introduced in 2000 with the publication of the Water Framework Directive of the European Communities (WFD, 2000/60/EC) to describe the continuum between freshwaters and coastal waters. In the Official Journal of the European Communities 43 (L327), 'transitional waters' are defined as 'bodies of surface water in the vicinity of river mouths which are partially saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows'. These areas are diverse, highly productive, ecologically important systems on a global scale and highly valuable for the services they provided to human societies since at least the Neolithic age. They supplied food, shelter, transportation and also served as natural wastewater treatment systems. The presence of human settlements along the shores of estuaries and lagoons is documented since very ancient times, representing the nucleus of early civilization and later social and economic establishments. In the Mediterranean basin, we have a number of documented evidences of a multiple use of coastal lagoons, from fisheries to transportation (Castagnoli 1976, Breber et al 2008). In the first century A.D., Romans used the Tyrrhenian coastal lagoon system as connection route between Rome and Naples for commercial and military purposes.

From the ecological point of view, transitional waters are ecotones between terrestrial, freshwater and marine ecosystems, being characterized by high spatial heterogeneity and temporal variability (Basset et al., 2006). The term transitional waters embraces a wide array of ecosystems types, including river mouth ecosystems, lagoons, coastal lakes, rias, fjords and fjards, brackish wetlands and hyper saline ecosystems. Due to the hydrological balance between fresh water and marine forces, transitional waters, particularly the rias and the lagoon types, are sediment and nutrient sinks, modulated through multiple scales of variation according to the dial and lunar tidal cycles, seasonal and longer terms, precipitation cycles, and climate (Comin et al. 2004; McLusky & Elliott 2007).

Transitional waters are under heavy anthropogenic impact being the sites of major cities and ports. Because of this, these waters have been degraded by port activities, dredging and the pollution from urban, industrial and agricultural areas, aquaculture and fishing. These problems have a profound impact on human well-being in coastal areas, since the goods and services provided by the transitional waters as diverse and special aquatic ecosystems are affected as well. Therefore, recently, the transitional waters of the European Union received special attention from legislators.

Transitional waters, being ecotones between freshwater, marine and terrestrial ecosystems, have always prompted the need to be categorized into operational types from both the scientific and applied points of view (Basset et al. 2006). Although an operational definition of transitional waters is provided by the EU Water Framework Directive, there is, indeed, an ambiguity originating from different approaches by the member states in defining transitional waters (Elliott & McLusky 2002; McLusky & Elliott 2007).

According to McLusky and Elliott (ibid.) the term "Transitional waters" is being used in practice as "Aquatic areas which are neither fully coastal nor enclosed or flowing freshwater areas" and may be defined by physiographic features or discontinuities or by salinity or any other hydrographic feature. In the next decade, these discussions of habitat definition will become more important within Europe, given the implementation of the EU Water Framework Directive (WFD, 2000/60/EC) and also the limits of jurisdiction of the Marine Strategy Framework Directive (i.e. whether it will stop at the seaward limits of the transitional waters or whether it will go to the Tidal High Water mark inside estuaries and lagoons). This will require the member states to define the different types of transitional waters throughout Europe and to delineate the borders of these waters.

The WFD is a wide-ranging and ambitious piece of European environmental legislation, which provides for a strengthened system for the protection and improvement of water quality and dependent ecosystems. The WFD process for identifying coastal and transitional water body types required the development of new approaches and the need to agree on a common set of typology factors (i.e. salinity, tidal range, exposure, etc.), and their categories for comparable and consistent typology categorization across the coastal areas of the regional seas. It was also acknowledged that the estuarine and coastal types are not distinct categories that can be easily identified by a set of factors, but rather a continuum.

Therefore the borderline between two separate types has often been difficult to define (Borja et al. 2010). It is questioned whether estuaries and other transitional waters should be excluded from the MSFD if they have a large marine influence, e.g. tidal systems or where salinity incursion occurs as these by definition are part of marine systems. In their conclusion, Borja et al. (ibid.) emphasize that there is a need for a completely merged approach and a harmonized, seamless transition from catchment through transitional waters and coast to an open marine system.

Despite the fact that the technical typology defined in the EU Water Framework Directive proved to be essential for defining a set of environmental descriptors and reinforcing environmental protection, the transitional waters are still a very complicated and often disguising term in this typology. This definition is even more problematic when applied to the three largest European transboundary lagoons situated in the Baltic region. The situation is especially complicated because two of these transitional water bodies are shared with the Russian Federation, which is not a part of the EU and, therefore, the term "transitional waters" has no legislative consequences in the Russian parts of the lagoons.

The distribution of various types of transitional waters varies largely between different seas of Europe. Schernewski & Wielgat (2004) highlighted that each Baltic country has adopted a slightly different approach and some do not appear to be designating any transitional waters. In the Baltic Sea area, Finland and Estonia do not appear to have transitional waters, while in Sweden it was attempt to overcome problems in designating transitional waters by even suggesting a further category, that of enclosed, brackish coastal types. The North Sea and Baltic coasts of Denmark have no transitional waters. In Germany transitional waters were designated for its North Sea estuaries (the Weser, Elbe, etc.) but not for its Baltic Sea estuaries and lagoons. For example in the Odra lagoon, the Polish and German parts belong to different typologies (the Polish part being designated as transitional waters whereas the German part as coastal waters), which are confusing for both research and management matters.

Lithuania considers the Curonian lagoon to be a transitional water body. Yet, the discharge plume from the Klaipeda Strait into the Baltic Sea is also designated as transitional waters. Latvia treats the Daugava River estuary and the riverine discharge plume into the Gulf of Riga as a transitional water area. Poland has designated as its transitional waters the entire areas of the Odra (Szczecin) Lagoon, Vistula Lagoon and a part of the Gulf of Gdansk (the inner Puck Bay) as well as parts of the Gulf of Gdansk and Pomeranian Bay where riverine plumes occur (Krzyminski et al. 2004). Poland has also designated the coastal areas affected by the riverine/lagoon plumes discharging into the open Baltic Sea as transitional waters.

Transitional waters play a key role as spawning areas for fish and invertebrates and support a rich biodiversity and provide migration corridors for fish and waterfowl (Breber et al., 2008). They are often valuable natural heritages, are suited for human settlements and provide relevant biological resources, which are commercially exploited since the pre-historical times (Viaroli et al., 2005). A step backward in our history shows that the spatial distribution of successful past societies was not random, but was rather the result of favorable ecosystem conditions, which, in turn, were determined by emergent properties at local and regional scales (ibid.).

ARTWEI – Action for the Reinforcement of the Transitional Waters' Environmental Integrity is a three-year transboundary cooperation project within the South Baltic Cross-border Co-operation Programme 2007 – 2013 of the European Union. The project aims to strike an operational balance between EU requirements for Maritime Spatial Planning framework, Water Framework Directive and Integrated Coastal Zone Management, which do often overlap or contradict each other. This aim is achieved by establishing the South Baltic Transitional Waters' partnership network of the key institutions based on the long-term cooperation agreement and supported by the regional activity network of EUCC – The Coastal and Marine Union. Thus, the cross-border cooperation of local and regional interest groups, citizens and politicians is crucial.

ARTWEI project has four cross-border transitional water regions of the South Baltic Area as target areas: Curonian Lagoon (LT/RU), Vistula Lagoon (RU/PL), Odra Lagoon (PL/DE), Oresund Sound (DK/SE). Concrete conclusions and recommendations for the durable reinforcement of the environmental integrity of the Transitional waters have been developed and politically endorsed in the form of a Good Practice Code of Conduct. A web-based multilingual platform, including webGIS and other ICT tools, are created facilitating an interactive knowledge exchange within and among Transitional Waters Stakeholder Bodies. Environmental education is an additional tool implemented in the form of a transboundary coastal dialogue, a photo competition and a public information system.

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BEACH NOURISHMENT AND THE IMPACT ON NATURA 2000

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The Belgian coastline: natural dynamics versus anthropogenic conservation

The Belgian coastline is a dynamic environment where currents, waves and wind interact with the natural coastal defense system of beaches and dunes. In some areas the net sand balance is in equilibrium or sand accretion takes place, but most coastal zones erode, dealing with sand deficits. In the past so called 'hard' infrastructures (dykes, quay walls and groins) were constructed to protect the land from the impact of the sea. Since more than 40 years however 'soft' measures were chosen to work together with nature in the protection against coastal flooding. Beach nourishments are the most common protection measure nowadays. The Belgian Coastal Division wants to guarantee a minimal protection against a 1000 year storm event, but in the weakest links only a 100 year protection level is reached at the moment. Pending the realization of the 'Master Plan for Coastal Safety', for which more than 10 million m³ of sand is needed to protect all weak links in the nearby future, these weakest beaches are maintained with annual nourishments of 550.000m³ sand. Belgian beaches contain fine sand (grain size 200-250 micron), whereas from a geotechnical point of view the nourished sand ideally has a grain size of about 300 micron creating more stable beaches, with less volume, which erode slower. From an ecological standpoint, however, it is recommended to use the same grain size as the natural beach. Clearly an optimization is needed.

Impacts of beach nourishments on the sandy beach ecosystem

The ecological effects of beach nourishments can be related directly to six factors, namely nourishment technique, timing and location, changes in beach slope, changes in grain size and amount of nourished sediment (Speybroeck *et al.*, 2006). Impact research focuses on macrobenthos, the seafloor inhabiting benthic forms larger than one millimeter, as these organisms play a key role in the wider beach ecosystem. They make up a large part of the diet of intertidal birds and fish and they act as good indicators of pollution and stress. Locally, strong negative impact effects are expected during and immediately following the nourishment. The layer of nourished sand usually has a thickness of around 1-2.5m and stays there for a long period. This reduces chances of survival of the original beach fauna and flora to almost zero (Harte *et al.*, 2002; Speybroeck *et al.*, 2004). Over the long term, the speed and degree of ecological recovery largely depends on the physical characteristics of the beach habitat. Macrobenthic organisms tolerate only small modifications in beach slope and their sediment preference falls within a range of 125-350µm. Recolonization will start with dispersion of juveniles from marine benthic organisms. Their larvae will settle on the sand if the conditions are suitable. Theoretically, the benthic communities can recover within a period of one to two years. However, some species don't have a pelagic stadium so the recolonization of those will be slower (e.g. Bivalvia and Echinodermata) (Speybroeck *et al.*, 2004). Total recovery of the beach might thus take four to five years. In general, phased nourishment with natural sediment and beach slope during winter should lead to positive effects for all intertidal flora and fauna (Van Tomme *et al.*, 2009).

Legal framework which regulates the impacts of beach nourishment on Natura 2000

When considering beach nourishment in the neighbourhood of European protected sites, one must take into account the strict regulatory framework with respect to Natura 2000, which is included in the Habitats Directive (Directive 92/43/EEC). Article 6 of the Habitats Directive is of the utmost importance for beach nourishment as it determines the relationship between conservation and land use. In particular, article 6, §§3-4 of the Habitats Directive contains a development regime, setting out the criteria under which plans and projects with possible negative effects on Natura 2000 may or may not be allowed. A precautionary approach is required when assessing the possible effects of a beach nourishment ("appropriate assessment"). In the Flemish Region this framework has been implemented in the Nature Conservation Decree in 2002, while the Royal Decree of 14 October 2005 contains the federal implementation for the Belgian part of the North Sea. Whilst the requirements of Article 6, §§3-4 of the Habitats Directive are quite straightforward, the application of them on beach nourishments proved to be quite burdensome the past years, partially due to the incorrect implementation of the Habitats Directive in the Flemish legislation.

The concept of "project", as used in the Flemish Nature Decree (Schoukens *et al.*, 2007), appears to be too narrowly defined in the light of the Habitats Directive. Only interventions in nature which are made subject to a prior license are to be considered as project with a potential effect on Natura 2000, while, in some cases, beach nourishments are exempted from a prior license and assessment. In order to allow also these cumulative effects to be assessed, during the past years, appropriate assessments had to be carried out on a mere facultative base.

More on a substantive level, the authority competent for nature conservation has a clear tendency to consistently widen the scope of the appropriate assessments needed for the bigger cases of beach nourishments. Though not directly linked to the species and habitats of the nearby Natura 2000-sites, also effects on other species or habitats need to be taken into account, even when this is not as such required by the general rules on nature conservation. Yet, on the same time, there is restraint to adopt a more strategic approach, allowing for offsite mitigation and compensation. The difficult and, in some cases, very incoherent application of the rules on nature conservation on beach nourishment, illustrates the need for a more coherent legal framework, in which a more ecosystem based approach should be adopted.

A case study: Raversijde-Mariakerke and the Master Plan for Coastal Safety

One of the weak links of the Belgian coastline is the area between Raversijde and Mariakerke. The Master Plan for Coastal Safety foresees a beach nourishment in combination with a storm return wall which will result in the aimed protection. The current beach slope (<5m TAW: 1/45~1/50) and grain size (medium sand with d50 ≈ 350 µm) will be preserved as much as possible. Due to the beach nourishment, the supratidal beach zone will enlarge (23ha) while the interdidal zone will reduce modestly (0.7ha) and 87ha of the subtidal area will be buried underneath a feeder berm with a thickness of 0.05m up to 2.50m.

The subtidal part of the nourishment will take place in 0.6% of the Natura 2000 Special Protection Area SBZ-V2 (14468ha) and in 0.1ha of the Special Area of Conservation 'Flemish Banks' (Vlaamse Banken – 100994ha), which is negligible regarding to surface-intake. The Conservation Goals (Degraer *et al.*, 2010) for the species and habitats in these parts of the Natura 2000 network are not opposed by the nourishment.

The intertidal and supratidal part of the beach do not fall within the Natura 2000 area, but the external impacts of the nourishment might negatively affect the Conservation Goals of the Natura 2000 species and habitats present in nearby Natura 2000 areas, like e.g. Habitat 1140: Mudflats and sandflats not covered by seawater at low tide. In Belgium, 2110ha belong to this habitat type, though only 16% lies within a Natura 2000 area (Paelinckx *et al.*, 2009). The local conservation status is not determined yet, but the global conservation status seems to be favourable (Paelinckx *et al.*, 2009). To investigate whether the intertidal beach nourishment in Raversijde-Mariakerke has a significant negative impact on the global conservation status, a threefold approach was followed. Firstly, a reference framework (IMDC, 2011) was written containing all the relevant available information regarding the status of this habitat along the Belgian coast.

Secondly, the Marine Biology Research group of Ghent University gathered, analyzed and compared seasonal field samples (spring and autumn) alongside other well-known intertidal Belgian coastal ecosystems. This revealed a moderate macrobenthic density with distinct dominance of *Scolelepis squamata*, and as a result, low macrobenthic diversity (Vanden Eede & Vincx, 2012).

Thirdly, the results of the reference framework and the field investigations of Ghent University were discussed in an ecological study group with representatives of ANB (Agency of Nature and Forests), BMM (Management Unit of the North Sea Mathematical Models), the Belgian Coastal Division, IMDC and Ghent University.

Finally the appropriate assessment for this beach nourishment (IMDC, 2012) was performed which concluded that the beach nourishment in Raversijde-Mariakerke will result in limited temporary effects. No significant effects can be predicted for the Natura 2000 habitats, species and conservation goals.

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WATER QUALITY IMPROVEMENT BY MUSSEL CULTIVATION – CASE STUDY SZCZECIN LAGOON, BALTIC SEA

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The German-Polish Szczecin (Oder-) Lagoon in the southern Baltic Sea is highly eutrophic coastal water that is affected by algae blooms during summer. To reach a good ecological status, as demanded by the EU Water Framework Directive, nutrient reductions in the river basin alone will not result in a sufficiently improved water quality. Several supporting internal measures are possible in theory to combat eutrophication, to remove nutrients, and to improve ecosystem quality: a) dredging or capping of sediment, b) enlarged reed belts and extended submersed macrophyte areas, c) algae farms, and finally d) enlarged natural mussel beds and mussel cultivation. Mussel cultivation seems to be a promising supporting internal measure to improve the ecosystem function of the shallow, oligohaline lagoon. Especially zebra mussels, *Dreissena polymorpha*, a species currently inhabiting the whole lagoon, help to clarify the water by high filtration rates. But presumably a lack of appropriate substrate has led to a decrease of the zebra mussel population during the last decades.
The cultivation of zebra mussels on lines or nets in combination with periodical harvest could reduce the turbidity and the nutrient content in the Szczecin Lagoon.
Accompanying researches as well as discussions with stakeholders are necessary to analyse pros and cons of internal measures and possibilities for implementation. Some of the criteria that have to be fulfilled, are:

- The measure must be ecologically justifiable. The ecosystem should not be disturbed or negatively changed by introducing invasive alien species for example. The Szczecin Lagoon is an important area for migrating birds and fish spawning. Large areas of the lagoon are FFH and NATURA 2000 sides. The measure has to be in agreement with the requirements of an environmental impact assessment.
- The measure must be socially acceptable. It is desirable to create jobs in this region with a high unemployment rate (>20%).
- The measure must follow the regional spatial plan. The lagoon is characterized by different uses such as fishery, shipping, and nature conservation. The measure should not compete with other traditional uses such as gillnet fisheries locating in the shallow areas of the lagoon. Economic loss must be prevented.
- The measure must be legally feasible. Numerous provisions like the Federal Building Code and laws of the state of Mecklenburg-Western Pomerania, Planning Law, Building Regulations, Environmental Protection Law, Water Law and Waterway Law must be applicable.

The presentation will give an overview about the findings of our case study analysis. It will show detailed results of the legislative analysis as well how an improved water quality can stimulate the demand for tourism on both sides of the lagoon (Poland and Germany).

MARINE BIOLOGICAL VALUATION MAPS AS A TOOL FOR VALUATION OF THE BELGIAN COASTLINE

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Increased anthropogenic pressures on the marine environment and multiple use conflicts have led to a worldwide interest in spatial planning with particular emphasis placed upon innovative, holistic approaches to management such as Ecosystem-Based Marine Spatial Planning (EB-MSP). It is important to remember that we can only plan and manage human activities in marine areas, not marine ecosystems or ecosystem components (Ehler & Douvere, 2009). Solid and meaningful biological and ecological information is as such needed to inform and underpin sustainable management approaches. Coastal planners and marine resource managers have used various tools for assessing the biological value of the marine environment in the past. These approaches vary in information content, scientific rigor and the level of technology used (Derous et al., 2007a & b).

The present work aims at establishing a spatial biological valuation of the Belgian coastal zone, using the marine biological valuation method (Derous et al., 2007b). The Belgian coastal zone hosts a complex of space- and resource-use activities with a myriad of pressures impairing environmental conditions both on the coastline and on coastal waters (Willekens & Maes, 2008; De Smet et al., 2010). Specifically at the beach zone, predictions on sea-level rise and flood risk for the North Sea have led to action plans and future coastal defense projects for strengthening the Belgian coastline (Roode et al., 2008). Among these plans, the soft engineering solution known as beach nourishment has been the most widely accepted for its lower ecological impacts (Greene 2002; Hamm et al. 2002; Hanson et al. 2002) and clear benefits to the tourism industry (Phillips & Jones 2006), which alone represents 2.8% of Belgium's gross domestic product (WTTC 2003). The word ‘nourishment’ means supplying a beach with sand because its sand has either flown away with the wind or got washed off with the waves. If implemented without good ecological practice (Speybroeck et al., 2006) and in combination with other recreational and management activities, beach nourishment potentially threatens habitats which are valuable to several beach-dependent organisms (Speybroeck, 2007). There is a clear need for integrative and ecosystem-based strategies to sustainably manage ongoing space-use activities at the Belgian coast. Therefore, a scientifically sound and spatially-based biological valuation of the Belgian coast would potentially assist local decision-makers and allow for the integration of “nature” at an early stage of policy implementation, for example through the Provincial Spatial Implementations Plans (PRUPs) (Maes & Bogaert, 2008). For practical purposes, two main scenarios of space-use conflict at the Belgian coast are investigated: beach nourishment and nature conservation. This bottom-up approach is an important step towards cross-sectoral, integrative and ecosystem-based management policies for the Belgian coast.

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SOURCES AND PATHWAYS FOR MARINE LITTER : BOTTOM UP APPROACH STARTING FROM LOCAL CASE-STUDIES FOR THE FOUR EUROPEAN REGIONAL SEAS

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Marine Litter is a global issue, affecting all the major bodies of water on the planet, from the surface to the sea-bottom. It can negatively impact wildlife, habitats, the economic health and burden of coastal communities and maritime activities but also become an issue of public safety, considering the emerging concerns over ingestion of microplastics by marine particle feeders (Davison & Asch, 2011; Murray & Cowie, 2011). Plastic revolutionised society in many ways, due to its versatility, lightweight, durability and low cost of production but due to its large scale use and extreme persistence in the environment it represents a considerable fraction of marine litter and the one that tends to receive more attention. Marine plastic litter poses therefore a complex and multi-dimensional societal challenge, requiring adjustments in the different phases of life-cycle and across sectors.

The European Commission has recently launched three studies to gather strategic information and support the implementation of the European Marine Strategy Framework Directive (MSFD) requirements on marine litter and further develop the policy framework for this issue. One of them is entitled *Pilot project – plastic recycling cycle and marine environmental impact – Case-studies on the plastic cycle and its loopholes in the four European regional seas areas.*

The main objective of this project is to pinpoint the major possible sources of marine litter in four study-sites, representative for each of the four European seas. The case-studies illustrate the process of litter and waste entering the marine environment. They indicate the main loopholes in the local material and waste cycles and identify which economic sectors or actors are the main sources of marine litter. Furthermore the study designs a set of feasible measures to address the loopholes. Based on multi criteria analysis four sites are selected: Riga (Latvia- Baltic Sea), Oostende (Belgium-North Sea), Barcelona (Spain-Mediterranean) and Constanta (Romania-Black Sea). These areas include river discharge, commercial ports and important coastal cities. Though the approach and methodologies used in the different sites are consistent and comparable, they have been adjusted to different cultural and economic contexts. Distinct profiles of marine litter lead to adapted sets of measures to meet the local needs.

This paper will present the results obtained so far in the project, providing the case-study of Oostende as an illustrative example of the main types of litter found in coastal and marine environment and the process of identification of their main sources, pathways and loopholes in this area, together with potential measures that could be used to avoid litter to enter the marine environment. This process included a participatory approach to gather local knowledge and obtain a concerted view on where, how and why (mainly plastic) litter is entering the marine environment in the area. It included as well the design of an adequate mixture of policy measures and strategies, targeting different key sectors and material flow phases. Finally, this set of measures will undergo an assessment of feasibility, in order to evaluate its economic, administrative and institutional implications.

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ORAL PRESENTATIONS: Innovative infrastructure

BUILDINGS AND INFRASTRUCTURE ON COASTAL DUNES

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Introduction

Coastal dunes have an important water defence function to protect a low hinterland against flooding. On the other hand, coastal towns benefit from the tourist industry related to a sandy coast, which leads to urbanization of coastal dunes. This means an increase in the number and size of buildings, which is not only visible above ground surface, but leads to an increase of pipelines, cables and underground car parks, as well. Other structures on coastal dunes are related to infrastructure for industries and national security. We think of pipelines for oil and gas, power plants, wind mills, water treatment, navigation support, harbours and military objects. All these objects may weaken the water defence function that may lead to loss of human lives, and damage of infrastructure with a large environmental and social impact.

In this paper we discuss the possible effects of building and infrastructure on the strength of coastal dunes, and describe the roadmap to legislative guidelines by coastal research. We give examples from the Netherlands where guidelines will be developed for spatial planning in the coastal area [Boers et al. (2011)].

Effects of buildings and infrastructure on coastal dunes Building and infrastructure objects on coastal dunes can have a number of effects:

- <u>Leakage</u>: When an object is disrupted, moved away by waves and current, or blown out by the wind, a breach in the dune may occur, which can be a pathway for flooding.
- <u>Flow contraction</u>: The presence of an object above ground surface may lead to flow contraction besides and behind the object. These currents are a threat to people and other objects.
- <u>Erosion</u>: The flow contraction leads to scour around the object. When the object is below ground surface, there can be additional dune erosion besides the object.
- <u>Contact damage</u>: Remains of objects that are moved by currents and wind may lead to contact damage to other objects or the water defence.

The presence of building and infrastructure is not always a treat. In some situations, they can strengthen the water defence or give shelter during a storm surge.

Typology of Storm surge, Coastal dune and Object

The possible effects of buildings and infrastructure on coastal dunes are determined by the storm surge, the coastal dune and the features of the objects. Figure 1 gives an overview of the relevant parameters. In this overview, we define the morphodynamics of dune, beach and foreshore as the bathymetry and grain size, which change in time due to natural processes and human activities. Sometimes hard structures are present for an additional protection of the coastal dune. The cumulative effect of multiple objects is addressed by the parameter "distance to other objects".

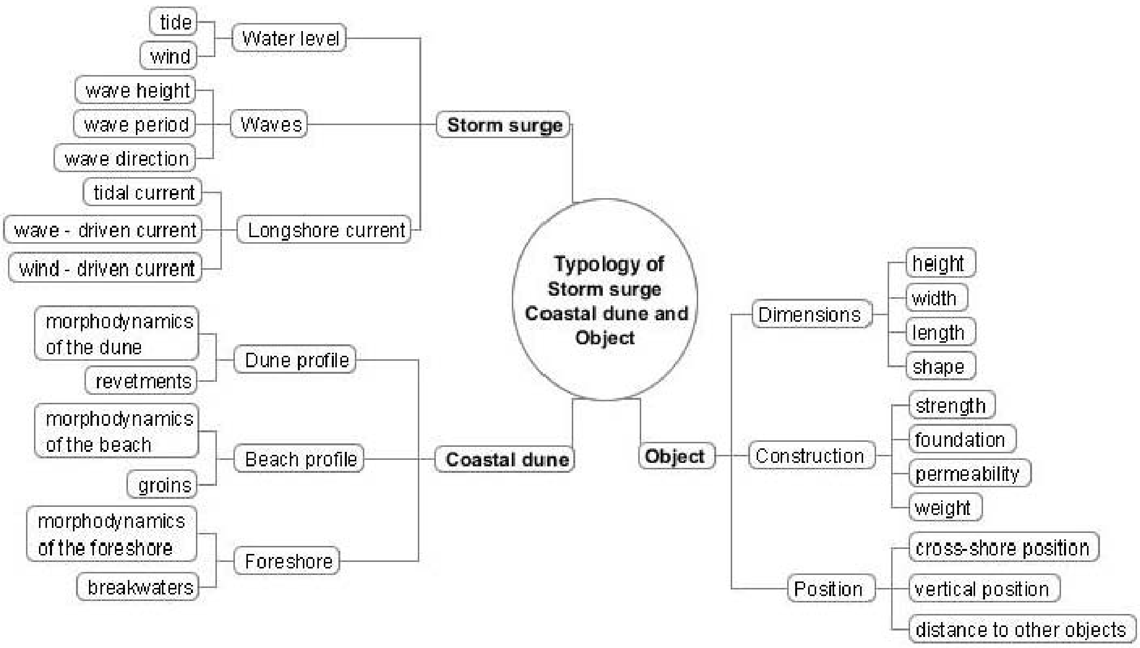

Figure 1: Typology of storm surge, coastal dune and object

Development of legislative guidelines by coastal research

Coastal zone managers face the challenge to balance between safety against flooding, spatial planning and the costs for water defence works and prevention of coastal erosion. Legislative guidelines that include the knowledge on the behaviour of building and infrastructure objects on coastal dunes during a flood hazard are very relevant for them. Coastal research gives an essential contribution to these guidelines, and is carried out by the following ways:

- Empirical knowledge: Catastrophic events do not only lead to awareness of the risks of buildings and infrastructure on coastal dunes, but also give insight in the physical processes during a storm surge.
- Laboratory experiments: Detailed insight in the physical processes related to hydraulic load and morphological response is obtained by laboratory experiments.
- Numerical models: Numerical models like XBeach (www.xbeach.org) that combine the physical laws of waves, currents and sediment transport are used to predict the possible effects of a storm surge [Van Geer et al. (2012)].

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CLIMATE RESPONSIVE RESEARCH BY DESIGN - THE OPPORTUNITIES OF THE 'VLAKTE VAN DE RAAN' WITHIN THE COASTAL AREA OF FLANDERS

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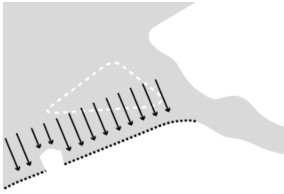
Raised interest for planning at sea
The sea recently attracts special attention in light of adaptation to global warming and socio-economic development. Among other problems, the climate change and the affiliated sea-level rise cause increased coastal erosion and larger extreme waves. As a result existing coastal defenses are getting outdated. The offshore *advance the line* strategy consists of measures to increase the robustness (IPCC CZMS, 1990; Klein and Tol, 1997). In Belgium this strategy has gotten picked up by private participants who developed the master plan Flemish Bays (THV Vlaamse Baaien, 2010). This master plan proposes to raise existing sandbanks and to construct islands in front of the current coastline.

In addition, the sea is claimed by different sectors, e.g. fishery, mining and shipping. The European Commission promotes a coordinated approach of these activities by means of marine spatial planning (European commission Maritime Affairs and Fisheries, 2011). In Belgium, this integrated approach has been explored in several projects; Gaufre and the future commons (Geldof et al., 2011; Maes, 2005).

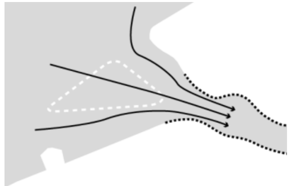
Climate related challenges and socio-economic developments at sea do not only attract the attention of (spatial) planners. The *Flemish Bays* master plan opened up a broad debate on planning at sea. Whether or not the proposed islands are feasible and favorable calls for technical research and general discussion to grow common vision. This research explores the opportunities new islands can offer to enhance both climate adaptation and development at sea. By means of research by design on the Vlakte van de Raan (a shallow zone in the Westerscheldt estuary where various climate-related problems and socio-economic developments occur in a confined space) different projects are integrated into one coherent project.

Climate change related challenges and socio-economic developments at the Vlakte van de Raan
Near the Vlakte van de Raan different problems, related to climate change, take place. Morphological changes of the Vlakte van de Raan could resolve each of these problems. Firstly, to remediate coastal defense, which will be outdated now or in the future by raising sea-levels, the *advance the line* strategy can be applied. Transforming the Vlakte van de Raan into an island, an action that is not part of the master plan Flemish Bays, could help protect seaside resorts Heist, Duinbergen, Knokke and Cadzand. Whether such islands actually provide protection is debatable (Reyns et al., 2010), yet the idea will be examined within the master plan Flanders Coastal Safety (Afdeling Kust, 2011).

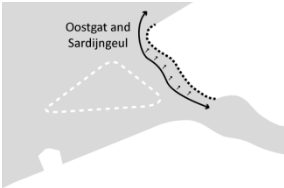
location Vlakte van de Raan



coastal safety Flemish coast



tides entering Westerscheldt



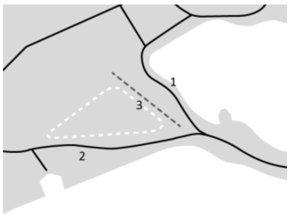
coastal erosion Walcheren

Secondly, the Westerscheldt estuary is vulnerable to climate change as it is exposed to potential storm surges. Historical land reclamation and dredging to maintain the accessibility of the port of Antwerp have resulted in a deep and narrow estuary. As a result the tide is pushed more and more upstream. In 1976, after a big flood, the Sigma-plan was developed to protect land and ecosystems from increasing tide. All actions in light of the Sigma-plan are concentrated inland, e.g. dyke reinforcement, creation of controlled reduced tide (CRT) and flood controlled areas (FCA). Besides these actions within the estuary, measurements could be taken to reduce the tide at the entree of the Westerscheldt estuary. Alternative strategies to lower the tidal inlet, e.g. linear transverse structures and artificial island, are being explored within the TIDE-project (www.tideelbe.de). Similar barriers for the Westerscheldt estuary could be situated near the Vlakte van de Raan.

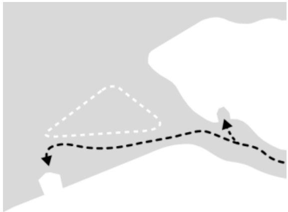
Coastal erosion is intrinsic to coastal systems and responds to climate change in complex way. At Walcheren, near the Vlakte van de Raan, erosion occurs as a result of a shifting Oostgat gully. This gully, one of the two entries to the Westerscheldt harbors, is gradually shifting landward creating a very steep coast (Israel, 2001; Provincie Zeeland, 2006). Safety is now obtained by repeated beach and dune nourishments, but structural measures, e.g. the creation of a new gully, could guarantee the necessary protection for a long-term.

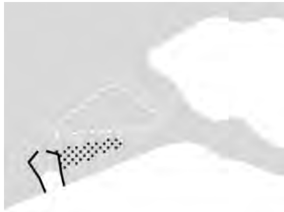
Besides climate-related problems, different socio-economic developments near the Vlakte van de Raan are currently being explored, planned or implemented. Large vessels can only access the port of Antwerp by fixed lanes where enough draught is guaranteed at high tide. The length of these lanes limits the period of entry. At present, most ships that call at Antwerp leave the international east-west traffic route near Westerhinder, navigate through the Belgian Part of the North Sea (BPNS) and use the Oostgat (1) and Wielingen (2) gully to enter the Westerscheldt estuary. However, within the Agency for Maritime and Coastal Services (AMCS) an alternative is being explored (interview Chantal Martens 2012, engineer within AMCS). Deepening the Geul van de Walvisstaart (3) creates a new and shorter sea lane. This reorganization of shipping in the Westerscheldt estuary would improve the accessibility of the port of Antwerp, the second largest harbor within Europe and renders both existing lanes unnecessary.

Inland navigation connects the various ports of the Westerscheldt estuary with an exception of the port of Zeebrugge. Because of wave conditions and currents near the Vlakte van de Raan only reinforced vessels with a raised bow may sail up the coast to Zeebrugge. This mode of transportation, called estuary shipping, now accounts for 4,5 percent of the further inland transport (Port Zeebrugge, 2011). An ambitious project near the Vlakte van de Raan could create favourable wave conditions and currents, which would make the route along the coastline to the port of Zeebrugge accessible for inland vessels. This would also be an alternative for current plans to widen the Schipdonk channel, a proposal to open the port to inland navigation that bumps into a lot of local protest.



shipping lanes Westerscheldt


estuary shipping Westerscheldt


accessibility port of Zeebrugge

NATURA 2000

In addition, scenarios to improve the accessibility of the port of Zeebrugge are examined within the policy plan *Flanders in Action, Pact 2020* (Vlaamse Overheid, 2011). At the moment entering vessels are hampered by lateral currents. Most scenarios to improve the accessibility foresee the extension of the existing breakwaters. Such obstacles, however, interfere with the natural transport of sand along the coastline. In the past such extensions have caused sediment deposition at Zeebrugge and Heist (De Moor, 2006). Further sediment deposition could endanger tourism at the local seaside resorts.

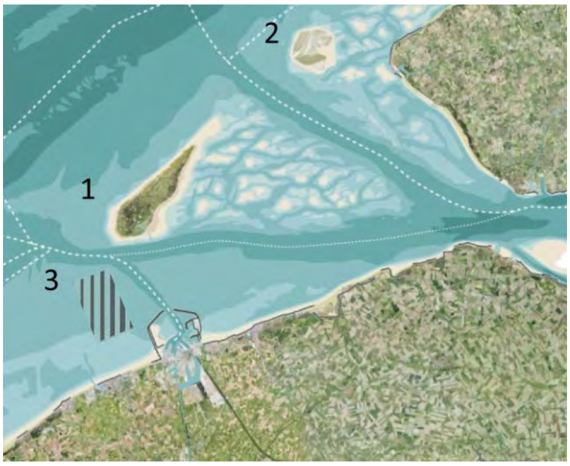
Besides these projects in favour of port and shipping activities near the Vlakte van de Raan, a nature conservation zone is actually being planned at the highest area of the shoal. While the Belgian part is used as a dumping site for dredged material (S2, S3, R4), the Dutch part has been registered as Natura 2000 site (Bleker, 2010). Both policies seem to conflict but might actually be closely connected. Research points out that increased biodiversity near the Belgian-Dutch border could be due to increasing availability of fines due to disposal activities. However, further research is needed to confirm this hypothesis (Van Lancker et al., 2012).

Research by design as a tool for an integrated project at sea

The reorientation of shipping lanes is a base for the CcASPAR proposal. A new gully, a deepened Geul van de Walvisstaart, creates a shorter link between the international east-west traffic route and the ports within the Westerscheldt estuary. As a result, the gullies Oostgat and Sardijngeul are no longer needed and structural measures to remediate coastal erosion near Walcheren can be put through. An intervention at the Vlakte van de Raan, reshaping the shoal and its surroundings, could create favorable conditions near the coastline which would render estuary shipping by reinforced inland vessels unnecessary. Such development would stimulate inland traffic via the Westerscheldt estuary and the project to enlarge the Schipdonk channel would no longer be needed.

At the moment, a natural deepening occurs at the gully Geul van de Walvisstaart (Peters, 2006). However, to create such a new gully some dredging will be unavoidable. In the CcASPAR proposal the dredging is organized as efficiently as possible. To avoid time-consuming (and therefore expensive) journeys to dumping sites, the dredged materials is disposed near the new sea lanes. As a big amount of sediment needs to be dredged, this intervention creates an opportunity to raise the shoal and to construct new islands. To maintain the gully continuous dredging is needed. This frequent dredging offers the necessary sediments to nourish the beaches and dunes of the new island(s).

This research by design proposes to construct three new islands, each one with its own typology and fulfilling different needs. Together they narrow down the Westerscheldt estuary, dissipate tidal energy and prevent storm surges upstream.



The biggest island (1) is situated near current dumping sites S2, S3 and R4. This island is permanent and can accommodate housing and tourism, as proposed in the master plan Flemish Bays. The island is situated way into the sea, so not to disturb the current open panorama at nearby seaside resorts. Furthermore, this island will be a barrier in the lateral transport of sediment along the coastline. Because there is a high rate of suspended matter at the Vlakte van de Raan (Van Lancker et al., 2012), one can expect that the rest of the Vlakte van de Raan will naturally silt up. Such deposition would create a composition of gullies and ridges, an interesting environment for nature rehabilitation.

Overview of CcASPAR the proposal

A second island (2) is situated in the Dutch part of the Vlakte van de Raan, near Walcheren. In contrast to the previous one, this island is not suitable for permanent activities. It is rather an offshore Sand Motor, like the one recently constructed near Ter Heijde, that replaces current nourishment near Walcheren and the entire western coast of Zeeland.

Finally, this research rejects prolonging the breakwaters of the port of Zeebrugge and proposes to build a floating construction or one on pilotis (3). Such intervention should slow down the current along the coastline in order to improve navigation conditions at the port of Zeebrugge. It is important that the construction does, however, guarantee some longitudinal current, otherwise regional sedimentation is unavoidable.

Within the CcASPAR project design, was used as a tool to create a coherent scenario. The design is not really a definite proposal that should make or break but rather a tool to build towards a common project. As such, the proposal is a test case for research by design as new tool for planning at sea and reveals the potentials of an integrated approach.

Acknowledgments

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MANAGING THE SEA, A VISION OF THE FUTURE. THE 'FUTURE COMMONS 2070' MAP

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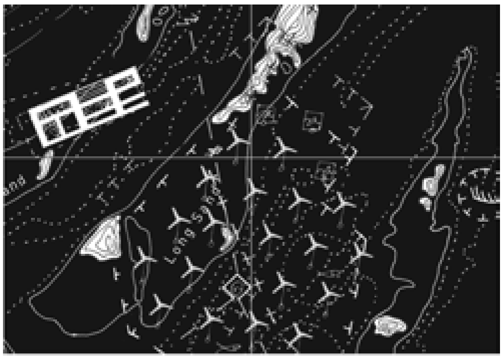

extract from 'Future Commons 2070', see www.magnificentsurroundings.org

We present the conference audience 'The Future Commons 2070' map, a design-based research project that addresses critical vision forming and synthetic imagination concerning the development of maritime spatial planning and ICZM on the Southern part of the North Sea. The map proposes a global vision of the sea and coastal area for and adjacent to the Belgian part of the North Sea, that outlines the key elements that develop the area into a Magnificent Surroundings+. In the concept of Magnificent Surroundings+ the sea is considered to become a common in 2070 and a synthesis is created between infrastructure and transport, energy production and ecological concerns in order to support this.

This project is part of the 'Magnificent Surroundings # North Sea and coastal area' research project and its purpose is to stimulate the awareness that the sea has this unique value to society: common interest. Everybody has the right to use the sea, to enjoy its benefits. Just like forests, water and the atmosphere, the sea can be considered as a 'common-pool resource', a natural common resource, quasi-free for anybody to enjoy. Although this seems evident, it cannot be taken for granted because natural common-pool resources are not inexhaustible, and hence, sensitive to problems like pollution, wastage and overuse. This is why the sea needs to be properly managed from a longterm perspective as a valuable future-orientated common good.

Oceans and seas are an immeasurable space, differing from the land in many respects, yet like all open space on earth, this immense area is increasingly under pressure. The increasing rate of land wastage is just one of the factors that will cause the demand to make open sea-space available for development ever more urgent. Throughout the centuries, maritime law has kept on connecting ever-larger maritime areas with their adjacent coastal states, and this is an ongoing trend. At the moment, a significant part of the surface of oceans and seas on earth is situated within the sovereignty of a coastal state (e.g. EEZ). However, the larger part of oceans and seas (e.g. 'international waters' or 'high seas') are not (yet) subjected to states' sovereignty, and are (to put it simply) intended for collective use; this part can be defined as a collective space on a worldwide scale. However, a collective status that has not been allocated or recognized explicitly is all too often demoted to the vulnerable status of 'freely available'... Clearly, maritime spatial planning is on the rise worldwide. Policy concerning this matter is evolving steadily. While Europe is setting out the basic outlines for its future marine and maritime policy options, project developers are already proposing their first initiatives.

In order to safeguard its status of common good the sea deserves due care and therefore, there is a need for a global vision of how to address this meta-question of commonality in maritime spatial planning. 'Planning' for the most part implicates accepting development, which, in terms of spatial use, translates as 'appropriation of extra space'. But Europe's intention to "guarantee economic growth in a climate of sustainable development" sounds a lot like its credo for planning on land, whereas planning and designing for marine areas is in fact a very different, location-time-specific matter. If we are prepared to validate this specificity, it seems more than probable that for maritime spatial planning, different planning principles from those for landlocked projects will be required.

The actual planning process needs to be backed up by existing fundamental scientific research, but it also requires global critical vision-defining research, in which an important role is reserved for design-based or projective research. In this type of research the default mode of thinking is imagineering and projectivity. Projectivity and imagineering , resulting in prefigurations, render prospective alternatives subject to discussion and anticipative reflection, also called proflection. Proflection enables reflecting on future possibilities and desirability, and in that sense, differs from scientific prediction which is rather reflecting on probablities. Global critical vision-defining research based on designerly thinking is orientated to goal-setting (what do we want?) and thus provides a necessary complement to the (natural) sciences. Framed within this particular research context, The Future Commons 2070 prefigures the development of the Belgian part of the North Sea and coastal area into a commons-inspired Magnificent Surrounding+ and proposes policy and planning principles to achieve this.

The 'Future Commons' map shows what may, by 2070, have become a new European Union 'Southern North Sea' Zone, namely a EU-Maritime Commons (EU-MC) Zone. Starting from the conviction that a relation exists between overexploitation of natural resources and the current use and governance of oceans and seas, we propose that the governance of all EEZ on a global scale should be reconsidered with this reflection in mind. We are proposing 2070 as the target year by which EEZ will convert into "maritime commons". In accordance with this future vision, these marine commons will be administered with a view to putting the common good at the top of the agenda, meticulously striving for a more balanced use of natural resources and respect for the dynamics and evolution of nature and species in oceans and seas. This vision for a new EU-Maritime Commons Zone was generated by design-based research and as a result this map features an absolute first: a specific example of simultaneous spatial planning for the marine area off the coast and the adjacent inland coastal zone area. It proposes to bring the former EEZ, including the 'contiguous zone', under management of the European Union (or a similar supra-national power) and consequently to divide it into larger, supra-national natural-jurisdictional parts, based on its constituent ecosystems. Transcending the existing state structure will allow the implementation of an international, coherent land, water and seas policy. Within a coordinating European policy framework, the territorial zone remains to be administered regionally. The 'Future Commons 2070' project advocates conservation of the sea as a common and recognition of its growing importance, strongly regulated by the European Union. Securing the sea as a common good guarantees consolidation of its social, economic, environmental and spatial significance in a dynamic whole. In addition, establishing additional commons on land - inland extensions of the sea - will create opportunities and favourable conditions for managing the effects of climate change in coastal zones. With this exploration of an updated concept of commons, the present project intends to fuel the ethical debate on maritime spatial planning, starting from a basic socio-ecologically inspired concern.

SUSTAINABLE SOLUTIONS FOR COASTAL ZONE MANAGEMENT OF LOWLAND AND RIVER DELTA COASTLINES

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Global Climatic Changes & Coastal Vulnerability

In recent years, the impacts of natural disasters are more and more severe on coastal and lowland areas. With the threats of climate change, sea level rise and potential subsidence, the reduction of natural disasters in coastal lowland areas receives increased attention. Moreover storm surges present a major natural hazard in coastal zones. At a global scale, an example of the effects of accelerated climate changes was demonstrated in autumn 2010 when the storm Becky reached the Santander Bay, Spain. As reported by THESEUS, the FP-7 EU project (2009-2013), the peak of nearshore significant wave height was about 8m, the storm surge reached 0.6m, with tidal level of 90% of the tidal range. This storm reflected at least a 20 years return period event. The recent coastal flooding in Alexandria on December 12, 2010, on the Nile Delta coastline was also a striking example of the severity of more progressive events. Egypt was hit by strong winds, exacerbated by heavy precipitation, up to 60km.hr with a10 hrs duration. These weather conditions resulted in waves of more than 6.5m height with a surge of over 1.0m which forced the closure of Alexandria main harbor.

Many barrier islands and lowland in the world such as that in the US and lowland and deltas such as in Italy and the Nile Delta (Fig.1) are also experiencing significant levels of erosion and flooding. A prime example is the Rosetta headland of the Nile Delta, on the western coast of the Nile delta, which has been subjected to the most severe erosion of the delta coastline due to the absence of the Nile sediments since 1964 (Fig.1). The Rosetta seawalls are currently protected by two flanking seawalls since 1990. To its west, the protection of the lowland within Abu Qir bay against flooding and over-topping is achieved by M. Ali Seawall, placed at coastal site, within Abu Qir Bay, East of Alexandria along the Nile Delta coastline.

Objectives

Most modelling and design activities do not take into consideration the impact of the structure- ocean wave interaction on sediment transport rates. The modified rates are responsible for the observed accelerated shoreline erosion at seawalls and subsequent down drift sediment accretion at the end of seawall or breakwater trunk.

Coastal zone management of coastlines is of utmost significance under the current and progressive effects of climate change. This study was conducted to investigate hydrodynamic and sediment transport mechanisms induced by the interaction of seawalls or revetments and the incident wave field. These mechanisms modify longshore and cross shore sediment transport rates along the coastal structure.

Further aim of this research project is to determine the special extents, cross and long shore, of coastline modifications which are associated with the induced effects of seawall-hard structures. Such design data are prerequisite to successful coastal zone management under impacts of anthropogenic and natural factors. Such data will help the costal designer to reduce wave overtopping on seawall structures. The third aim is to highlight the opportunities to use coastal soft defence measures.

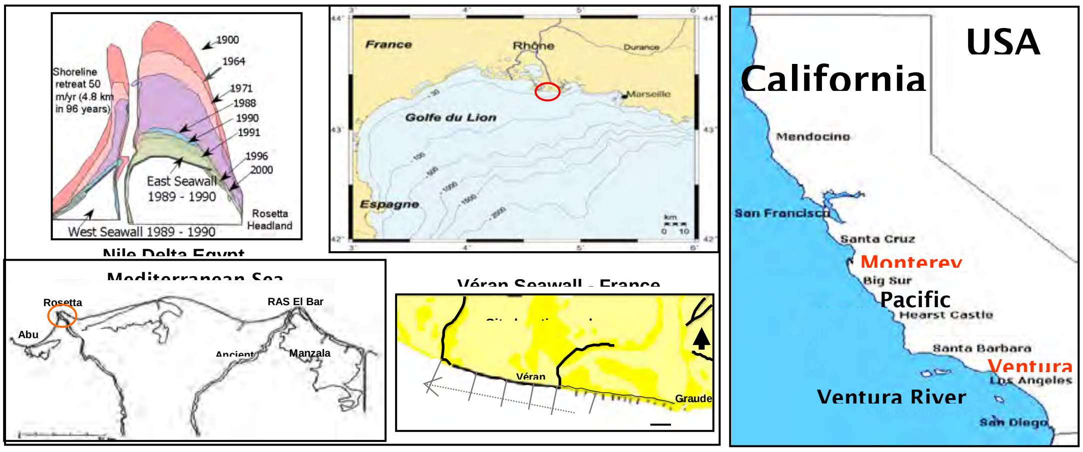
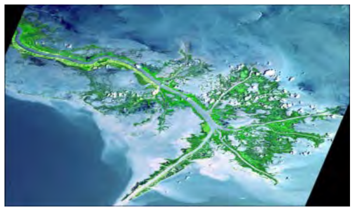


Figure 1. The Rosetta headland of the Nile Delta, and location of case studies in the Gulf of Lions, France and the Gulf of Mexico, USA



Mississippi River Delta USA

Impact of Seawall and Ocean Waves Interaction

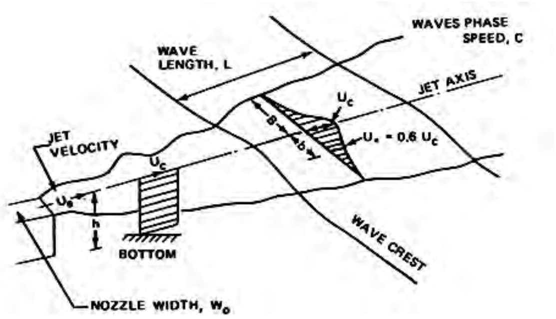
The prime case study addresses the seawalls constructed in 1990 at the Rosetta headland in response to the severe modifications and retreat of the Nile delta coastline after the operation of the Aswan High Dam in 1964 (Fig.1). The analysis was conducted on the basis of the extensive field work, performed by Egyptian government authorities. Use has been made of recent satellite remote sensing data for the Rosetta headland in 2005 and 2007 and the results of the numerical prediction of GENESIS coupled with an estimate of field data of the scour rate at the western seawall   It has been found that wave reflection and the generated wave pattern in front of the Rosetta headland seawall on the Nile Delta Coast enhance the rate of offshore sediment transport as well as the long shore transport rate. The obtained estimates of the alongshore and cross shore sediment transport rates agree with the corresponding values obtained from the results of fluorescent tracer experiments conducted at the Rosetta western seawall.

Review of field data published on other seawalls and coastal structures constructed in the USA and Europe confirms qualitatively the above results. Further the increased rates of sediment transport and reshaping of the coastline are strongly influenced by the cross-shore location of the seawall in the surf zone, the variability of wave climate and modifications of coastal circulation.

Longshore Modifications due to River Flow and Wave Interaction

The extent of the reshaping process of the Nile delta coastline due to the absence of the river Nile current, east of the Rosetta headland, is further explored from the work by Ismail and Wiegel (2003). The aim is to obtain the relation between the relative strength of waves to current momentum action and the alongshore distance where river flow was previously effective to entrain sediments. Based on the time and length scales and using the time average of the depth integrated conservation equations, as developed previously by Ismail and Wiegel (1983) for wave-current system on a smooth bottom. It is found that the relative strength of the wave action on the jet could be represented by the following dimensionless parameter; R_{sm}

$$R_{sm} \approx \frac{\frac{1}{2}\rho_S a_0^2 g\left(\frac{L_0}{h}\right)C_g}{(C_0 - U)} / \rho_0 U^2 w$$



Velocity and length scales of waves and opposing current system

The numerator of the above expression is proportional to the wave momentum action and the denominator is proportional to the initial momentum flux of the jet. In the above expression, ρ_s is the seawater mass density, ρ_o is the river current mass density, a_0 is the deep water wave amplitude, g is the acceleration of gravity, C_g is the wave group velocity, L_o is the deep water wave length, h is the average water depth near the river mouth, C_0 is the deep water wave phase velocity, U is the average jet exit velocity and w is the river mouth effective width. Confirmation of the above correlation was obtained using the experimental results of the extensive experiments which involved wave and current measurements as well as flow visualization techniques (Ismail and Wiegel, 1983, 2003). The obtained correlation is shown in Fig. (2). The figure shows that the expected length of coastline reshaping would be in the neighbourhood of 20 km east of Rosetta headland (1992-2007). This estimate would explain the continuous rates of erosion in the groin set segment of the coastline as could be seen in the satellite image of 2008 for Rosetta headland.

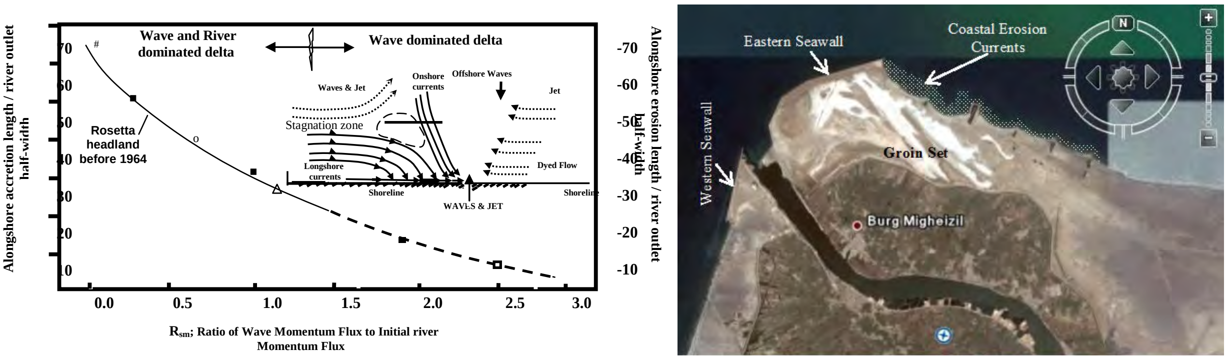


Figure 2. Correlation between wave-jet relative momentum thrust and length scale of the alongshore zone of accretion and erosion and Satellite image for Rosetta headland (2008)

Conclusions and Way Forward

The study concludes that new design alternatives to protect eroding lowland shorelines of deltas and barrier islands such as that implemented for Surfer's Point (CA, USA) should be explored. These managed retreat systems were adopted to restore coastal resources near the mouth of the Ventura River, Southern California (Fig.1). Furthermore other soft engineering alternatives such as beach nourishment, sand dunes stabilization and use of integrated barrier island and coastal lagoons would act as a buffer zone to defend main land. The sustainability of the integrated natural systems would require (1) barrier island and shoreline restoration and (2) hydrologic and vegetation restoration of coastal lagoons. Such restoration projects will require a major undertaking by national governments and international institutions.

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PROTECTIVE EFFECT OF COASTAL LEVEES AGAINST THE MEGA-TSUNAMI OFF THE PACIFIC COAST OF TOHOKU CAUSED BY THE 2011 EARTHQUAKE

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Abstract: On 11 March 2011, a mega-tsunami caused by the 2011 off the Pacific coast of Tohoku Earthquake destroyed most of the coastal levees along the Pacific coast of northeastern Japan. These coastal levees were constructed in response to previous tsunamis and storm surges. The life-saving effect of coastal levees was examined by comparing on-site observation data from this tsunami with records of the Showa Sanriku Tsunami (1933). To compare human fatalities among coastal towns, the fatality rate was defined as the sum of the number of fatalities and missing persons as a proportion of a town's population. Examining the relationships between the fatality rate, the tsunami inundation height, and the existence of coastal levees for the different tsunamis revealed markedly different outcomes in terms of the number of fatalities associated with a tsunami inundation height. As a result, at a tsunami inundation height of 10 m the Showa Sanriku Tsunami's fatality rate reached 3 to 90%, while that associated with the off the Pacific coast Tohoku Earthquake Tsunami's was only 1 to 3%. Since the coastal levees were mainly built after the Showa Sanriku Tsunami, it is cleared that one of the factors that contributed to a decrease in the fatality rate was the protective effect of the coastal levees against inundation by tsunamis.

1. The 2011 off the Pacific coast of Tohoku Earthquake and Tsunami

The M9 earthquake, named the "2011 off the Pacific coast of Tohoku Earthquake" by the Japan Meteorological Agency, which originated off the northeastern coast of the Japanese mainland in the Pacific Ocean on 11 March 2011, caused extensive damage to the Tohoku Sanriku Region. The associated tsunami, which had a maximum run-up height of 37.9 m at Iwate-Miyako, caused numerous casualties and extensive damage to property in Iwate, Miyagi and Fukushima prefectures. Elsewhere along the coast, such as at Iwate-Ofunato and Miyagi-Onagawa, the run-up heights of the tsunami reached 29.6 m and 18.4 m, respectively. In these prefectures, the tsunami either destroyed or severely damaged numerous breakwaters, tidal embankments, coastal levees, and coastal towns in the Iwate, Miyagi, and Fukushima prefectures. In addition, as a result of the earthquake and associated tsunami, 15,854 people died, 3,155 went missing 26,992 were injured, approximately 470,000 were displaced, and at least 383,246 buildings were either destroyed or damaged.

2. History of restoration following natural coastal disasters in the Tohoku Sanriku Region

Several large offshore earthquakes have occurred previously in the same geographic region, including the Keicho Sanriku Earthquake in 1611, the Meiji Sanriku Earthquake in 1896, and the Showa Sanriku Earthquake in 1933. Each of these events was associated with devastating tsunamis along the Sanriku Coast of the northeastern Pacific Ocean in Japan. The coastline of this area is particularly vulnerable to tsunami events, because it is composed of numerous V-shaped bays (saw-tooth coastline) that open toward the ocean; the effect of this V-shape is that it amplifies the effect of incoming tsunamis or surge waters. The M7.6 earthquake of 1896 produced tsunamis as high 38 m, and the M8.6 earthquake along the Sanriku coast in 1933 produced tsunamis as high as 29 m and caused 3,064 fatalities. In 1960, the Chilean Earthquake Tsunami was propagated across the Pacific Ocean and hit the Sanriku coast. In addition, storm surges have occasionally caused extensive damage along the southern Sendai coast. Many of the breakwaters, tidal embankments and coastal levees along the Sanriku coast have been destroyed or severely damaged by these large earthquakes, tsunamis and storm surges, and many of these structures have been reinforced or restored throughout the long term.

Most of these coastal embankments and levees were destroyed by the tsunami associated with the 2011 off the Pacific coast of Tohoku Earthquake. Fig. 1 shows the alongshore height of the previous coastal levees, i.e. the heights of the coastal levees before the earthquake, as well as the tsunami inundation height and the fatality rates of areas extending from the Kuji coast in Aomori in the north to the south coast of Sendai Bay in Miyagi to the south. In this figure, the fatality rate is defined as the sum of the number of fatalities and missing persons as a proportion of a town's population. The figure shows that tsunami height, fatality rate, previous levee height, and the planned levee height differ markedly between areas. Since the relationships between these difference parameters are not clear and cannot be inferred from the figure, we intend to investigate these aspects in a future study.

According to a survey by the Japanese newspaper, Asahi Shimbun, restoration plans for new coastal levees have been drafted by Iwate and Miyagi prefectural governments, but reconstruction work is only expected to be undertaken on 18 km of the 190 km damaged levees in Iwate, Miyagi and Fukushima prefectures. The survey found that many residents oppose the construction of higher levees, as the higher structures may obstruct their views of the sea or prevent them from sighting future tsunami inversions. Moreover, by limiting visibility of the ocean, it is considered that the coastal levees may adversely affect the ability of local residents to read the condition of the sea by observing wave patterns.

Because residents have yet to reach consensus on the proposed reconstruction plans, we need to illustrate the scientific basis upon which the coastal levees could prevent fatalities in the even of future tsunamis.

3. Life-saving effects of coastal levees

Regarding the tsunami that followed the Showa Sanriku Earthquake in 1933, Watanabe (1985) examined the tsunami inundation height, number of fatalities, and population of each of the affected coastal towns in Iwate Prefecture, it is not clear whether the number of fatalities in that study included the number of people who went missing.

In addition, the coastal levees that existed in 1933 are considered to have been insufficient or non-existent, because Watanabe's report did not describe any coastal levees along the Iwate coast in that report. We compared Watanabe's 1933 tsunami data with the data from the 2011 off the Pacific coast of Tohoku Earthquake Tsunami. Specifically, we examined the life-saving effect associated with the coastal levees by examining the relationship between the fatality rate and the tsunami inundation height (Fig. 2). Using Watanabe's data, the fatality rate was defined as the ratio of the number of fatalities to the population of a coastal town. For the Meiji Sanriku Tsunami, Fig. 2 also shows the scattered data-range by 'x--M.Iwate--x' mark for Iwate prefecture, and by 'x---M.Miyagi--x' mark for Miyagi prefecture, respectively. The figure also shows the trend (two dashed lines) between fatalities and tsunami height reported by Kawata (2011).

Since Watanabe's (1985) survey data was restricted to Iwate, we only examined the relationship between the fatality rate and tsunami inundation height for the 2011 off the Pacific coast of Tohoku Earthquake and the areas in Iwate (Fig. 2). Data is shown for following points on the figure: areas where coastal levees exist along the coastline (□); coastal levee and coastal town on middle-high ground (□); coastal levees and coastal towns on high ground (□); coastal levees and the existence of tsunami breakwaters present in bay mouths (□). Points indicated by 'Fs' and 'FH' show data from the Iwate-Fudai village obtained during the Showa Sanriku Tsunami and the 2011 off the Pacific coast Tohoku Earthquake Tsunami, respectively. "High ground" refers to towns located above the tsunami run-up height. "Middle-high ground" refers to towns located between sea level and the tsunami run-up height.

The ranges in fatality rates at different inundation height for the for the Showa sanriku Tsunami and the most resent tsunami are shown by the dashed and solid lines in Fig.2, respectively. While the fatality rates in Fudai village (Fs), reached levels as high as 98% in the Showa Sanriku Tsunami, these values decreased to 0.03% in the most recent tsunami (FH). In other words, fatality rates in Fudai village at the time of the Showa Sanriku Tsunami, fatality rates in the Fudai village were as high as 98% when the tsunami

inundation height was 8 to 13 m, and as low as 0.03% in the most recent tsunami when inundation height was 18.5m.
One of the reasons for the marked differences in the ranges of the tsunami inundation heights (i.e. 2-6m and 11-24m) at a fatality rate of 1% is considered to be due to the effect of the concrete coastal levees that were constructed after the Showa Sanriku Tsunami. Indeed, this difference in the ranges of these variables is considered to reflect the life-saving effect of the coastal levees. Of course, the observed life-saving effects cannot be attributed entirely to the existence of hard countermeasures, as soft countermeasures, such as tsunami warnings, drills and evacuation procedures, and the difference between night (Showa Sanriku Tsunami) and day (the most recent tsunami) are also very important.

4. Conclusions

The life-saving effect of coastal levees was assessed by comparing data from the Showa Sanriku Tsunami (1933) and the 2011 off the Pacific coast of Tohoku Earthquake Tsunami. Importantly, while the life-saving effects reported in this study were likely due to a combination of both hard and soft countermeasures, the results of this study can be summarized as follows:
1) Alongshore variations in levee height are related to the history of previous restoration efforts that focused on repairing damage due to tsunamis and storm surges in each area. The fatality rates in each area were not only related to the effect of coastal levee height, but also due to a variety of other factors.
2) Using a diagram to show the relationship between the fatality rate, tsunami height, and the existence of coastal levees, a tsunami inundation height of 15 m was associated with a fatality rate of 10-90% in the Showa Sanriku Tsunami. However, these rates decreased to less than approximately 10% after the most recent tsunami.
3) In the most recent tsunami the existence of coastal levees had a great effect on saving lives by comparing the Showa Sanriku Tsunami, i.e. for a fatality rate of 1%, the tsunami inundation height would have been as low as 3-8m at the time of the Showa Sanriku Tsunami vs. 11-24 m for the tsunami following the 2011 off the Pacific coast of Tohoku Earthquake.

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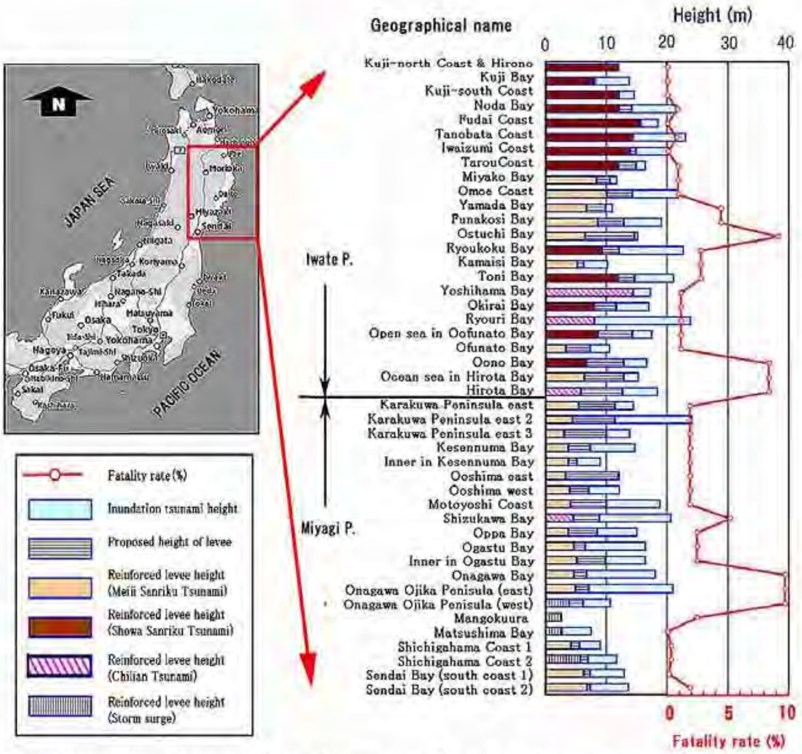

Fig.1 Alongshore distribution of previous coastal levee height, proposed levee height, tsunami inundation height, and fatality rate due to the 2011 off the Pacific coast of Tohoku Earthquake Tsunami between the Kuji coast and Hirono in Aomori in the north and Sendai Bay in Miyagi in the south.

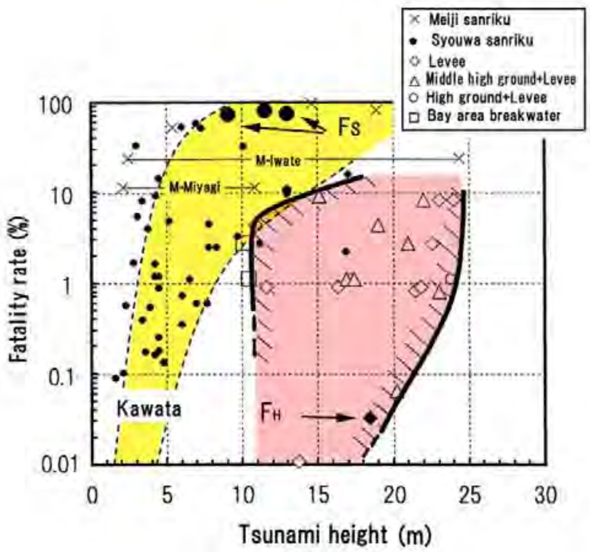

Fig. 2 Comparison of the Showa Sanriku Tsunami (yellow area) and the 2011 off the Pacific coast Tohoku Earthquake Tsunami (pink area), and the life-saving effect of the coastal levees. Dashed lines show the ranges indicated by Kawata (2011) based on records from the Meiji Sanriku Tsunami, the Showa Sanriku Tsunami, the Thonankai Tsunami, the Nankai Tsunami, the Okushiri Tsunami Generated by Southwest-off Hokkaido Earthquake, and the Flores Island Tsunami in Indonesia.

CLIMATE RESPONSIVE SPATIAL RESEARCH BY DESIGN – A CASE STUDY ANALYSIS ON THE COASTAL AREA OF FLANDERS

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In search of alternative adaptation strategies for the Belgian coast
Low-lying coastal zones are highly vulnerable to climate change and coastal protection attracts special attention within adaptation planning. The Intergovernmental Panel on Climate Change (IPCC) defined an international framework describing three strategies within coastal adaptation practices; *protect*, *retreat* and *accommodate* (IPCC CZMS 1990; Klein and Tol 1997). In Flanders the Coastal Division of the Flemish government recently developed the Master Plan for Flanders Coastal Safety to assure the necessary protection until 2050 (Afdeling Kust 2011). This master plan lists different measures, e.g. elevated dikes and beach nourishment, all within the *protect* strategy.

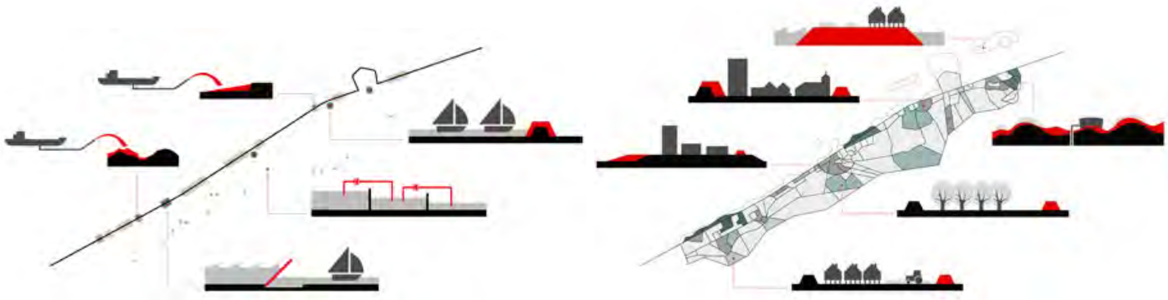
The *protect* strategy focuses on reducing risks, but as climate change and sea level rise continue (Nicholls, Hanson et al. 2006) each intervention in light of risk mitigation will eventually be outdated. The *retreat* strategy reduces vulnerability by removing existing structures and activities. Nevertheless, utilization of the coast increased dramatically during the past century (Nicholls, Wong et al. 2007). The *accommodate* strategy focuses an increased flexibility. This research, which took place within CcASPAR, concentrates on compartmentalization as tool to create flexibility at a local scale. Research by design is applied to explore the concept, to analyze its feasibility at the Flemish coast and to nurture the public debate on climate adaptation.

Climate related challenges at the Belgian coast
Sea level rise dominates the international literature and debate on climate adaptation in coastal areas (Nicholls, Wong et al. 2007). Belgium is no exception as current adaptation policies are restricted to maintaining coastal safety. As the coastal zone is an interface between land and sea, it is indeed vulnerable to coastal erosion and flooding during storm at sea. At the Belgian coast, sea level rise will raise water levels near the current coastline. This will cause higher waves and increases the impact of a storm at sea. At the Belgian coast sea level rise by only one meter would cause waves up to four meters (Reyns, Verwaest et al. 2011). In addition, climate induced coastal erosion would cause loss of beaches by 17 to 50 percent by the year 2100 (Van der Biest, Verwaest et al. 2009).

However, the coastal region is also threatened by impacts within the coastal zone and its hinterland (Nicholls, Wong et al. 2007). Local changes in precipitation might cause pluvial flooding, drought and salinization in the low lying area called 'polders'. As Yser and (drainage) channels link hinterland and coast, alterations in precipitation further inland might cause fluvial flooding. The whole range of climate impacts (e.g. drought, flooding) needs to be addressed when adapting to climate change.

Besides this multitude of climate impacts, the recent increase of human activities renders coastal zones extra vulnerable to climate change (Nicholls, Wong et al. 2007). In Belgium, two periods marked the coastal area and its landscape. During the 11th and 12th century, agriculture was a driver for land reclamation (Verhulst 1966; Verhulst and Gottschalk 1980). Pumps, channels and river embankments were constructed to transform the landscape. Until the beginning of the 19th century, the dune area stayed scarcely inhabited, but attracted many tourists during the past two centuries. This lead to a strong urbanization that was backboned by the development of a tramway, road (called Royal Route) and dyke along the coastline (Van Acker 2011). At the moment, the Belgian coast is by far the most urbanized coastal region within Europe (Eurosion, 2004) and consists of an ageing population, caused by increasing retirement migration (Safecoast, 2008). Up to 88 percent of the Flemish coastline is protected by dykes and beach nourishment (Eurosion, 2004).

Compartmentalization as framework for technical and spatial adaptation measures
As an answer to the climate related challenges, the CcASPAR project researched a new concept: compartmentalization. Within the compartmentalization concept, the current system and its safety levels are revisited at a local scale. As all climate impacts are water related (either flooding or drought) new embankments are added to split up the coastal zone into different compartments, each with its own water management. Such division creates a possibility to rescale the adaptation debate. Whether or not coastal erosion, fluvial and pluvial flooding, drought and salinization (might) occur and whether or not this will cause problems, can be analyzed for each compartment individually. Furthermore, the system within each compartment -its land use, its socio-economic characteristics and its landscape- can be revisited separately. If one wishes to maintain the existing system, technical strategies (e.g. dyke reinforcement, new pumps and increased water supply) are in order. If not, the climate impacts could be integrated into the compartment through conditions. Such conditions are not particular destinations (e.g. floodplains) but guidelines for local land use. In this way, space and spatial measures (e.g. elevated buildings, salt resistant crops and building restrictions) become part of the climate adaptation planning.



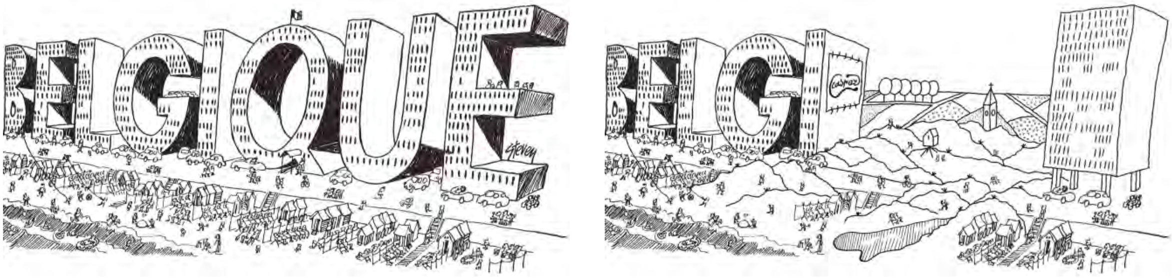
left: Masterplan for Flanders Coastal Safety (source: CcASPAR) / right: compartmentalized coast (source: CcASPAR)

Feasibility at the Flemish coast
The implementation of the proposed concept demands the development of a new infrastructural layer: a pattern of dykes. However, in the past millennium several embankments (e.g. historical dykes, roads, motorways, railways, sound and sight barriers) were built within the coastal region. Flood models, like the one developed within the Master Plan for Flanders Coastal Safety, mark that these structures already reduce the consequences of flooding. Yet, the embankments are not continuous or designed to function as dykes. The research by design within CcASPAR proposes to reuse the current framework as basis of the compartmentalization.

Benefits of the compartmentalization concept
The compartmentalization concept has several benefits and puts current developments in perspective. Firstly, the new pattern of embankments offers opportunities to balance the system and its safety levels at a local scale. As such, one can avoid implementing extreme protection measures wherever they are unnecessary or undesirable. Especially when sea level keeps rising and dyke reinforcement gets more and more expensive, this may be an important benefit. Moreover, investments can be spread over time. The proposed framework of dykes does not have to be developed immediately and the embankments might be purely theoretical. Only when the safety level is locally modified, they must be constructed.

Secondly, the compartmentalization strategy creates opportunities to *build with nature*. Several dynamic processes are now counteracted by current policies, while these processes actually insure a natural adaptation of the coastal landscape. For instance, hard

infrastructures do not only reduce the impacts of sea level rise but also cause loss of ecosystems due to coastal squeeze (Knogge 2004). By redefining the system at a local scale this natural adaptation can be put to use. For each compartment strategies can be developed that integrate the natural dynamic and the local socio-economic development.
In addition, such approach creates chances for new growth at ‘underdeveloped’ compartments. Finding a new equilibrium demands an innovative approach and an integrated vision on local climate adaptation and socio-economic development. Yet, once the desired equilibrium has been defined and decisions on spatial measures have been taken, investments in adaptation are no longer restricted to major infrastructures like dykes and pumps. In this way, climate adaptation, financed by the public and/or private sector, puts redevelopment of landscape and land use into motion.



left: caricature current Flemish coast (source: Steven Wilsens) / right: caricature compartmentalized coast (source: CcASPAR)

In the long-term, the urbanized coastline, which is rather monotonous at the moment, becomes a composition of traditional and alternative landscapes. This new coastal region –a collection of compartments- will be a new interface between land and sea, capable of absorbing any (climate related) impact in the long-term. As such, the compartmentalization concepts increases the flexibility of the Belgian coast as a whole.

Acknowledgments

This research is part of CcASPAR, a strategic fundamental research project on climate changes and changes in the Flemish spatial structures. Within work package five the University Ghent (Center for Mobility and Spatial Planning[1]) and University College Ghent (School of Arts[2]) have conducted research by design on climate adaptation at the Belgian coast. We would like to thank the other members of the design team. We thank Pieter Foré[2] and David Verhoestraete[1] for their for their innovative ideas on climate adaptation and coastal landscapes. Furthermore, special thanks go to Bjorn Verhofstede[1] for framing all ideas within the international adaptation debate and for his constructive input during the entire design process.

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INTEGRATIVE COASTAL ZONE SUSTAINABILITY

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Coastal zones are precious ecologies. Over a long period of time diverse agencies have interacted. At the Belgian coast, water, land, wind and sun have been shaping a complex and paradoxical bio-physical milieu, with different characteristics depending on location and moment. While the contact between water and land is a given, the line of contact is constantly moving. While nature is the dominating force, man is perverting the balance. While subsistence economy sustained the initial human presence, luxury recreation has become the dominant economy. While sea and land need each other badly, they turn their back at each other. This coastal formation of interactive diversities and dynamic interdependencies is a highly adaptive but fragile system. Its self-organizing capacities seem to have reached certain limits. A new and 'strong' story is needed if we want this spatial system to continue as an adaptive, open ecology.

Integrated coastal zone management (ICZM) is part of this story. However, as the European Commission states, the institutional circumstances for ICZM are all but favourable.

"Yet, coastal planning activities or development decisions still take place in a sectorial way, hardly being linked to each other. This fragmented approach to planning and management leads to inefficient use of resources, conflicting claims on space and missed opportunities for more sustainable coastal development." (European Commission, 2012)

As a reaction to this situation, already in 2002 the European Parliament and the Council adopted some recommendations for a more effective coastal planning and management. The main principles include "the need to base planning on sound and shared knowledge, the need to take a long-term and cross-sector perspective, to pro-actively involve stakeholders and the need to take into account both the terrestrial and the marine components of the coastal zone." (European Commission, 2012)

Since 2009 the European Commission has launched initiatives to review the recommendations. The need for new instruments is concluded.

The main aims of this paper are:

to describe the most important challenges and opportunities of the coastal zone and problematize those;

to outline basic principles of a framework which can cope with these challenges;

to suggest building blocks for the implementation of such a framework.

Reading the coastal zone

Many coastal zones face problems of deterioration and decay. Natural resources are spoiled and become depleted, threatening economic and cultural development. Climate change is expected to expose the coast to flooding, erosion and watershed degradation. Migration is stimulating income divides and generating socio-economic monocultures. Traditional economic activities are can hardly survive and diversification is weak.

Governance has a very local and 'autarchic' character. Real estate quality is substandard in physical and morphological terms ... This list of main challenges demands for the mobilization of local and specialized knowledge. Imaginative initiatives have to be deployed, effective measures have to be taken.

Such initiatives can be built upon a very attractive conglomerate of diverse and attractive geomorphological subzones (sea, beach, dunes, polders), a multitude of NGO's and ad hoc organizations, some with a coast-wide ambition (Coördinatiepunt Duurzaam Kustbeheer, Westtoer, Beaufort ...), performant infrastructures ...

A strong story as integrative framework

Future EU instruments and actions will certainly have to stress and assess potential environmental, social and economic consequences of new initiatives (European Commission, 2012). Promoting development along these Planet-People-Prosperity-dimensions or Environment-Equity-Economy-aims can lead towards a more sustainable (coastal) development (New Jersey, 1999; Knox and Mayer, 2009). Their integration and simultaneous development can serve as a measure for/of sustainable development (Newman and Kenworthy, 2003; Schreurs, 2007a). Integrated coastal zone management can certainly be built upon these dimensions.

However, such a complex situation does not only need an integrated framework. Such a frame should be a dynamically integrating planning process. Its quality "is determined by the ways in which vision, knowledge and democratic legitimacy are interwoven and embedded in the process of articulation and coordination" (Hajer, Grijzen, and van 't Klooster, 2010:)

Since sectorial divides and political fragmentation are ruling most of the time, an alternative for the 'business-as-usual scenario' has to be made. Integrating coastal zone sustainability therefore starts from the conviction that two dynamic fields of action have to be continuously interactive: imagination and realization.

An ambitious vision on future development is needed. It has to be the result of collective imagination. The question 'what kind of coast we want' needs reality check from designerly research. Designerly competence can stimulate debate and enrich the process of collective envisioning (Schreurs, Martens, 2005).

Complex partnerships are needed to realize transformations which fight problems and realize hopes. Depending on location and issues, constellations of shareholders (the ones directly and compulsory involved) and stakeholders (the ones indirectly involved or merely interested) have to organize themselves. Depending on advancing opinions and time horizons, shifts amongst and between those constellations can be expected.

Designerly research and evolving governance will be the main integrating 'threats' for a strong story about the coast.

Building blocks for an integrating framework

On several occasions already, we have been involved in the making of building blocks for such a 'strong story'. Partially they are even already tested with local and regional stakeholders. The main moments of production are:

coproduction with stakeholders at the Belgian coast, of a 'language for quality', applied to six challenging situations at the Belgian coast (Schreurs, 2006);

interactive mutual enriching of project definitions and research by design (Schreurs, 2007b);

development and demonstration of a methodology for the actualisation of a strategic policy plan for tourism at the coast (Vanhaverbeke, Schreurs and Vandeven, 2009)

identifying an alternative approach and criteria to assess centrality in small and medium sized cities in a dynamic way (Loopmans et al., 2010) developing a vision on involving privileged witnesses and stakeholders of the coastal network using research by design: (Martens, Schreurs and Wauters, 2011)

coaching research by design about opportunities to strengthen sustainable development at the coast (with focus on Ostend) during Studio Strategic Spatial Planning, Master Urbanism and Strategic Planning, department of Architecture, Urbanism and Planning, KU Leuven (academic years 2010-2011 and 2011-2012)

These building blocks contain all necessary ingredients to construct an approach for Integrative Coastal Zone Sustainability. The paper will explore the threads of this 'strong story'.

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LARGE-SCALE SAND NOURISHMENT STRATEGY OF THE DUTCH COAST; A SYSTEMS APPROACH

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Coastal policy in the Netherlands: maintenance by sand nourishments
In 1990, the Dutch Government adopted the national policy of "Dynamic Preservation" aimed at a sustainable preservation of safety against flooding and of values and functions in the dune area. Acknowledging sand as 'the carrier of all functions', the principle intervention procedure is nourishment of sand, making optimal use of and providing optimal space for natural dynamics (hence Dynamic Preservation). The implementation of the policy was guided by the definition of tactical objectives at different scales, i.e. preservation of residual dune strength at the small scales, of the basal coastline at medium scales and of the coastal foundation at large scales. The total yearly averaged nourishment volume since 2000, is 12 million m^3 of sand.

Upscaling of nourishments
The latest evaluation of the Dynamic Preservation policy shows that coastline preservation is successfully accomplished. However, with respect to the objective of maintaining the coastal foundation, evaluation was hampered by the lack of a clear benchmark. Regarding a recent update of the sand balance of the Netherlands coastal system, the conclusion might be that in this respect, the policy until now has failed: the update indicates a yearly deficit in active sand volume in the coastal foundation of ca. 20 million m^3, at the present rate of sea level rise of 2 mm/year. The objective to preserve the sediment balance of the coastal foundation would require a raise in yearly nourishment budget from 12 to 20 million m^3/year. In a study on climate adaptation of the Dutch Delta, the Delta commission suggests a raise of nourishment budgets up to 85 million m^3/year until the year 2050, considering an extreme sea level rise of13 mm/yr.

Design aspects of a large-scale nourishment strategy
In current discussions on an appropriate large-scale nourishment strategy, the dominant aspects relate to the basic questions: How much, where and when, how and who is responsible? Each of these questions will be briefly elaborated, indicating the major issues, arguments and approach.

How much?
The large-scale objective of the Dutch nourishment policy to maintain the coastal foundation, aims to preserve morphological boundary conditions for the coastal system as a whole, in order to allow it to grow with sea level. Thus, it is very important to define the limits of the coherent active coastal system at a larger time scale: coastal zone, tidal inlets and back barrier systems together. Then a decision has to be taken either to be reactive (or adaptive) to the rate of sea level rise, or to be pro-active to an estimated future increase in rate of se level rise.

Where, When and How?
Next discussions concentrate on the optimal distribution of nourishments sands both in space and in time. Since1990 in the Netherlands, the nourishment distribution has been governed by the definition of a reference coastline and a yearly nourishment scheme, predominantly consisting of shoreface nourishments with typical sizes of200 – 400 m^3/m. To investigate the effects of downscaling the frequency and of up scaling the intensity, an experiment was started in 2011 with a mega-nourishment of 10,000 m^3/m ("Sand Engine"). In parallel, discussions are ongoing to experiment with nourishments at sea dykes and nourishments of tidal flats in ecologically valuable areas in Wadden Sea and Delta.

Who?
The need for upscaling of nourishments is related to the governments (large-scale) responsibility for sustainable preservation of functions. Preservation of the active sand volume of the system is primarily the government's stake. The distribution of the volume affects stakes at all levels, national, provincial, regional and local. Taking the large-scale requirement for upscaling of the nourishment volume as a starting point, active involvement of all stakes in the design process of the distribution scheme may enhance integration between sectors.

Workshop
Coastal Governance

THE NEED FOR DATABASES AND VIEWERS TO SUPPORT DECISION MAKING AND LEARNING

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Coastal management - general
Coastal regions provide multiple and important benefits to society (safety against flooding, fresh water supply, nature, environmental quality). Therefore, various actors in society are affected by coastal management (or the lacking in coastal management). Different actors may not only have different interest, but can also possess different information (data) on the biophysical coastal system and coastal functions (needs, demands and benefits), or have different access to this information.

Why is it not possible for actors to 'fly' through *all* available data and Coastal State Indicators at once, comparing the development of different indicators, for different time-periods and for different areas? Could this not support the decision making by coastal managers and the draw up of expert advise by scientists and engineers?

Data management and dissemination – pilot Dutch case
In order to optimize the coastal management strategy in the Netherlands, insight in the (long & short term) development of the system is required, in particular the past, present and expected future trends in sediment volumes and distributions (*present* state). Likewise, the present and future societal need and demands on coastal functions are vital (the *desired* benefits). Data is an important resource to gain insight in this *present* and *desired* state. In addition, data analyses result in determining the *efficiency* of previous interventions: learning from the obtained feedback.

Although data is available for the Dutch coastal system, it is frequently not public available and usually not stored in international, uniform standards which makes an integral analyses severe. By developing and/or applying existing state-of-the-art techniques to share and visualize data a group of Dutch scientists attempt to contribute to fulfill the desire to easily 'fly' through all coastal data. One of the assets is a general toolbox to plot any data type in Google Earth (examples are given in Figure 1). With this toolbox it has become very easy for marine and coastal experts to disseminate their data via Google Earth. It enables the coastal community to make its data available to end-users and the general public with only little effort. What we are in fact trying to build is an analog of YouTube for viewing marine and coastal data: 'DataTube'.

Based on this new, easy accessible database and knowledge obtained in current research programs, a thorough description of the functioning of all coastal sections along the Dutch coast is drawn up. In these so-called Coastal Registers long term, large scale morphological changes due to sea level rise and large scale interventions (closure of tidal inlets) are related to short term development in coastal indicators, sediment distribution patterns are related to safety levels and environmental quality, nourishments related to sediment redistributions etc. The final goal is to draw up guidelines for sustainable coastal management for all various coastal sections taking all available data in account, using (learning) from the feedback of the coastal system.

Figure 1: Examples of a general toolbox to plot any data type in Google Earth. Data credits: Rijkswaterstaat. Plot credits: Deltares and Van Oord. Image credit: Google Earth™ mapping services. More examples (pilots) are available on the following websites: http://publicwiki.deltares.nl/display/KV/Kustviewer & http://test.kustviewer.lizard.net

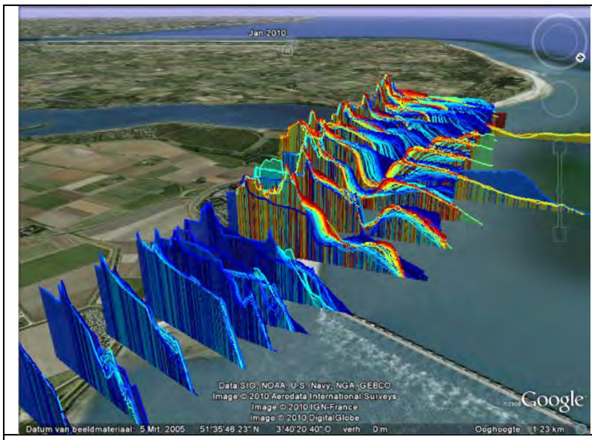	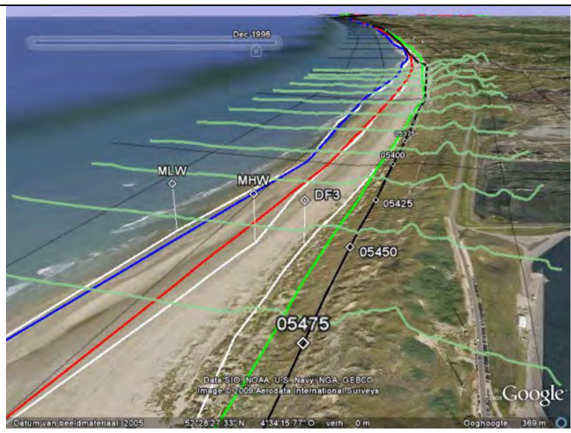
Figure 1a: Plot of JarKus transects around the Eastern Scheldt barrier from 1965 to 2010. The color represents the time at which a profile was collected (blue =old, red=recent). This makes the morphological development (erosion and deposition) clearly visible. Available data: X-Y-Z value per transect per year.	Figure 1b: Example of JarKus transect in one year with beach line indicators overlaid. Available data: Coastal state indicator (e.g. beach width) per transect per year.

Figure 1c: Map of bathymetry (height) dataset in 2008. Available data: X-Y-Z value per gridcell per measurement.

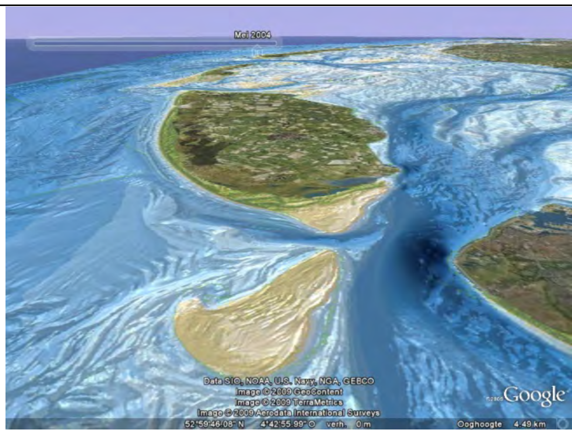

Figure 1d: Map of bathymetry (depth) dataset in May 2004. Available data: X-Y-Z value per gridcell per measurement.

Figure 1e: Example of plot of beach and foreshore nourishments since 1952. The area indicates the sand volume (assumed 1 m thick), the color indicates the nourishment type. Available data: Nourishment characteristics per nourishment.

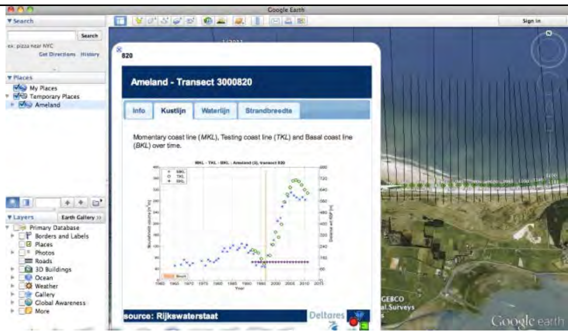

Figure 1f: Example of graphs of the development of coastal indicators (right axis) and nourishments (left axis) for a selected Jarkus transect in Google Earth. Available data: Coastal state indicator per transect per year.

A FRAMEWORK FOR COMPARATIVE ASSESSMENTS OF VULNERABILITY AND RESILIENCE APPLIED TO TEN DELTAS

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The challenge for sustainable development of deltas is to strike a balance between economic development and environmental stewardship. In a research conducted by Deltares and Alterra, trends and responses have been identified and compared for ten major deltas of the world: Nile delta (Egypt), Incomati delta (Mozambique), Danube Delta (Romania), Yellow River Delta (China), Rhine Delta (the Netherlands), Mekong River Delta (Vietnam), Chiliwung River Delta (Indonesia), Ganges-Brahmaputra Delta (Bangladesh), Mississippi River Delta (USA) and the California Bay Delta (USA). In all these deltas, climate change, population growth and economic development are the main drivers for change. These developments pose extensive demands on the available natural resources. In addition to these drivers there are a number of societal trends – of which decentralization and privatization are the most prominent – that affect the organization and outcome of planning for sustainable delta development. The challenge is to utilize the advantages of both trends, while minimizing their undeniable drawbacks. This calls for a selective enhancement of governance structures, reflecting the regional scale, integrated nature and long term perspective of delta development.

This inventory used an innovative analysis framework that combines environmental, infrastructural and occupational delta characteristics with institutional and governance aspects. A major finding was that notwithstanding the diverse cultural, environmental, technical and political conditions of the studied deltas, significant similarities exist in the way societies strive to overcome climate change and related problems towards more sustainable delta development. By using this common analysis framework the exchange of knowledge and experiences between the deltas of the world can be enhanced, thereby enabling to share their best practices

LINKING SYSTEMS AND ACTORS TO UNDERSTAND POLICY GAMES IN THE MANAGEMENT OF DELTA INFRASTRUCTURES

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Infrastructures, whether man-made or formed by nature, are intended to provide various goods and services to societies. Also natural infrastructures such as dune areas or tidal estuaries are increasingly maintained, modified or managed by human society. In these processes, various actors are involved, often with diverging interests and perceptions. Nature organizations may argue for the maintenance of certain natural infrastructures so that also future societies can benefit from the resulting ecosystem goods and services. Business groups may argue for increased modification and control of natural processes, to allow current generations to reap the benefits that rural delta regions can bring. For actors in these processes, but also for government agencies responsible for facilitating such multi-actor decision-making processes, it will be useful to see how they could strategize to influence the process and its outcomes.

This paper presents a conceptual framework that helps to organize and identify various possible strategies for influencing such multi-actor decision-making processes that revolve around the management of biophysical (delta) systems. The framework is based on a combination of systems analysis and actor analysis frameworks. It has been developed as part of a larger research project to study developments over time in decision-making on coastal management in the Netherlands and in South-Africa. In the Netherlands, national and provincial coastal management processes have been studied. In South-Africa, the construction and operation of the Wolwedans dam upstream of the Great Brak estuary has been studied. The use of the framework will therefore be illustrated with examples from these cases.

INTEGRATING SCIENCE AND SEDIMENT MANAGEMENT IN A BILATERAL SETTING, IN THE SCHELDT ESTUARY

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The Scheldt estuary plays a crucial role in the relationship between the Netherlands and Flanders/Belgium. Both countries require flood protection, need accessibility to large ports (Antwerp, Ghent, Terneuzen, Vlissingen) and value it as one of the few remaining natural estuaries in North West Europe. This requires a sustainable and balanced policy. A long term vision was developed and executed in cooperation between the two countries. The cooperation was formalized in a Treaty (December, 2005). It included the agreement to do joint research to support policy and management.

A main challenge is to come to 'integrated sediment management'. Soft measures (dredging, disposal, sand mining, nourishments) are, due to flexibility and reversibility, preferred over 'hard measures'. Options for sediment disposal differ horizontally (near or far away) and vertically (on intertidal areas, in secondary channels or in deep parts).

We discuss the recent (post 2005) history in cooperation, the bilateral aspects and efforts to come to a joint research program. A bilateral set of working groups is now responsible for 'posing the right questions' (a joint list), a common monitoring program and operational sediment management (a flexible disposal strategy).

We elaborate, using a policy analysis scheme, fig 1, on:

- -The importance of conceptual models to make system knowledge understandable and effective for policy and management;
- -How to balance between short and long term effects of management options, including autonomous developments like climate change;
- -The role of a joint framework, to assess monitoring results as well as for evaluation of management options;
- -Cooperation of knowledge institute, consultancies and estuarine managers;
- -Do's en don'ts to make research of value for decision making in estuarine management and policy. Usefulness depends on the ability to link states and changes in morphology and hydrodynamics to estuarine functions, including the ecological response.

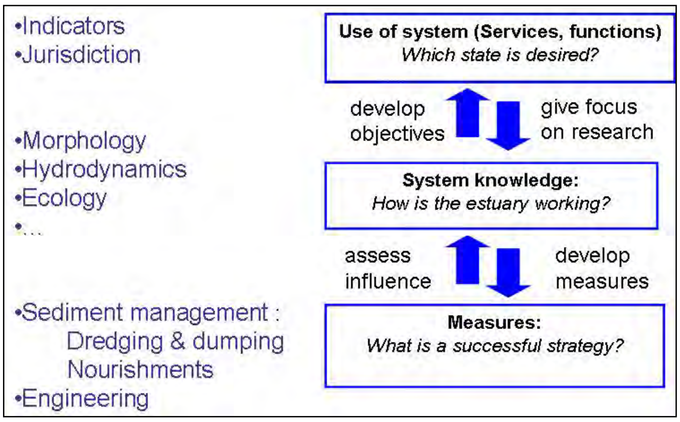

Fig. 1: Making bridges from management to system knowledge

HOW SCIENTIST LEARNT ABOUT THEIR ROLE IN GOVERNANCE: THE CASE OF GREAT BRAK

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Angry citizens drew scientists into the negotiations on environmental flows of an estuary located in a rural region of the southern Cape coast of South Africa. A major dam development was threatening their lifestyle and safety. Although environmental impact assessments were not a legal requirement at the time, scientists were commissioned to conduct such an assessment and come up with a management plan for the estuary. This study, which was the first of its kind in South Africa, moved the government authorities from a stance of technocratic decision making on water planning to a cooperative coalition, including local citizens and scientists. Scientists brought evidence-based knowledge of biophysical processes to the negotiations, informing the decision making. And so a fourteen year period of learning from monitoring and through negotiation and interaction followed, culminating in a revision of the original management plan in 2004. The Great Brak case study played a critical role in revising South Africa’s water law, acting as an exemplar of the process of incorporating ecological water requirements in strategic water planning and in so doing preserving local social and economic values. In 2009 an ecological flow requirements study as required under the revised water law was conducted, the outcomes of which are still (politically) disputed.

The paper provides an analysis of how scientists participated in this process and explores options for their future contributions to water governance.

POSTER PRESENTATIONS: Coastal management

TOWARDS SUSTAINABLE COEXISTENCE OF AQUACULTURE AND FISHERIES IN THE COASTAL ZONE

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Globally, coastal areas are subject to an increase in competing activities. Coastal fisheries and aquaculture are highly dependent on availability and accessibility of appropriate sites. Aquaculture production is increasing, whereas fisheries are at best stagnant. Coastal activities also include activities such as recreation, tourism, facilities for renewable energy production, all of which are expected to increase in importance. There is also increasing focus on Marine Protected Areas (MPAs). Thus, competition for available sites will probably increase, emphasizing the need for Marine Spatial Planning (MSP) and improved management tools supporting policies for space allocation along the entire European coastline.

Successful MSP is not likely to be achieved without a certain level of conflict, and without iterative adaptations in management actions. MSP is viewed an essential part of advancing ecosystem-based management as demanded by the Marine Strategy Directive. The biological interconnectedness of fisheries and aquaculture is strong, with factors such as competition for space, disease transmission, genetic impact from escapees, availability of food for cultured finfish, and organic and inorganic waste management. Furthermore, the public perception of aquaculture in Europe and North America may be characterized by the view of aquaculture being a "new" and "unnatural" activity, whereas fisheries are viewed as "traditional" and "natural" (Bergh 2007). However, in an ecosystem-based management context, both industries represent human activities strongly influencing, and influenced by, the environment.

Depending on where and how marine spatial management is applied it can have dissimilar impacts on the natural, economical and social environments (Pascoe et al. 2009) Conflicts between different activities could hamper development. In Europe, annual growth of aquaculture has declined to 1%. This is partly because of market factors, but also because the industry is subject to stringent regulation and sustainable development is a major condition. This means that the bulk of the projected thirty million tonnes of additional aquatic products needed to feed the planet by the year 2050, when the world population is expected to reach nine billion, will be cultivated outside Europe (Ferreira 2012)

Management of aquaculture and fisheries, as well as other uses of the coastal zone, should be considered integral parts with local variations in their respective importance. Since different activities advance towards dissent economic, environmental and socio-cultural objectives, conflicts occur when these multi-dimensional activities collide, according to different spatial contexts and institutional settings. The COEXIST project aims at outlining a process which avoids unnecessary conflicts or even enhances mutual benefits between different activities in the coastal zone. By means of using a transparent approach based on multi-criteria analysis (MCA), we characterize and establish priorities of future development and/or conservation in coastal areas. MCA is a useful technique to incorporate stakeholder preferences when evaluating marine spatial management and propose improvements (Soma 2010) Data are obtained from enquiring different groups of stakeholders in six different case studies from Europe's coastal zone, representing different complexity, and different natural and social conditions.

By definition, aquaculture implies rearing large numbers of animals of the same species in limited space. This favours the establishment and proliferation of pathogens, i.e. viruses, bacteria and parasites capable of exploiting the reared animals as hosts (Krkosek 2011). Diseases can be spread from wild to farmed animals and vice versa, emphasizing the importance of limiting the potential of such transfers (Johansen et al. 2011). Pathogens may be spread by wild organisms, escapees from aquaculture, transport of cultured organisms, transport of equipment or people, ballast water from ships or water currents. We are investigating how disease interactions particularly affect the aquaculture activities - and the environment - in contrasting case studies. Models are used to review and analyse pathogen transmission and spreading (Murray 2009) are applied, and strategies for disease control, such as fallowing (Werkman et al. 2011), are investigated. By definition, fallowing, and control with area management are key issues. A possible development is a coherent and transparent management of larger areas or regions, in contrast to the individual farm-based management seen in most of Europe today.

An aim of the project is to identify ways to adapt currently applied spatial management to integrate different forms of aquaculture and fisheries in the coastal zone, while taking into account other key users (e.g. tourism, wind farms, aggregate extraction, shipping) and future developments and exploiting mutual opportunities. Conflicts and synergies are equally important study areas, improvements should be sought through decreasing conflicts and increasing synergies. For each case study, the currently applied marine spatial management of coastal activities will be evaluated, and improvements proposed based on scenarios. The objectives are to:

- Evaluate the effectiveness of the currently applied marine spatial management of coastal activities in achieving aquaculture and fisheries specific objectives within the framework of sustainable development of coastal zones
- Evaluate the efficiency of the currently applied marine spatial management of coastal activities in achieving aquaculture and fisheries specific objectives within the framework of sustainable development of coastal zones

- Evaluate adaptations to the currently applied marine spatial management and planning process in achieving aquaculture and fisheries specific objectives within the framework of sustainable development of coastal zones
- Propose improvements to the currently applied marine spatial management and planning process that will benefit the aquaculture and fisheries sectors specifically, and within the framework of sustainable development of coastal zones, limit the potential impact on other users as well as exploit mutual opportunities

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INITIATING ORGANIZATIONAL CHANGE IN ORDER TO IMPROVE SERVICE QUALITY IN TOURISM AND HOSPITALITY ORGANIZATIONS AT THE BELGIUM COAST

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More and more hospitality and tourism organizations (whether in the commercial or non-commercial sectors) have recognized the importance of providing quality service as a competitive advantage.

In Belgium the Flemish government decided in 2006 to subsidize a project to develop a support program aimed at raising the service quality of hospitality and tourism businesses at the Belgian coast, the vacation destination par excellence in Belgium.

Designing quality into services, involves a planned approach to organizational change. In the literature about quality management, little attention is given to the planned approach to organizational change necessary when implementing a service improving strategy. **The focus of this paper is on this planned change aspect.**

At the University of Ghent we analyzed the literature on service quality management and the different national programs to support the hospitality business to improve their service quality. On the basis of these analyses and by putting the Lewin's three step model and the Gleicher Beckhard and Harris change model together, we arrived at a particularly powerful support program to help hospitality businesses to improve their service quality.

This support program consists of the following components: a service quality check, workshops about service quality, one-to-one business counseling, best practice visits and evaluation with a mystery guest.

The central question in many organizations is**: How do we get started on service-improvement?** It is our experience and that of others that **a service quality check (customer survey and benchmarking) is the most effective way to start** because it makes staff aware of what customers want and do not want and in particular, to highlight the organization's service failings. Moreover, the results of a survey and a benchmark confront all employees of a company with facts they did not know before, e.g. differences between the service expectations expressed by the customers and the supposed expectations of the employees.

SOCIO-ECONOMIC EFFECTS OF MANAGEMENT MEASURES OF THE FUTURE CFP (SOCIOEC)

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The new basic regulation for the Common Fisheries Policy (CFP) is set to introduce reforms to the European fishing industry. The new regulation, which comes into force latest in 2014, will probably implement a fisheries management system that will strive to bring the economic realities of the sector back in line with society's long-term interest in healthy seas and thriving fish stocks. The challenge for the sector including managers and stakeholders from the environmental side is to interpret the overarching EU objectives in local and regional contexts. There is a need to translate EC requirements, consistent with the aims of the new CFP as well as the Marine Strategy Framework (MSFD) and other EU directives, so that they are understandable by the wider stakeholder community and engage their support.

SOCIOEC, Socio Economic effects of management measures of the future CFP, is a recently started Seventh Framework Programme (FP7) project that will deal with the socio-economic effects of the main management principles of the new CFP. The aim of the SOCIOEC project is to develop and analyze, in cooperation with stakeholders, a range of available management measures and tools that specifically aim to endow fishermen with the incentives to overcome the identified failings and thereby achieve the objectives of the future CFP. The project will (i) investigate how the objectives regarding ecological, economic and social sustainability can be defined in a clear, prioritised and overall acceptable manner, (ii) analyze which management measures and at what organization level create the right incentives to tackle the main structural failings mentioned in the Green Paper of the Reform of the CFP, (iii) determine the socio-economic and spatial effects of these management measures and, (iv) considering the points above, provide socio economic impact assessment of the range of management measures selected.

Overarching principles of the CFP

The EU-Commission published an analysis of the current basic regulation (EU 2371/2002) in 2009 and stated there are still great structural problems in the implementation of a sustainable exploitation of fish stocks. In general there is a broad agreement that a sustainable exploitation of resources has to be the central premise of future fisheries management (Shelton and Sinclair, 2008). Sustainability can be considered in terms of the three pillars of sustainability developed by the UN at the 2002 Johannesburg Summit and elaborated by the EU in terms of environmental, economic and social sustainability (Kate et al., 2005). Especially in fisheries the three dimensions of sustainability are intimately connected and, as long as the sustainability concept has strong ecological and ethical roots, without ignoring the necessities for exploitation, there is the need for a clear socio-economic approach, focusing the sustainable debate within a socio-economic context.

One of the main research activities of the SOCIOEC project will be to develop a series of broad, generic objectives that encompass the three sustainability dimensions and focus on their application in any future revision of the CFP. This will be done through a literature review including both conceptual studies and real-world experiences and an appraisal of how the sustainability objectives were addressed in the past. This will be focused on the CFP its failures, successes, and their raison d'être where possible. From a research perspective, the analysis of objectives considered by SOCIOEC will include examples covering a wide range of management approaches discussed in the project, as technical measures (e.g. closed areas and seasons), command and control instruments (e.g. TACs, effort and quota management), market instruments (e.g. transferability of collective or individual rights), structural programme instruments and social instruments (e.g self- and co-management possibilities). With clearer objectives on the regional as well as the broader EU level, SOCIOEC will then interpret these objectives in the context of individual case study fisheries, and present second level objectives that are consistent with those on the EU and regional level, and appropriate for the fishery in question. In a first workshop the overarching objectives were discussed and a short list for the discussion in the regional context in the Case Studies agreed (Doering & Goti 2012). Part of this list is the objective to fish stocks on a level that produces the Maximum Sustainable Yield (MSY) and the economic objective to optimise gross value added (what fisheries deliver to society as a whole).

Incentives of existing and future management measures

There is a general understanding that the structural failures of the current fisheries policy have to do with wrong incentives leading to fishers' behavioural responses which conflict with the aim of the CFP (encouraging sustainable exploitation of natural resources) and that stakeholder influence and involvement on a regional basis is not strong. The concept of sustainable development in a social context includes concepts such as employment, food security and worker safety among other, but can also include a cultural dimension. This can comprise the issues of ethical orientation and action-leading values, lifestyle debates, cultural diversity, traditional knowledge and skills, local and regional space of reasoning and acting, gender issues, etc. (Stoltenberg, 2010). So, the social and the cultural context can also play a crucial role in informing fisheries management. This is particularly the case with coastal, small-scale fisheries, in which locally rooted knowledge and traditional skills are still maintained and passed on, and the concept of sustainability management might still interact with traditional values that we seek to maintain.

Within the SOCIOEC project, the cultural and social dimensions for the local community will be examined. The incentive structure and associated behavioural responses of fishers will be analysed using several methods within the case study research design. Each case study follows the same line of thinking in order to be able to make generalizations that will serve for the management toolbox afterwards. Overall four methods will be used to assess the incentive structures behind fisheries management measures in a way that adapts to the qualitative differences of the targeted populations and also to the available resources for data collection and contact stakeholder. The first method is the collection and evaluation of existing literature in the area, specifically related to incentives. The second basic method will consist of conducting interviews with fishers, complemented with interviews with people surrounding fishers who possibly influence fishers' decisions. (Bennett and Adamowicz, 2001; Hynes et al., 2008). The third method will investigate the impact of various forms of rights-based management (RBM) on short-term fleet dynamics, building discrete-choice models (Random Utility Models, RUM) widely used in fisheries literature (Holland and Suttinen, 1999), to evaluate the impact of closed areas (Hutton et al., 2004; Vermard et al., 2008), and also of Individual Transferable Quota (ITQs) (Marchal et al., 2009). Finally, the fourth method employed is a game table approach; "ecoOcean" (Schmidt, 2012), a graphical interface presenting a cellular based projection of an ocean with fish stocks, where up to four players/users (stakeholders) can navigate their vessels and trawls. This will allow the researchers to observe behaviour in a different context than a one-to-one interview.

Improved governance and improvement in self- and co- management

The CFP as it is now remains basically a top-down hierarchical system with the Fisheries Council adopting the basic regulation, which is then implemented and enforced primarily by the Member States under the auspices of the Commission. From the management point of view the European Commission makes a number of important suggestions regarding the future decentralisation of the CFP as well as the introduction of management structures that encourage the industry to take great responsibility for the implementation of the CFP. In particular the Commission believes that decentralization which gives fisher and fishers' representatives a stronger voice in the policy decision-making process has the potential to engender a culture of greater compliance with the regulatory requirements underpinning the policy.

Decentralized fisheries management systems already exist at a local or regional level in several EU member states which go well beyond mere consultation structures. SOCIOEC seeks the analysis of such examples on the case study level while also reviewing the CFP in the context of the overall Maritime Policy, and look at the possibility of taking the CFP from the current "government consultation of stakeholders" to true "partnership between government and stakeholders" in management.

Impact assessment – methodological improvements

The impacts of the new (proposed) management measures will be measured based on a set of indicators (social, economic and ecological) that will be defined in relation to specific objectives set and defined according to the overarching principles of the CFP and its implementation at regional/local level. One technique of analysis that the project will use to take into account stakeholders opinion is the *focus group* (Morgan, 1988; Krueger, 1998), a social science technique, which will be used with different objectives: (i) to identify, in a general framework, all the potential social, economic and ecological effects of the proposed new policy options using a scenario approach, (ii) to identify the most important social, economic and ecological potential effects and assign to them a probability and a magnitude with the help of the relevant actors and, (iii) to discuss and draw some conclusions about non quantifiable impacts (mainly relating to social aspects) and finally, (iv) to discuss inputs and results to/from the quantitative simulation phase in a participatory modelling approach constituted by cyclic feedback loop process. The above qualitative analysis will be integrated with quantitative analyses to infer on the ecological and socio-economic impacts. The aim of the quantitative analysis will be to develop projections based on the scenarios defined by each case study. SOCIOEC will use a range of existing bio-economic models to evaluate, through stochastic simulations, the future impact on the natural resources and human benefit of current and alternative management measures, options and strategies based on the different indicators and descriptions.

Conclusion

The EU FP7 project SOCIOEC is the only fisheries project at the moment with a clear socio-economic focus. The project addresses the following main research questions: overall objectives of the CFP, incentive structure of management measures, better governance and integration of stakeholders and improvement of methods for socio-economic impact assessment. The specificity of the project lies on its framework of analysis (objectives-incentives-governance-impact) and the possibility to pretest it in an integrated way with a set of case studies that at the same time approach the main issues in the coming CFP and are designed to be compatible with the latest developments in the current CFP.

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PRELIMINARY RESULTS FROM AN ONGOING INTEGRATION PROCESS: THE 'ICZM PLAN RÉGHAIA' IN ALGERIA.

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'ICZM Plan Réghaia' is a program being developed on two coastal municipalities in **Algeria**, which have important environmental problems. It is part of the process of integrated management of coastal areas, and in the context of the implementation of the ICZM Protocol Madrid. Its realization process is based on the **"*Guidelines for the preparation of Director Coastal Plans in Mediterranean / Towards an Integrative Methodological Framework (IMF)*"** in the «Strategic Partnership MAP / UNEP-GEF for the large marine ecosystem of the Mediterranean (**MedPartnership**).
We present some aspects of our experience with the approach that we developed for the transversal activity entitled '**Sustainability *and integration*'**, in the **'ICZM Plan Réghaia'**, with the first results. The following will be treated:

- Presentation of the study area and construction parameters of the territorial system
- Exposure to a general scheme ***"sustainability-integration (participatory)"***
- Preliminary results (application of the method ***'Imagine'***)
- First analyzes and continued activity "sustainability and ICZM process."

APPLICATION OF METHODS FOR CHANGE DETECTION TO IDENTIFY GEOMORPHOLOGICAL CHANGES. CASE STUDY: MOUTH OF THE EBRO DELTA

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Abstract
This work shows an evolutionary analysis of the different geomorphological units present in the mouth of the Ebro delta in order to evaluate, through methods for change detection, the most significant changes taking place in that area. The period 1957-1984 was much more dynamic and intense that the period 1984-2009. It also found that the most important processes that take place are coastal erosion and anthropogenic expansion.
Key words: Geomorphology, change analysis, geomorphological units, Ebro delta.

1. Introduction
The coastal area is subject to different, and sometimes strong, derivate impacts of natural and anthropogenic processes which concur therein. Its current state is the result of the combined action of physical agents and human agents (Rodriguez et al., 2009). Any variation in these combination results geomorphological changes in relatively short periods of time and, in many cases, can constitute a risk to human activities. The main risks in the coastal zone are coastal erosion, changes in sea level and storm sea (Andrew and Grace, 2002).There are many studies of coastal dynamics, but few of them (Ramírez-Cuesta et al., 2011) have focused on the geomorphological evolution in detail, despite being a key element in such important areas as coastal risks.
Therefore, the aim of this study is to analyze the changes of different geomorphological units of the Ebro river mouth.

2. Study Area
The Ebro Delta, located in the NE of the Iberian Peninsula, south of Tarragona, is one of the major Mediterranean deltas. The selected area is the last section of the mouth of the river Ebro, because it is the place where geomorphological changes have been most evident because the waves impact more strongly than in the rest of the delta. This area has a very flat profile and a low slope, which assists the development of sandbars. The selected area has a total extension of 70.36km^2.

3. Methodology
To determine the geomorphological evolution, georeferenced images of the years 1957, 1984 and 2009 were selected, which were photo-interpreted in the different geomorphological units, and later this were digitized.
Finally, a change analysis was carried out using a transition matrix or cross tabulation because it is a methodology that has certain characteristics that make it capable of being used in such studies, despite being used primarily on issues of land use (Pontius Jr. et al., 2004). This process identifies the most significant transitions in order to detect the processes that generate these transitions.

4. Results and discussion
As a result of the photo-interpretation, geomorphological maps were obtained for the three dates of interest (Fig. 1), and the area occupied by each geomorphological unit in the different years was calculated. Thus, it was observed that the larger units in the total period studied are wetlands, as befits the typical environment of deltaic areas, and anthropic areas, which shows the great importance of agriculture, mainly rice, in the study area.

Then it proceeded to perform the analysis of changes in order to identify the most significant transitions between different geomorphological units (Fig. 2). Thus, significant transitions found for the period 1957-1984 reflect processes of sedimentation, erosion, sand dunes stabilization, anthropic advance and level variations of wetlands and coastal lagoons. Sedimentation is reflected in the increased size of the bars present in the mouth of the delta in 1957, which defend a large wetland behind them. Regarding erosion, it concentrates on the beach, the unit more exposed to waves causing the beach moves inland.
Much of the sedimentary deposits located at the mouth of the river Ebro disappeared as a result of the construction of Riumar urbanization in the 60s. This is not the only progress of human activity. The expansion experienced by rice was also very marked, mainly affecting the surface devastated by the waves flooding, concentrating this transition in the region north and south of the study area.
Variations of level of wetlands and coastal lagoons are caused by the needs of irrigation in rice cultivation, so the water level of these lakes is higher during the months of May to December than during the rest of the year. Furthermore, due to the expansion of farming plots, mostly in the southernmost lagoon, these ponds and wetlands experienced a great loss of surface during this period.
Transitions identified for the period 1984-2009 show that coastal erosion is concentrated in the beach surface. In this period there is also an increase of the barrier islands of the area N of the mouth due to coastal aeolian transport of sediment by prevailing winds from the NW-SE and also due to the accretion process in the northern coast of Riumar urbanization.

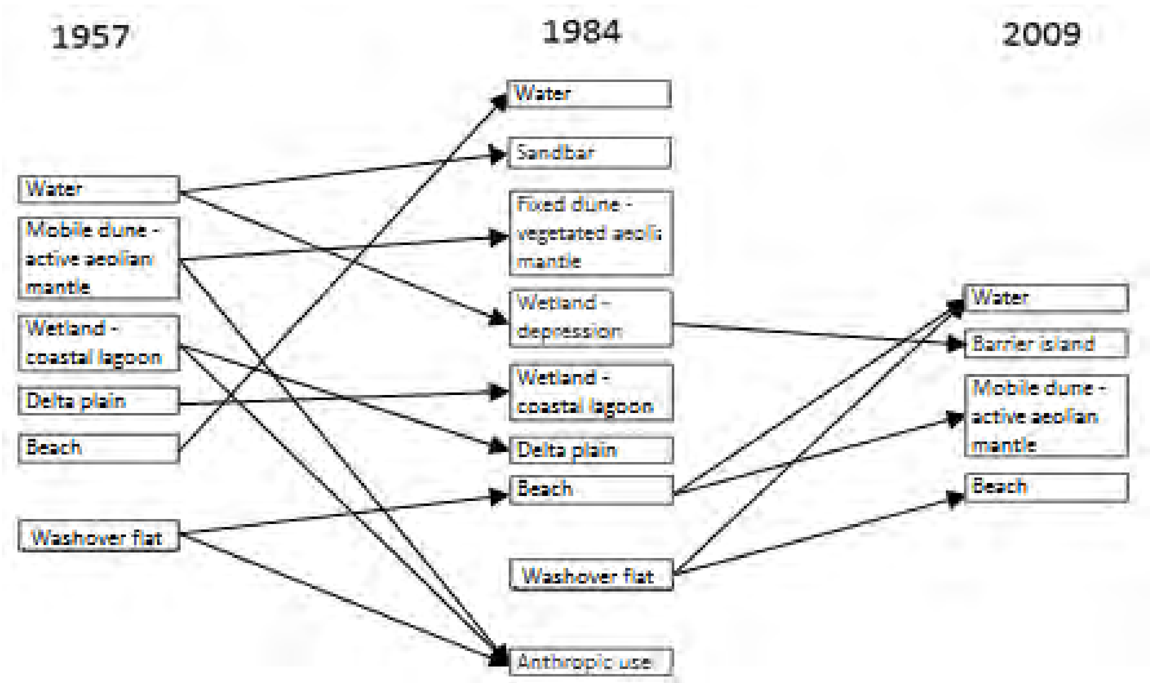

Fig. 1. Significant transitions identified for the entire 1957-2009 period.

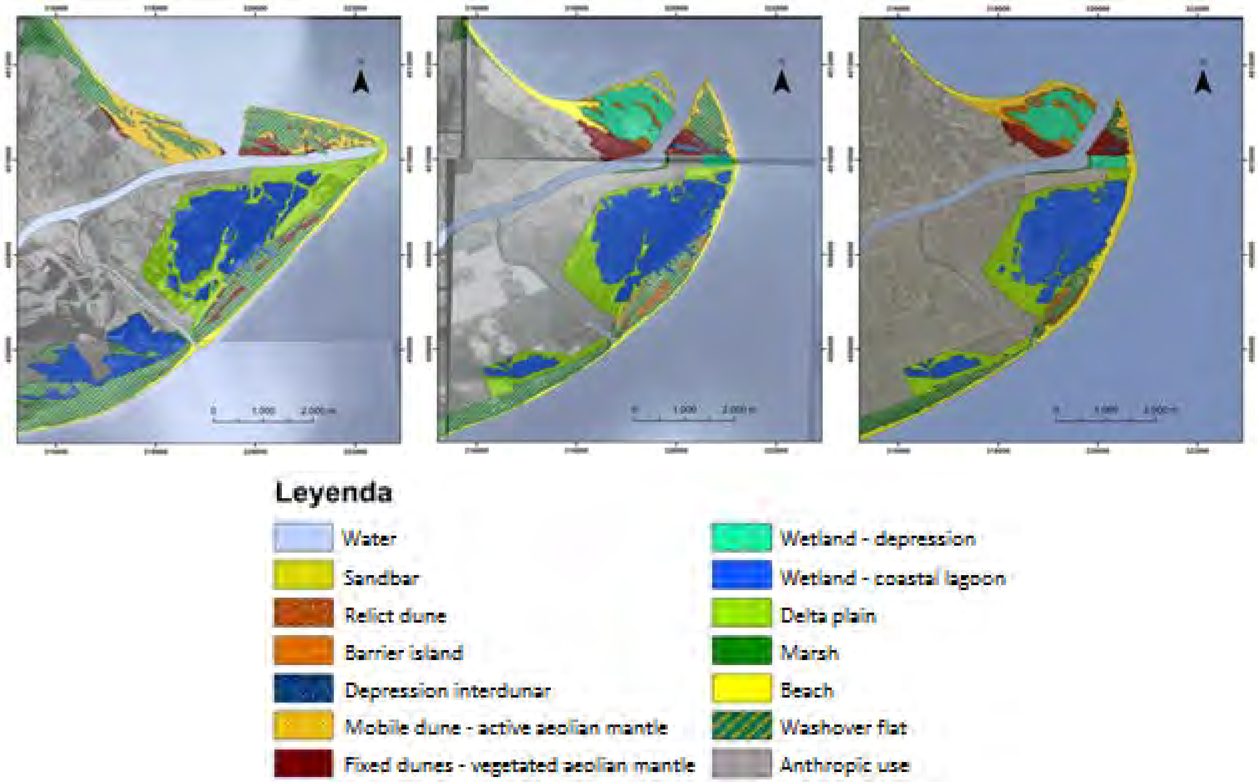

Fig. 2. Geomorphological maps obtained for the three dates of interest obtained by photo-interpretation

5. Conclusions

Change detection methodology is applicable to the field of coastal geomorphology, allowing identification and characterization of the major transitions between geomorphological units identified.

The main processes taking place in the area of the mouth of the Ebro Delta are coastal erosion processes and agricultural expansion.

The period 1957-1984 was more active in terms of geomorphological changes that the period 1984-2009. This suggests that the Ebro Delta is becoming a form that allows cushion the variations mainly by coastal erosion.

Acknowledgements

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TRANSCOAST EU-INTERREG PROJECT (WWW.TRANSCOASTPROJECT.COM)

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Sea ports and the related economy of maritime sectors have made an important contribution to shaping the socio-economic structure of the 2 Seas areas and allowed its port cities and coastal regions to flourish. In recent decades however, coastal regions in the 2 Seas area have experienced a decline in the economic importance of their industrial and commercial ports. As a consequence towns and regions turned away from the sea to focus on other opportunities. And many harbour areas slowly degraded into neglected, disadvantaged areas.

TRANSCOAST is a cooperation initiative of 12 local and regional authorities from France, the UK, Flanders and the Netherlands, that aim to counter this development in their territories together with a total investment programme of 12 million Euros. All are planning or starting a transformation of their degraded port areas to give their towns and regions a socio-economic impulse. An important development to renew economic vitality in these areas is the creation or improvement of marinas and facilities for maritime leisure and tourism (yachting, water sports).

The port transformation programmes are generally without local precedent and their scale and complexity exceed the competences and knowledge of any single local or regional authority. The partners recognise they need to join forces with other actors travelling down the same road, to improve their responses to this challenge.

In this context the main aim of TRANSCOAST is to strengthen the economic vitality of coastal regions in the 2 Seas area by providing cross-border support to the planning, design and implementation of measures to transform derelict and sub-standard port areas into new functions, most notably as marina's, and of measures to mobilise local communities to engage in the maritime economy in the wake of these transformations.

Website: www.transcoastproject.com

ADAPTATION TO COASTAL EROSION AND CLIMATE CHANGE IN PORTUGAL: ENGAGING LOCAL COMMUNITIES FOR A SUSTAINABLE COAST

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European coasts are increasingly threatened by coastal erosion phenomena, which are expected to worsen as a result of climate change. The Portuguese coast is one of the most energetic in Europe. Coastal erosion has been increasing mainly due to the reduction in sediment supply and sea level rise (SLR), which was about 15 cm in the 20th century and an average of 2.5 mm per year-1 over the 2000-2009 decade. In the past two decades the coastal retreat rate has increased significantly, reaching 7 m per year on some stretches.

This makes the Portuguese coast one of the most at risk due to climate change, coastal erosion and economic vulnerability, especially in the current context of economic recession. The Portuguese coastline concentrates most of the country's population and economic activity, and over the last decades the State has been unable to hold urban sprawl, illegal dwellings and tourism pressure.

Meanwhile, in the current context, public authorities have increasingly less funds to build and maintain heavy defence infrastructures and new adaptation strategies are starting to be considered by experts and policy-makers. Solutions such as the relocation of people, buildings and economic activities, previously avoided, may have to be carried out in the near future.

On the other hand, recent studies on climate change suggest that sea level rise and other phenomena – such as changes in wave patterns - may lead to significant impacts on Portuguese coast.

This double jeopardy – economic recession and climate change – makes Portugal an interesting coastal case study, whose results may be usefully extrapolated for other coastal countries in Europe.

To face these new challenges and implement future adaptation strategies on a densely populated coastline, fostering public participation in coastal policies, through a greater involvement of local stakeholders and populations, is critical.

Moreover, it is fundamental to understand how stakeholders and population (re)act according to the most recent and localized future scenarios developed for each of the studied regions (within this project) by: a) showing coastal zone areas according to their degree of vulnerability; b) sharing practical guidance in the selection and prioritization of adaptation measures; c) visually (2D map) distinguishing flood prone areas, run-up and overtopping phenomena; and d) communicating the uncertainty associated with SLR projections based in the IPCC 4th Assessment Report and in more recent scenarios.

It is also crucial to measure the impacts of past and current coastal policies on the sustainability of these coastal areas. In Portugal the "hold the line" policy, with little public involvement, has been dominant until now. The Integrated Coastal Zone Management (ICZM) approach is just beginning to take ground. However, in the near future other alternatives may have to be considered, following cost-benefit analysis, which have been nearly absent from policy-making processes.

A national strategy for ICZM has been approved in 2009, and the second generation shoreline management plans (SMP) are just starting to be elaborated. These are expected to take into account the impacts of climate change. There's an opportunity for an appropriate evaluation of the implementation of the first plans - most of these plans have been in force for more than 10 years - as well as the coastal defence infrastructures and initiatives in which governments have been investing over the last decades.

It is crucial to assess whether ICZM initiatives have been delivering economic, social and environmental benefits and to what extent they contribute to improve sustainability on the coast. This paper captures the representations of coastal populations on coastal erosion and climate change, but it also addresses their perceptions on the effectiveness of coastal policies and planning.

The research is also innovative in the way it addresses the financial issue of coastal defence and management. It not only questions stakeholders on possible reduction of funds from public budgets, it also addresses the willingness of local actors to pay for further protection of their coastal areas and their possible direct involvement in alternative funding schemes in the future.

The social sciences approach to coastal issues in Portugal is still rare. Aiming to fill this gap, this paper includes some of the results of the project CHANGE – Changing Coasts, Changing Climate, Changing Communities (2010-2013) – which combines the approaches of social and natural sciences.

The study is focused in three coastal stretches in Portugal, all of them characterised by a recent history of accelerated settlement and tourism investment. In these three cases, isolated historical communities, mainly fishermen, were joined in recent decades by an amalgam of people coming from different places with various interests on the coast that overwhelmed the weak municipal authorities.

This research combines: a) scientific assessments on the past and future evolution of the shoreline, taking into account the expected impacts of climate change; b) social research based in interviews with policy-makers, coastal experts and interested stakeholders, as well as local extensive surveys; c) the outputs of a model for coastal governance and community building, based on local discussions through focus groups and community workshops.

KNOWLEDGE CONTINUUM FOR COASTLINE MANAGEMENT IN THE NETHERLANDS

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Coastline Management

A good understanding of both the natural dynamics and socio-economic developments along the coast is crucial to conduct cost-effective and sustainable coastline management. At present, 60-70 million euros from the Dutch national treasury are spend annually on sand nourishments in order to protect the sandy coastline of the Netherlands from erosion and sea-level rise. These sand nourishments provide physical boundary conditions for beaches and dunes, which is important for coastal safety, recreation and freshwater reserves for the densely populated hinterland. Rijkswaterstaat is the agency responsible for coastline management.

Knowledge continuum

The independent research institute Deltares supports Rijkswaterstaat on a regularly basis. A continuum is established in state-of-art knowledge of the Dutch coast through long-term research programs and simultaneously use for many short-term advices to coastline management. Policy makers and coastline managers are constantly involved in discussing results and formulating new research questions (joined fact finding). Besides Deltares, other research institutes are also involved.

Coastal research

The research topics relate to three spatial layers:

- Base layer: Fundamental research of the natural coastal system, e.g. on morpho-dynamics of ebb-tidal deltas along the Wadden Sea coast. Knowledge on the behavior of long-term and large-scale coastal processes is essential in planning new sand nourishments in such areas,
- Infrastructure layer: Continuous evaluation of coastal erosion of the 'infrastructure' of dune embankments, beaches and foreshore, and the performance of recently conducted sand nourishments. Knowledge on the cost-effectiveness and sustainability of current practice is essential for new sand nourishment programs (learning-by-doing) as well of addressing new policy questions;
- Occupation layer: Policy analysis of socio-economic interests and future sand nourishments, e.g. to tackle increased sea-level rise in the 21st century or to support coastal developments. This might result in changes in the current coastline management, e.g. by increasing the sand nourishment volume.

POSTER PRESENTATIONS: Measuring sustainability

REMOTE SENSING, AN IMPORTANT TOOL FOR INTEGRATED COASTAL ZONE MANAGEMENT

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The dynamic dunes along the Belgian coast are an important ecosystem with respect to nature conservation. They are the habitat of a specific and at least regionally rare wildlife. Beside their biological value they serve as a natural seawall, protecting the hinterland against floods. The integration of nature conservation and public safety requires balanced decisions and forms a major topic within the Integrated Coastal Zone Management (ICZM) in Belgium. Therefore, the coastal defence and nature conservation administrations authorities from the Ministry of the Flemish Community need detailed vegetation maps of the Belgian coast for policy planning and evaluation. From an Integrated Coastal Zone Management point of view, the development of efficient tools serving both authorities is desirable. For several decades, vegetation and topographical maps of the mobile dunes, mud flats and salt marshes have been produced for the Belgian coast by means of visual interpretation of aerial photographs. This technique however, does not provide enough detail about the vegetation classes in comparison to the effort needed, and the technique is not as precise as it should be.

Therefore new methods for objective, detailed and cost-efficient vegetation mapping were developed over the past years which made use of different types of Remote Sensing (RS) imagery and different processing and classification techniques. This paper gives an overview of the different scientific projects preformed prior to the development of an autonomic operational tool for coastal vegetation mapping along the Belgian coast.

In 2002 a first hyperspectral trial study was conducted over a test area at the west coast of Belgium. 48 bands imaging spectroscopy data with a spatial resolution of 1.3m was collected by the Compact Airborne Spectrographic Imager (CASI-2) and was used to obtain a first classification result. Focus in this project was on the investigation of different classification techniques. In 2004 the HyperKart project focused on hyperspectral imagery for classifying coastal dune vegetation in as much as possible relevant vegetation classes. The Airborne Imaging Spectrometer for Applications (AISA-Eagle) imaging spectrometer was used to collect data over the Westhoek nature reserve. After radiometric, geometric and atmospheric pre-processing of the high spectral (32 bands) and high spatial (1m) resolution data, different image analysis techniques were applied to obtain highly detailed vegetation maps on two levels. A high 'biological' level with 22 classes resulting in an overall accuracy of 75%, and a low 'seawall protection' level with 11 classes and an overall accuracy of 80%. Besides hyperspectral imagery it was investigated if airborne digital camera (DigiCam) images eventually in combination with LiDAR data could be used map the coastal dune vegetation. The advantage of this technique is the high spatial resolution of the DigiCam images (30cm) which was used for textural analysis beside the multispectral information (4 bands, Red, Green, Blue and Near Infrared). Additional vegetation height data, derived from the LiDAR data was used to increase the classification accuracy. The obtained accuracies strongly depends on the number of output classes. When using a high 'biological' level, classification accuracy is rather unsatisfactory, however on the low 'seawall protection' level the overall accuracy reaches 55% and can increase till 71% if the multispectral data is fused with the LiDAR data. Based on these experiences and on request of the Agency for Maritime and Coastal Services, Coastal Division from the Flemish Government in 2010, an autonomous classification and validation tool was developed. This stand-alone application, called 'AutoKart', allows the user to easily classify the entire Belgian coast at the 'seawall protection' level. DigiCam images (RGB-NIR) in combination with vegetation height images serve as input. In an interactive way the user can make trial classifications and validations for observing the obtained results and for fine-tuning the classifier. Seawall protection classes can be easily added or removed depending on the users need whereas sub-areas to be classified can be defined via vector shape-files. Via a build-in visualisation option the user can visualise the used and obtained images, i.e. the input RGB-NIR images and the obtained classification results.

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IMPLEMENTING A TOPOBATHY DATABASE IN MOZAMBIQUE

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Introduction

The country of Mozambique has a coastline of almost 2.700 kilometres. Approximately 20.5 million people, more than 60% of the total population, live in coastal areas. In many places this consists of lowlands with sandy beaches, estuaries and mangroves. These conditions mean a high vulnerability of both people and landscape to natural events like tropical cyclones, tsunamis, flooding and sea level rise (Mavume & Bundrit, 2009).

Better knowledge of the bathymetry and the topography of the coastal zone can help to take measurements for protection against these events. In this article a project is described within which a database with combined topographic and bathymetric information is created for two pilot areas in Mozambique. Digital elevation models generated with this database, can serve as a basis for better wave run up modelling and coastal zone protection and management.

Project Context

After the devastating tsunami in December 2004 the UNESCO Intergovernmental Oceanographic Commission (IOC) has launched the Indian Ocean Tsunami Warning System. In the framework of this program IOC and the International Hydrographic Organization (IHO) initiated the Coast-Map-Indian Ocean (Coast-Map-IO) project.

The focus of this project was to increase the capacity of countries around the Indian Ocean to collect and use bathymetric and topographical data, to support management of tsunami risk and other extreme ocean events in coastal areas (Berque & Travin, 2009). With more bathymetric and topographic knowledge, governments are better able to protect their countries by building infrastructure like dykes and by preventing people from living in areas that are too vulnerable.

As part of the Coast-Map-IO project, mapping agencies and hydrographic offices in the region were visited during joint IOC/IHO assessment missions, to get a good idea of the current capacities and needs of the different countries involved.

Based on the assessment mission in Mozambique, it was suggested that a pilot database with combined topographic and bathymetric data (a topobathy database) should be set up and that appropriate means and training should be provided to manage the data. After successful completion the results should be made available to other participating countries. The government agency responsible for this database should be the Mozambican Hydrographic Office: the Instituto Nacional de Hidrografia e Navegação (INAHINA) (Travin, 2008).

Based on the above the geomatics software company CARIS is cooperating with INAHINA to accomplish the setup of this topobathy database. In this project a database is filled with both topographic and bathymetric survey data for two defined pilot areas around the coastal port cities of Beira and Quelimane. These areas were identified by IOC/IHO together with INAHINA, because they are large population centres that are extra vulnerable to natural disasters.

The topobathy database software application that will be used at INAHINA is an application of the CARIS Bathy DataBASE suite, which offers a database solution to store, manage and visualize gridded bathymetric and topographic elevation datasets.

As in Mozambique the area for which hydrographic surveys have been done is very limited, there was not much data available to fill the database with. To be able to use the data in the topobathy database to, for example, create a good model for (tsunami) wave prediction, more bathymetric data was needed.

For this reason INAHINA and CARIS also partnered with the company BMT ARGOSS. Specialized in using earth observation data from satellites, BMT ARGOSS offers an efficient alternative to conventional surveys for shallow water areas where no adequate bathymetry information is available.

Using Landsat satellite images of the areas of Beira and Quelimane, the assessment of bathymetric information is based on the optical properties of the water and the seabed. By calibrating the intensity of light reflection with existing datasets a good approximation of bathymetric depths can be accomplished. This depth approximation is not as accurate as a ship survey, so the data should not be used for navigation. However, the accuracy is much higher than any data currently available for the area and is therefore a good input for further modelling.

Project Execution

In the period of October 2011 to January 2012 the project started with a first assessment of available geospatial data in Beira and Quelimane to put in the database. This resulted in some recent INAHINA singlebeam surveys as well as topographic data for both cities acquired from CENACARTA, the topographic office of Mozambique.

At the same time BMT ARGOSS has made an assessment of suitable satellite images and subsequently used the INAHINA survey data to calibrate the resulting bathymetry against. This resulted in two datasets with depth information of a 50 metre resolution for an area of about 150x75 km around Beira and about 100x50 kilometres around Quelimane, which could be imported into the topobathy database.

Finally two publicly available datasets have been used to fill the database in those parts of the pilot areas where no other data was available. For the bathymetric data the GEBCO dataset has been used. The acronym GEBCO stands for General Bathymetric Chart of the Oceans and its aim is to provide the most authoritative, publicly-available bathymetry for the world's oceans. It operates under the joint auspices of the IOC and the IHO.

For areas on land where there was no CENACARTA elevation data available, the public dataset used was the ASTER topographic elevation model. ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) is a satellite imaging instrument that can measure elevations.

In total there were 5 different data sources used for the initial filling of the topobathy database for Beira and Quelimane. These datasets where imported into the Bathy Database application and stored as continuous grids called BASE Surfaces. All 5 surfaces were combined into one digital elevation model, but only after all surfaces had been shifted to the same mean sea level (MSL) vertical datum. The whole workflow is shown in figure 1.

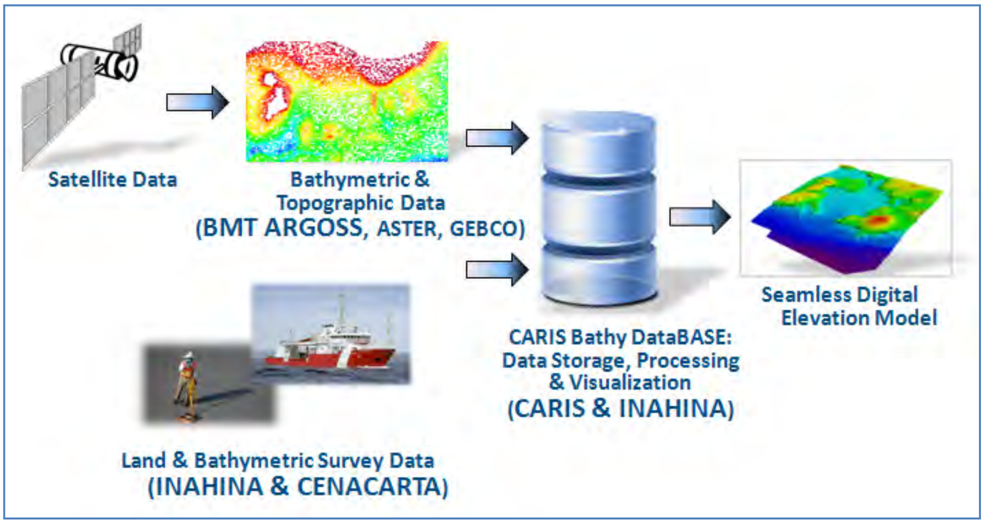

Figure 1: Topobathy database workflow

As a preparation CARIS established and executed a workflow for the Beira area and a training manual based upon this was created. Thereafter, in February 2012, a two week training was held at the INAHINA office in Maputo, Mozambique.

Apart from hydrographers, cartographers and an oceanographer from INAHINA, a cartographer from CENACARTA, as well as a meteorologist from INAM where participating in the training. INAM is the national meteorological institute of Mozambique and they can use the resulting topobathy elevation models, to better model (tsunami) waves and currents.

In the first week the students were trained in the conversion, management and visualization of the different geospatial datasets. The workflow to create a combined topobathy elevation model for the Beira area, as described in the manual, was followed. In the second week the CARIS Bathy Database suite was implemented at INAHINA, so that it can be used to store and manage all bathymetric and topographic datasets in a central location.

In the period of March to June 2012 INAHINA has executed the same workflow that was set up for Beira, to create a combined topobathy elevation model for Quelimane.

The project will be finished in July, with a second consultancy period in Mozambique. In this period the created elevation model for the Quelimane area and the future use of the database at INAHINA will be discussed. After that the results will be shared with the other in Coast-Map-IO participating countries.

After the Project

In the coming years INAHINA can expand their topobathy database in time and space. To improve the elevation model for Beira and Quelimane, new bathymetric & topographic data can be added and implemented, as soon as it becomes available. The area for which geospatial data is stored and managed can also be expanded to other coastal areas, thus supporting the buildup of a spatial data infrastructure for Mozambique.

Next to input for tsunami and storm surge models, the data can be used as a basis for multiple other purposes. Depending on the source and the accuracy of the data, INAHINA can use it both for the creation of nautical charts, as well as for the creation of gridded elevation models. In this way the knowledge based on the topobathy database can be shared with and used by different governmental as well as private organisations, for purposes like coastal engineering and disaster management in Mozambique.

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KEY ENVIRONMENTAL CONCERNS ASSOCIATED WITH SHIP BEACHING AND WRECKS ON THE NIGERIAN COASTLINE.

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The Nigerian coastline stretching about 853km is composed by low-lying sandy and muddy (Mahin Mud coast) shoreline. The shoreline is wave dominated with mostly plunging breakers which generate littoral drift mostly from west to east. The entire Nigerian coastline is highly susceptible to coastal erosion caused by both natural and anthropogenic activities. Some of the natural forces include wave and tidal climate, sediment characteristics, low-lying nature while anthropogenic forces include harbour construction activities, beach sand mining and other several human activities. Recently, abandon ships have been beaching along the shoreline. The ship wrecks act as perpendicular groins trapping littoral drift on the updrift side and causing large scale erosion on the downdrift side. Between the year 2010 and 2011, more than fifteen ships beached on the beach along the Lagos/Lekki barrier coastline. Along the Alpha beach especially, ship wrecks have caused massive erosion along the beach causing the devastation of the coastal road, beach tourism facilities, loss of power lines with concomitant flooding of the back beach. This human activity involving ship wrecks beaching on the beach is now aggravating the already erodible beach. Ship wrecks are either accidental or intentional. However, the effects of ship wrecks on the beach are detrimental to the stability of the beach and back beach and hence pragmatic solutions to continuous ship wrecks beaching along the coastline should be sought.

THE PEGASO PROJECT: INTEGRATED COASTAL ZONE MANAGEMENT ICZM IN THE MEDITERRANEAN AND BLACK SEAS

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The Mediterranean and Black Seas regions provide many economically important commercial, residential and leisure opportunities. However, both regions face serious challenges. The answer is to develop and agree upon joint strategies to manage for future growth, to identify and apply specific adaptation measures for a healthy marine and coastal environment, and to improve the integration and cooperation of the different management structures affecting coastal areas. With these objectives, the Protocol for Integrated Coastal
Zone Management (ICZM) in the Mediterranean was signed in 2008. It is a novel agreement that formalizes an integrated coastal management between the riparian countries based on the ecosystem approach. The ICZM Protocol offers, for the first time in the Mediterranean, an opportunity to work in a new way, and a model that can be used as a basis for solving similar problems elsewhere, such as in the Black Sea.

To support the implementation of the ICZM Protocol, the PEGASO (www.pegasoproject.eu) project works with policy makers, scientists and planners toidentify and integrate the instruments needed, and build the capacityfor implementing the principles of ICZM Protocol in order to help countries to put the Protocol into practice.

In order to achieve its objectives, the PEGASO project is committed to:
- Develop an ICZM Governance platform that will be used as a bridge between scientists and end users (administration bodies, managers,...).
- Develop a spatial data infrastructure (SDI) of coastal and marine zones in the Mediterranean and Black Seas to allow partners to apply sustainability assessment tools aimed at a better informed decision-making at all levels.
- Test and apply sustainability tools developed by PEGASO through field based case studies at all levels: local, regional, national and international.
- Build a common understanding on priority issues and institutional perspectives affecting the coastal zones and the sea of the two regional seas.
- Produce technical and methodological multi-scale tools for the coastal zones to makea comprehensive assessment of the drivers and issues of coastal areas and to provide guidance on management strategies and options scenarios.
- Develop an approach for an integrated regional assessment of the Black and Mediterranean Seas to allow partners to identify threats to regional seas and effective management responses.
- Develop training material on ICZM to build and enhance capacity among stakeholders and facilitate the implementation of the Protocol.
- Identify mechanisms for strengthening networking and capacity development.

PEGASO (People for Ecosystem-based Governance in Assessing Sustainable development of Ocean and coasts) is funded by the European Union within FP7-ENV.2009.2.2.1.4 Integrated Coastal Zone Management, and runs from February 2010 to January 2014.

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NEW METHODOLOGICAL APPROACH FOR STUDIES OF FISH BEHAVIOR IN OFFSHORE WIND FARMS.

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Offshore wind energy has become a leading candidate for the generation of renewable energy. There has been a rapid development in the construction of offshore wind farms (OWF) in Europe during the last years. Currently, 1,371 turbines operate in 53 wind farms over 10 countries totaling 3812,6 MW. The UK has by far the largest number of turbines and, therefore, it is the largest supplier of offshore wind power with 2,094 MW. After UK, Denmark, with 857 MW and the Netherlands (247 MW), Germany (200 MW), Belgium (195MW), Sweden (164 MW), Finland (26 MW), Ireland (25 MW), Norway (2.3 MW) and Portugal (2 MW), with just one turbine (Wilkes et al, 2011). In recent years, several European studies have been carried out to test the local effects that OWF may lead in terms of redistribution of fish species and incorporation of new species. These effects refer mainly to "FAD" (fish aggregation device) effect (Ybema et al, 2009; Scheidat et al, 2011) produced by the tower and its shadows on the water surface and to the artificial reef effect resulting from the foundations (Lindeboom et al, 2011; Wilhelmsson et al, 2010). Most attempts to quantify fish populations near hard structures, and natural and artificial reefs have used visual techniques. To improve the results, we propose the use of an acoustic and visual warning based system integrated into a computes part of a remote sensing platform (POR). The POR provides a continuous sampling over time based on echograms detecting presence of fish and on observation of species in real time. POR gives the possibility of quantifying fish populations plus studying their behaviour around the foundations and within the OWF. Therefore, this method can be applied in different scenarios to investigate the regional effects of OWF on local distribution patterns of pelagic and semi-pelagic communities but also on the study of attraction/avoidance behaviour of fish species.

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EVALUATION OF THE SEA-FLOOR INTEGRITY IN LITHUANIAN BALTIC SEA WATERS

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Nowadays coastal and maritime activities are becoming more intensive and variable. Traditional marine activities as fisheries, shipping, coastal recreation are supplemented by new economic developments such as aquaculture, offshore oil extraction, alternative energy production, electricity connection lines, gas pipelines and LPG terminals and lots of other developments in marine space. Offshore wind energy development is becoming a challenge of the first importance. However, traditional activities are still keeping their place and also expand pretty rapidly. Furthermore, pressure at the coast for tourism and recreation space is growing, along with the demand for both residential property and holiday homes. Also natural values are of the great concern and it is considered to expand the marine area of protected and NATURA 2000 territories. All these activities impact the marine ecosystem and on the other hand they are being impacted by the quality of marine environment. For example fisheries and recreation are directly dependent on the marine state and unsustainable use of marine resources could negatively impact not only the marine environment, but also the human activities at the sea.

Seeking to ensure the implementation of long-term sustainable development targets and objectives at the marine areas in 2008 The Parliament of European Union approved The Marine Strategy Framework Directive (2008/56/EC) (MSFD) which states the most important milestones for marine environment protection. This directive foresees that implementing economic activities in the marine area its characteristic, natural processes, protected habitats and sensitive species have to be taken into account. First step for implementing this MSF directive is to analyse the characteristics of the marine environment and the pressure of the existing activities, evaluate the common state of the marine environment.

In the MSF directive there are listed eleven Qualitative descriptors for determining Good Environmental Status. Seeking to avoid negative subsequence of physical changes of the environment two special descriptors have to be analysed: hydrographical conditions and sea-floor integrity. It is important to answer two questions: whether irreversible changes of hydrographical conditions could have negative impact on marine ecosystem? and is the sea-floor integrity retained enough to ensure that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected?

This presentation will focus on evaluation of sea-floor integrity identifying current state of the bottom, its characteristics, current and planned economic activities in the Lithuanian Baltic Sea aquatory. Criteria for the evaluation of this MSFD descriptor will be discussed.

There is no single opinion in European Union (Borja A., *et al.* 2011) or in the Baltic Sea region what criterion should be used for evaluation of the rate of changes of physical environment and what quantitative value have to be used for assessment of those criteria. This is mostly because of very different physical environment in different geographical latitudes. Even the Baltic Sea itself is different when talking about sea-floor physical conditions. For example, in the bottom of Gulf of Finland crystal rocks formed millions of years ago can be found, and in Lithuanian aquatory marine bottom is covered with glacial and postglacial sediments aged by only few thousand years.

Physical characteristics of the sea-floor can be changed because of the impact of human activities: relief, composition of bottom deposit. Depending on the rate of the impact and particular sea-floor area characteristics these changes can have or not to have negative impact on biotopes and on general condition of the ecosystem. For the evaluation of the state it is important to monitor human impacted bottom areas and its proportion with not impacted bottom.

So firstly the physical damage of the sea-floor done by human activities has to be evaluated taking into account characteristics of bottom sediments (substrate). This criteria is very important in the areas of intensive trawling, damping and sediment extraction places; in all are areas where physical changes of the sea-floor can have a direct impact onto bottom biotopes.

Physical environment of the sea-floor also could be described by relief and sediments. These features together with hydrologic conditions determine the structure of biotopes. 4 types of substrates could be defined: 1) soft substrate – fine sand and mud (size of particles < 2mm), 2) gravel substrate – gravel and pebbles (size of particles from 2mm up to 256mm), 3) hard substrate – boulder, main rocks (particles size >256mm), 4) biogenic substrate - shelly ground (Ricea J., *et al.* 2012). In the Lithuanian Baltic Sea aquatory first three types of substrate are common: soft substrate – sand, silt and mud; gravel substrate – gravel, pebbles and different sand and hard substrate – boulders, moraine and clay. Soft substrate type is being formed by modern sediment and other substrate types – mostly by earlier geological periods and earlier Baltic Sea development stages. Because of changed sedimentation conditions and deposit material sources lythological composition of sea-floor deposits and limits of distribution of different sediments type could be changed. In the Lithuanian Baltic Sea bottom already there are areas of damped deposits. This shows that sea-floor is already affected by human activities. In Lithuanian aquatory activities that mostly affect changes of physical characteristic of the sea-floor are damping of dredged material of Klaipeda sea port, sand extraction for beach nourishment, and trawling by bottom trawls. There was no research of the trawling impact on the Lithuanian Baltic sea-floor conducted, so only areas where this activity is going on can be defined.

It is foreseen that in the future more intensive use of marine areas will have more impact on the sea-floor. There are plans to built an electricity cable from Sweden to Lithuania, reconstruction of Sventoji Sea port already begun, plans to build a new deepwater port and to develop the offshore wind energy are considered. So identification of sea-floor areas impacted by human activities is one of the objectives of evaluation of good marine environment status. For the evaluation of the Good Environmental Status identification of changes of areas of lythological types of deposit could be used.

Evaluation of changes of hydrodynamic conditions is also very important for Lithuanian aquatory. Klaipeda state sea port is situated in the Klaipeda straight which connects Curonian lagoon with Baltic Sea. Deepening of the port impacts the hydrological conditions and water exchange between freshwater Curonian lagoon and saline Baltic Sea.

Development of the port impacts changes of hydrological conditions and sediment transport, and also coastal dynamics. More and more saline water comes into the freshwater Curonian lagoon because of the deepening of Klaipeda state sea port. Increasing the depth, reconstructing and building new hydrotechnical equipment the distribution of water outgoing from Klaipeda straight is changing. Changed hydrological conditions can affect all ecological situations.

Developing the port new breakwaters are build, entrance channel is deepened. This affects the dynamic of waves and currents, sediment transport and state of coast. Tendencies of coastal dynamic were changed by reconstruction of port breakwaters and deepening of port entrance channel. Before the reconstruction of the port breakwaters beaches situated close to the port entrance was stable, and recently they are eroded. Opposite tendencies are on the coast of Curonian Spit – after the reconstruction of breakwaters accumulation of the sediments started and the beach widened. No threshold values are set for the hydrological parameters. Collection and analysis of data are necessary, highlighting tendencies of extreme occasions. Coastal conditions could be assessed by monitoring changes of coastline position and sand volume on the beach.

Identification of activities impacting the sea-floor integrity, defining sea bottom areas which are already under the pressure of on-going human activities will serve as a basis for preparation of the programme of environmental measures which could help to achieve or maintain good environmental status in the marine environment.

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CLIMATE CHANGE ADAPTATION IN COASTAL TOURISM – NETWORKING TOWARDS THE UNKNOWN.

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In many European regions, coastal areas provide attractive tourism destinations. Together with natural and cultural resources, climate is one of the most important factors for their attractiveness. As a consequence, coastal tourism is highly sensitive to prospective climate changes. Baltic coasts are no exception to this. Possible direct climate impacts for the region include changes in air temperature and precipitation patterns as well as erosion processes and flooding due to sea level rise, and an increased frequency or amplitude of extreme events. Secondary impacts caused by changes in salinity or water temperature could affect the stability of coastal ecosystems and the quality of coastal bathing waters in a negative way. Induced impacts such as shifts in tourism travel patterns or overall economic and financial developments will also have its influence on the coastal tourism sector. However, a concrete level or dimension of the impacts as well as a specific regional scaling cannot be projected and might never be. For the tourism sector, this poses a substantial problem as planning horizons are with 5-10 years rather short given the fact that climate projections often refer to 2050 or 2100. Uncertainty is a common feeling with regional coastal tourism stakeholders and up to now hinders pro-active and strategic climate adaptation actions of the sector. If action is not yet regarded necessary as impacts still seem to be far away, what can be done to adequately prepare the sector for future climate changes and for the at any rate resulting necessity of adaptation? Does the communication of climate adaptation possibly need 'covering fire' from another future-oriented idea – the idea of sustainability?

In recent years, the idea of sustainable development has gained ground amongst tourism destinations along the German Baltic coast. With accepting nature and coastal environment as the region's major touristic resources, sustainability is ascribed an increasing role in long-term planning processes. Including the challenge of climate change adaptation into evolving sustainability strategies will add an important dimension to them. Initiating a local exchange on experiences and best-practice can be a successful method to start the exploration of the topic and to further regional cooperation on it. Sensitising coastal tourism stakeholders for possible future challenges might therefore not just be the very first but rather one of the most important steps towards successful sectoral adaptation. Approaches at the German Baltic coast showed that co-operative relationships with regional tourism networks are a promising way to gain access to regional decision makers. Established networks form important for a to internally discuss the vulnerability of the destination as well as potential risks and chances for tourism due to a changing climate, and they provide adequate communication channels. To support sustainability and adaptation strategies, they should be provided with the necessary level of information for strategic planning. Up-to-date scientific facts can be provided by scientific institutions but should be downscaled and translated into comprehensible sector relevant information by intermediaries, such as NGOs.

With respect to possible future climate impacts, keeping one watchful eye open will be the minimum action that regional coastal tourism stakeholders should commit themselves to at present. However, the visibility of a sustainable development strategy and a pro-active approach towards the challenges of altered climatic conditions may even be of advantage for future marketing campaigns. Due to the rising awareness of sustainability as a lifestyle and consequently the growing demand for sustainable products in Western societies there might be a potential for the topic to become a unique selling proposition. As tourism works highly competitive, those who participate actively in topical networks might be ahead by a nose when preparing their destinations with an adaptive strategy for an unknown future. Our presentation focuses on experiences with applied methods for communicating relevant climate impacts to one the study region's main economic branches: coastal tourism. The experiences cover national and pan-European projects, in particular RADOST (http://www.klimzug-radost.de/) and baltadapt (http://www.baltadapt.eu/).

INTERANNUAL EVALUATION OF MARINE RECREATIONAL WATER QUALITY BASED ON CLIMATIC FACTORS

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In recent years there has been an increased public awareness and concern regarding the pollution of coastal waters, particularly where the waters have become increasingly used as receiving waters for the discharge of domestic effluents, industrial by-products, agricultural run-off and urban drainage. Although the discharge of point source pollution has now been generally controlled and minimized within the EU and many other developed countries, the control of diffuse effluents is still difficult to manage, and such discharges can pose a significant threat to coastal waters.

Antalya is an important and vulnerable tourism centre on the Mediterranean Coast with its perfect climate, historical and natural beauties. In this study, the effects of climatic factors, population and tourism activities to microbiological sea water quality were researched in Antalya. For this evaluation, climatic factors, population growth, tourism potential and microbiological sea water analysis results were obtained from Turkish State Meteorological Service, Turkish Statistical Institute and Blue Flag Organization. Then the relationship between these parameters and microbiological quality is investigated. The increase in microbiological pollution of sea water was examined for a ten year period. As a result, a general increase in indicator bacteria level was seen. Although climatic factors affect sea water quality, the most important impacts to pollution is population and excess usage. Because of importance of coastal tourism in Antalya, sustainable usage of coastal areas must be provided. In addition, management of these areas has to be taken into consideration and pollution prevention strategies should be determined.

Methods

Seawater samples for indicator bacteria analysis were collected from Antalya coastline, amongst April and October months fortnightly from 2001 to 2010 years. Samples were collected and measured at more than 18 stations in the study site. Water samples were collected 30 cm below surface in inverted sterile bottles on the windward side of boat and kept in ice boxes in the dark before filtration. Water samples were taken during the official batting season. Total (m-Endo media) and Fecal Coliform (m-FC medium), and Fecal Streptococci (Azid medium) determined by membrane filtration technique. Wind speed and direction, and rainfall data were taken from Department of Meteorology, Ministry of Forest and Environment.

Conclusion

We used five years (2001-2010) of rainfall, wind speed and direction, and population data to assess indicator microorganism levels in Antalya Bay. Positive relationship were observed between and indicator bacteria rainfall and population density, whereas inverse relationship observed with wind speed and all variable. Because of indicator bacteria correlates with increased human illness and pathogen levels within water column should be documented to determine human and animal population on the beach. The mean concentrations of microbial indicators in Antalya bay were below guidelines levels during the five years but it also FC and FS showed hyperbolically trend an increase.

SEAFARE : WORKING TOWARDS A MORE SUSTAINABLE FUTURE FOR AQUACULTURE

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The aquaculture industry is an important contributor to economic well-being, particularly in rural peripheral areas of the Atlantic Area. Aquaculture is developing in line with the EU's commitment to high levels of environmental protection and complying with legislation that is based on the precautionary principle. Stringent EU regulations generate competition from other world regions, such as Asia and Latin America. For the past decade, the EU aquaculture sector has stagnated, a situation that is in stark contrast to global growth. In order to increase the EU aquaculture industry's growth it is essential that the industry resolves a number of issues relating to sustainability and legislative issues. Both these issues represent significant bottlenecks which need to be overcome.
Sustainable development in coastal and marine areas involves the promotion of economic development that does not pose a threat to our natural heritage. This reflects the basic fact that human activity cannot be allowed to proceed at the expense of natural ecosystems. While aquaculture developments bring welcome economic and social benefits, associated pollution and other negative ecological impacts are a valid cause for concern. The aquaculture industry has managed to reduce its dependence on medicines and disinfectants to treat fish diseases and has improved the efficiency of diets and feed systems which has reduced the release of nutrients and other chemicals into the environment. However, there is still plenty of room for improvement and the need to promote sustainable aquaculture practices is as great as ever.

The SEAFARE project is addressing the potentially negative impacts of aquaculture by developing and promoting environmentally sustainable technologies. In response to the urgent need to increase the sustainability of the aquaculture industry, SEAFARE is designing and providing tools to SMEs and public authorities to help them implement sustainable and environmental friendly aquaculture practices. The SEAFARE project is strengthening the links between researchers and industry, and influencing policy development at regional and national levels. The project is delivering innovative solutions for coastal zone management and the protection of habitats by contributing to the sustainable management of economic activity.

The main objectives of the project are (1) to promote diversification of the aquaculture industry by providing a greater range of species and alternative production systems, (2) to protect sensitive coastal environments through the development of novel integrated farming systems in sensitive wetland habitats and to minimise impacts of aquaculture discharges through the use of wetlands as natural biofilters, and (3) to assess the dangers associated with introduced aquaculture species using Pacific Oysters as a model.

(1) Promoting diversification of the aquaculture industry by providing a greater range of species and alternative production systems.

To achieve this objective, SEAFARE is (i) determining the usefulness of genetically selected strains to contribute to sustaining European flat oyster (*Ostrea edulis*) and sea bream (*Diplodus*) populations along the Atlantic Cost of Europe, (ii) assessing the physiology of growth performance of alternative ingredients to develop diets to maximise production of bream species (*Diplodus*), (iii) developing systems for microalgal biomass production for aquaculture feed by assessing new microalgal properties for fish larval development, and (iv) using technology to conserve and restore threatened species by developing rearing protocols for different life stages of the European smelt (*Osmerus eperlanus*).

(2) Protecting sensitive coastal environments through the development of novel integrated farming systems in sensitive wetland habitats and minimising impacts of aquaculture discharges through the use of wetlands as natural biofilters

The restoration of wetlands for sustainable exploitation began with the development of techniques to help optimise the ecosystem functions of wetlands and combining these with economically beneficial farming practices. A model for zero-discharge fish production systems that can be integrated with wetland rehabilitation for ecological and economic sustainability has been tested. As has a model for developing extensive production of marine fish in constructed wetland lagoon systems. The SEAFARE project has optimised periphyton-based nursery systems for marine fish in wetland lagoons by testing the contribution of periphyton to nutrition, growth, and quality of fish using different substrates within replicate enclosures. The project constructed wetlands using the halophytic plant Salicornia as a sink for nitrogenous waste and conducted experimental production of polychaetes and shrimp to assess their feasibility as secondary production in integrated pond systems.

(3) Assessing the dangers associated with introduced aquaculture species using Pacific Oysters as a model

The partners started by surveying key sites along the coasts of Portugal, Spain, France, the United Kingdom and Ireland for the presence of naturalised populations and then went on to assess the abundance and temporal dynamics of Pacific oysters (*Crassostrea gigas*) in selected populations. The SEAFARE project has sampled naturalised and aquacultured Pacific oysters for genetic analysis and investigated the ecological impact of naturalised Pacific oyster populations on native marine communities. The last stage of the SEAFARE project involves the exploration of the biological and physical factors affecting the rate of range extension of naturalised populations and the study of temporal variation in annual spatfall and recruitment at selected sites using molecular genetic markers. By comparing growth and physiological performances between northern and southern naturalised populations, the partners will be able to test for local adaptation and in a concluding step they will propose management strategies to minimise the ecological and economic impact of the naturalisation of Pacific oysters.

The SEAFARE project addresses important issues about conducting sustainable aquaculture. The knowledge generated by the project will be transferred to the private sector and to other stakeholders (i.e. coastal policy makers, conservationists etc.). The SEAFARE project is dedicated to solving specific problems within industry and delivering workable solutions to achieve a more sustainable future for aquaculture.

THE SAND ENGINE – A SUSTAINABLE COASTAL APPENDIX

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What is the Sand Engine

The Sand Engine is an innovative pilot project aimed at protecting the Dutch sandy shores. Along the Delfland coast of the province South Holland, a mega nourishment has taken place, creating a large hook shaped barrier above water perpendicular to the Dutch coast. This peninsula is 128 hectares large and consists of 25 million m^3 sand and is an alternative to the common Dutch technique of coastal protection by underwater foreshore nourishment each 5 years. By using natural tidal and wave action, the sand is being distributed along the adjacent coast. Thereby the Sand Engine works according to the principles of 'Building with Nature'. This principle aims at developing sustainable ways of ecologically sustainable coastal zone management in combination with economic profitability.

Goals monitoring

Due to the unique and experimental character of this project, it is the aim to scout the effects of the Sand Engine on its direct surroundings. To closely follow the natural development of the Sand Engine and the near-field effects, a monitoring and evaluation program was developed for at least the next 5 years. This program is currently being carried out in a consortium of various research institutes and consultancy organizations.

The creation of the Sand Engine has four main goals:

1. Stimulating natural growth of dunes in the coastal area of Hook of Holland to Scheveningen for safety, natural and recreational purposes.
2. Generating knowledge and innovation to assess the additional natural and recreational value of this method of coastal protection.
3. Adding an attractive recreational and natural area to the Delfland coast.
4. Collecting enough and adequate information to properly manage the Sand Engine and its surroundings.

Why monitoring the Sand Engine?

Goal of collecting Sand Engine data is to learn about the functionality of mega nourishments in general, to explore the opportunities for future projects.

Creating a large sand barrier perpendicular to a concave coastline will strongly change local currents and wave action, and result in a transport of sand from the Sand Engine along the coast. This is expected to enhance coastal protection. The Sand Engine has been designed to slowly move in northern direction, with in its centre a sheltered lagoon that will eventually be filled up by sand due to wind, waves and current. Thereby the two most important subjects of research are the speed of change and the effect range of the Sand Engine.

As a result of this moving sand barrier, natural habitats and processes in the local area change dramatically. This may also occur in the dunes. The Sand Engine area already is a regular home to shorebirds and common seals. In the early life of the lagoon, a harbor porpoise has been sighted. The lagoon and the sheltered area of the hook are also expected to be an interesting area for benthos and juvenile fish (nursery function). On the Sand Engine itself dune forming may take place, and it is expected that the increased aerial sand transport influences dune morphodynamics and the development of vegetation.

For the dunes all data will be analysed to answer the central question: "Does the Sand Engine affect protected nature in the Solleveld dune area in a negative way and can these possible effects be prevented or mitigated?" In the existing dunes effects are expected from an increase in sand deposit, whereas salt spray will probably decrease. This can lead to changes in the delicate dune habitats, which are protected by the Habitat Directive (European legislation).

What do we monitor about the Sand Engine?

Data are collected from measurements on local hydrodynamics, morphological developments of the foreshore, the beach and the dunes, including the Sand Engine itself. Data of the changes in vegetation and fauna, both under water and on the beach and dunes is collected. Where is the erosion most severe? And where is the sand deposited? How does the wild life react? What is the effect on the sea bottom? Will there be more or less foraging biotopes? Will the lagoon act as a nursery? But also: are there more possibilities for recreation?

Data is stored in an especially for this project designed data management system, able to cope with data from different sources and making it available for analysis and evaluation.

Next to the hydrological, morphological and ecological developments, also changes in groundwater level and quality and recreational use of the area is followed.

The dunes further inland contain precious vegetation and wild life. It is protected via Natura 2000, the European network of nature preservations. Even though it is thought that the Sand Engine is a sustainable way of protecting the coast, with unique beach nature and beach processes as a result, deterioration of nature elsewhere is unwanted. Therefore the dune area monitoring contains morphological and ecological parameters, such as sand dynamics, wind energy, salt spray, sand spray, the increase of ground water influences, change in vegetation, habitat development and breeding birds. We study these parameters to decide in five years what kind of effect results from the Sand Engine. To learn more about the ecological and geomorphological processes and to evaluate if mega-nourishments are a good as sustainable solution to protect coast lines from eroding. But also for knowing if we should protect vulnerable dune nature against artificial impacts.

What do the parameters tell about the Sand Engine?

The monitoring and evaluation program is directed at answering to what extent the goals above will be reached. With the formulation of such abstract goals, it is of importance that the studies are focused at answering more specific hypotheses. This problem analysis has been carried out to large extent before commencement of the monitoring. The power of the data to give these answers is largely influenced by the spatial and temporal planning of the monitoring operation. However, the power of a sampling scheme is not easy to assess when the variability of the system under scrutiny is not well known.

From start on, the available budget was too limited for applying the desired monitoring scheme. Currently, the emphasis lies on monitoring of hydro dynamical and morphological changes and less on ecological changes. Recently, the program has received additional European funding to increase the quality of monitoring. The Technical University of Delft also has received funding, which will be used to study morphological changes along the coastal area around the Sand Engine. Lastly, a consortium of universities and research institutes have tendered for a project that, if funded, will start a large project studying the natural changes of the Sand Engine in more detail.

How well the monitoring and research programs are able to answer to what extent the above goals will be reached is unknown. There are no clear criteria formulated for where and when such abstract goals are reached. This is a process that can only be started when data become available. Adaptive monitoring may be needed when circumstances change or when the data appear not the give the expected answers. The additionally obtained funding will be able to pay for a certain level of adaptation in monitoring and of evaluation.

After one year, monitoring showed already obvious changes to the morphology of the Sand Engine; the speed of movement along the coast to the North is dramatic. It is hard to estimate the life expectance of this barrier, but it appears to be shorter than expected.

COASTAL COMMUNITIES 2150: BUILDING RESILIENCE & REDUCING VULNERABILTY THROUGH COMMUNITY ENGAGEMENT

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Introduction

Climate change is expected to affect coastal communities globally over the coming century. Sea Level Rise (SLR), although only one part of climate change science, will be one of the greatest consequences seen at the coastal zone, with increasing flood risk, coastal erosion and saline intrusion posing a host of socioeconomic and environmental pressures. The successful integration of the natural, physical, social and economic processes occurring at the coast will be a major challenge (Nicholls and Branson, 1998) and will be key to ensuring the sustainable management of coastal systems. Gaining public support for climate change adaptation policy depends on a clear understanding of how people process information and make decisions (Center for Research on Environmental Decisions, 2009) this equally applies to any future alteration to current shoreline management practice.
Coastal Communities 2150 (CC2150) is a three year €2.9million communications project, co-funded by the INTERREG IV A Two Seas Programme, engaging and helping vulnerable communities who are at long term risk from coastal climate change. The project is a partnership between Hampshire County Council (UK), Kent County Council (UK), Alterra (part of Stichting Dienst Landbouwkundig Onderzoek, the Netherlands), the Province for West Vlaanderen/Coordination centre for ICZM (Belgium), the Agency of Coastal Maritime Services – Coastal Division (Belgium), and the lead partner, the Environment Agency (UK). The project has been extremely well received by the chosen priority communities and has been strongly supported by INTERREG programme.

Coastal Resistance, Vulnerability, & Resilience

Whilst there has been increasing progress towards more sustainable shoreline management over the last decade or so, and more specifically in the UK through the recent second round of Shoreline Management Plans (2010), there is still public pressure towards maintaining the perceived status quo at the coast. This attitude conflicts with some of the ongoing changes in policy concerning erosion and flooding and in effect reduces coastal resilience by influencing political process in favour of established protection policies which hold the line; many of which are not economically or environmentally sustainable in the long term. This attitude was identified as a problem by Leafe et al in 1998 and is a problem that still persists now, some 13 years on.

Coastal systems and communities in Europe can be viewed as less vulnerable to climate change and SLR than other global regions, given that socioeconomic vulnerability is determined by impact potential and society's technical, institutional, economic and cultural ability to prevent or cope or adapt to risk (Klein et al 1998). There is however a pressing need to redress the balance between the protection of people and the economy against the costs of degradation to the coastal environment. The process of increasing coastal protection has arguably increased the resistance of the coastal system at the expense of resilience (Klein and Nicholls 1999). Methods aimed at reducing the physical risk of flooding and erosion in the longer term may increase the vulnerability of populations to such events in the future. Vulnerability therefore, is registered not by exposure to hazards and risk alone; it also resides in the resilience of the system experiencing the hazard (Turner et al 2003). Resilience in its original form is the capacity of a system to maintain itself despite a disturbance (Holling 1973, 1986). Human systems are naturally resilient and, despite the uncertainty surrounding the rate and extent of sea level rise and the inherent difficulty this poses for decision and policy makers, we can be fairly certain that communities will adapt to them through necessity. However the amount of disturbance can be managed, in human terms, in order to reduce the overall loss and to embrace the disturbance as an opportunity for positive change.

Tompkins and Adger (2004) outline that building resilience into human-environment systems is an effective way to cope with change characterized by future surprises or unknowable risk. Understanding how to reduce social and natural vulnerability to climate change and sea level rise, by building resilience, then becomes an exercise in adaptation planning. (Dolan and Walker 2004).

The CC2150 Project

Resistance, resilience and vulnerability were once concepts related more to philosophy than with devising real solutions to the problems of coastal systems (Stratton, 2006) however, over the past five to ten years there has been a notable filtering down of the concepts from academia into policy. The CC2150 project is one such example that looks forward to the year 2150 and aims to help communities increase their understanding of how long term climate change will affect the coast line they live on and how they can adapt to these changes. Through engagement, the CC2150 project aims to reduce the vulnerability of coastal communities by building their long term resilience to future coastal change. The year 2150 was chosen because it encourages people not to focus wholly on the short term issues without being so far in the future that they cannot relate to the time frame.

Berkes (2007) outlines the four clusters of factors relevant to building resilience, all of which underpin the thinking behind the CC2150 project. These are (1) learning to live with change and uncertainty, (2) nurturing various types of ecological, social and political diversity for increasing options and reducing risks, (3) increasing the range of knowledge for learning and problem solving, and (4) creating opportunities for self organisation, including strengthening of local institutions and building cross scale linkages and problem solving networks.
Set in a European context the CC2150 project takes a strategic cross border approach and looks at the issue of SLR from within a variety of political frameworks where the historical evolution of coastal management has been influenced by different culture, society and economics.
Each partner has established their own community engagement groups building in careful consideration of the social and physical barriers to engagement on climate change issues (Sutton, 2012). They will develop and test a suite of new communication tools, chosen in consultation with their local communities, that will increase awareness of coastal climate change and the economic, environmental and social sustainability of the shoreline management options available in the future. From this position of knowledge communities will develop their own long term coastal visions and adaptation plans. CC2150 partners will learn from each other's pilot communities and use this to improve integrated working and how they plan for coastal climate change issues at a local, regional and national level. Experience and best practice will be shared at the end of the INTERREG funded project with the hope that the lessons learnt and communication toolkits will be transferable and used beyond the life of the project funding.

Conclusions

It is clear that decisions about future coastal management options concerning SLR and its implications cannot easily proceed without a strong grounding in coastal climate change science and equally decisions regarding mitigation and adaptation by government institutions and society, cannot easily move forward without a sound understanding of social values. CC2150 is a genuinely interdisciplinary project aiming to bring together the natural and social sciences. Future coastal management in the face of SLR will ultimately and unsurprisingly be governed by the degree and speed of changes seen to relative sea level and any alterations to extreme weather such as storm surges. Hopefully though, as a result of the CC2150 project, it will also be influenced by an increased understanding of coastal climate change and SLR within the CC2150 priority coastal communities. This will involve not only the consideration of how SLR effects communities physically, socially and economically but also how the choices communities make in terms of adaptation will affect the natural system and its resilience, and ultimately then the long term vulnerability of coastal communities.

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SUSTAINABLE COASTAL AND SMALL ISLANDS DEVELOPMENT: A PERSPECTIVE FOR COASTAL TOURISM IN INDONESIA

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Indonesian Archipelago has the key characteristics of a country with long coastline and thousands small islands with diverse coastal and marine resources and long maritime history and culture as well. Natural and cultural resource potential in the coastal and small island areas in Indonesia can potentially be developed into resource-based economic activity such as tourism and fisheries. The opportunities and challenges of coastal and small islands development in Indonesia are applying the principles of sustainable development that can provide optimum benefits for the communities while minimizing undesirable ecological and socio-economic impacts to the coastal and small islands resources. Increasing environmental degradation in coastal and small islands due to natural and anthropogenic factors presents threats to the sustainability of coastal and small island resources. The climate change phenomena further increase the threat to coastal and small island areas. Therefore, more concern is needed for the development and management of coastal and small island areas in Indonesia to ensure its sustainability and to appropriately use its potentials. This paper will first explain a general overview of coastal and small island areas in Indonesia and their resource potential in the context of coastal tourism development. The authors then look at the strategy of coastal and small islands development and the management policy of coastal and small island areas in Indonesia. This paper will conclude by discussing ecosystem approach for coastal and small islands management in as a perspective for coastal tourism planning and development in Indonesia.

ON THE APPLICABILITY OF EMPIRICAL FORMULAE FOR SALIENTS TO SOUTH SARDINIA (ITALY) BEACHES

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Most commonly an offshore obstacle, such as a reef or breakwater, creates a salient of sediment deposition in its lee. While considerable work has been done on shoreline response to breakwaters along the Mediterranean coasts, the effects of natural obstacles, both submerged structures and emergent reefs or islands, have not been systematically investigated yet. Nowadays, the performance of coastal area morphological models has not reached a level high enough to yield a reliable prediction of long-term (months to decades) shoreline evolution, especially where bathymetry and evolving dynamic is complex as in the lee of a natural obstacle. In reference to that, additional use of empirical predictive formulae can be seen as complimentary tools that could lead to preliminary reliable results to respect to the shoreline evolution of a salient.

Black and Andrews (2001) defined empirical relationships to describe the morphology of salient and their geometry as a function of position and size of reefs and islands by visually inspecting aerial photographs of the coastlines of south eastern Australia and New Zeeland and without taking into account the variations in wave climates on different beaches. In their paper, Black and Andrews highlighted the need of further investigation of the effects of reef depth, reef width and reef morphological complexity in the context of local wave climates. Headland-bay beaches in static equilibrium are the most stable landform under persistent swell and can be predicted empirically using the wave direction alone (Hsu and Evans, 1989). The parabolic quation (Hsu and Evans, 1989) has received recognition in the new Coastal Engineering Manual to calculate the ideal static equilibrium shoreline of a headland-bay beach. The parabolic equation has been also applied to salients in the lee of offshore emergent breakwaters and island To avoid a manual tedious application of the parabolic model, the MEPBAY software package was developed that significantly reduces the computational time needed for practical applications (Klein et al., 2003).

Within a broader research program funded by the Sardinia Government on coastal erosion, the Department of Civil and Environmental Engineering and Architecture at the University of Cagliari (Sardinia, Italy) has been verifying the validity in the Sardinia coastlines of formulae for salient description from the Black and Andrews' study and of the parabolic equation.

All the shoreline positions were collected in field surveys by walking the length of the beaches using a Real-Time Kinematic Global Positioning System (RTK GPS). Salients appear as an smooth and regular departure from the existing natural shoreline and sometimes it was difficult to define where the shoreline adjustment begins to diverge from the undisturbed shorelines. Through the standard definition for the main geometrical properties of the salients proposed by Atzeni and Sulis (2009), geometrical properties of the salients were collected. Figure 1 shows the application of the standard definition sketch to Tuerredda beach (latitude φ=38°53'40''N; longitude λ= 8°48'47''E).

The main geometrical properties of the salients were compared to Black and Andrews relationship that predict amplitude (Y) and basal width (D) of the salient from non-dimensional variables (S-Y)/B and S/B. Results from the 8 salients were found to be in good agreement with results by Black and Andrews in the coastlines of south eastern Australia and New Zeeland. Then, the condition of salient stability was assessed through the MEPBAY software that allows a user to automatically trace static equilibrium profile (SEP). The SEP were found to be a good approximation of the salient planforms with maximum errors significantly lower than previous applications of SEP to headland-bay beaches along the western Mediterranean coast.

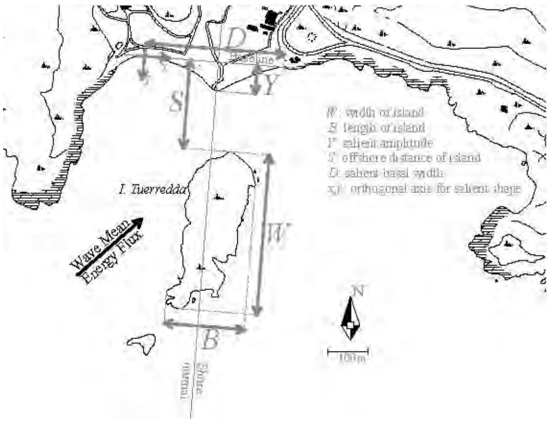

Figure 1. Standard definition sketch of geometrical properties of salients at Tuerredda beach

Figure 2. Application of MEPBAY to SEP at Sa Mesa Longa beach

Results suggest that this assessment of natural stability should be the first step in any proposal for man-made utilization of beaches that include these fragile morphologies, in order to avoid or minimize possible negative environmental impacts.

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BEACH MULTI-HAZARD ASSESSMENT AND MAPPING FOR RISK MITIGATION AND SUSTAINABLE RESPONSES

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Beaches are often the basis of economic and social development, especially when tourism activities are considered, but they are also among the most dynamic and exposed systems in the coastal zone. This exposure is related to the local conditioning and triggering factors such as waves, tides, sediment size, morphology and planimetric shape of the beach system that can promote dramatic morphological changes and/or flooding during extreme events. Every year changes associated with beach planimetric retreat due to profile volume loss and marine flooding through overwash endanger people and property and therefore have a socio-economic impact on local communities. It must be stressed that this type of coastal systems have resilient properties even if the impacts of storms are considered, but this common characteristic hardly means a significant protection to local communities when extreme events are considered.

Due to the multi-hazard nature of beach systems and its close relations to the often dense human territorial occupation it is necessary to establish assessment frameworks that can evaluate coastal communities exposure to the local types of coastal hazards. As in most exposed coasts, beach specific hazards are directly dependent on wave climate and wave power among other variables and coast line recession and inland flooding due to wave overwash are among the most frequent events with destructive potential.

This research proposes two indexes that can express the local beach susceptibility to erosion and to marine inland flooding due to extreme storm events. These indexes are builded, calculated and mapped using field data and model predictions and have the objective to provide a tool for accurate coastal risk mitigation and sustainable responses preparedness.

The flooding potential index (*fpi*) and the erosion potential index (*epi*)(Trindade, 2010) were applied and tested in three beach systems in the west coast of Portugal (NW of Lisbon), the S^{ta}. Rita beach (a composite beach-dune/beach-cliff embayed system), the Azul beach (a large beach-dune system) and the Foz do Lizandro beach (a small beach-dune system). This wave dominated stretch of coast is a high energetic coastal environment with winter offshore mean significant wave height reaching 2,5m. Storms are frequent and beach erosion is a common phenomena. (Pita e Santos, 1989; Costa, 1994; Gama et al., 1994).

The *fpi*represents a predicted extreme water level attainable in a 100 year storm wave height return period and depends on incident wave parameters, mean spring tide heights (*MST*), storm surge heights (SS_{max}) and runup levels ($R_{2\%}$, Stockdon*et al.* (2006) (eq. 1). The state of the beach profile previous to the storm occurrence is carefully taken into account by considering a near reflective ($_{tan\beta\ max}$) and a dissipative ($_{tan\beta\ min}$) starting profiles.

$$fpi_{tan\beta\ min}^{tan\beta\ max} = 0m\ (msl) + MST + SS_{max} + R_{2\%} \qquad \text{eq. 1}$$

The *epi*is representative of extreme beach profile retreat due to de same type of storm event considered in the determination of the *fpi*. It is calculated and mapped as a result of the beach profile extreme response empirical modelling. Results include local model calibration and validation with high accurate beach profile data.

Flooding and erosion susceptibility mapping is used to accurately predict extreme storm impact on local coastal systems and communities that rely on coastal resources.

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PLASTIC WASTE IN THE BELGIAN COASTAL WATERSAND MARINE INVERTEBRATE WILDLIFE

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In recent years, the numerous reports about the Great Pacific Garbage Patch have raised the concern about marine litter. Some types of marine debris, notably plastics, are known to degrade very slowly and as a consequence they remain in the marine environment for a long time. This waste affects the marine ecosystem in several ways, e.g. by entanglement of wildlife or ingestion of plastics by seabirds. Another issue is that, due to the impact of currents, waves and UV radiation larger parts of plastic debris eventually break down to smaller particles known as microplastics (< 1mm).

The occurrence of these microplastics has recently been receiving increased attention. Moreover, laboratory experiments have shown that various marine organisms can ingest these microscopic particles. Microplastics smaller than 10µm were even shown to translocate from the gut cavity to the circulatory systems of mussels (*Mytilus edulis*) (Browne et al., 2008). However, in all these experiments the exposure concentrations were over a thousand times higher than any concentration observed in the field. As such it is difficult to assess the relevance (and the potential associated risk of adverse effects) of these laboratory observations for organisms living in natural marine environments.

In a unique research effort, we monitored marine litter in the Belgian coastal ecosystem in three environmental compartments: the beach, the seafloor and the sea surface. Macro debris was monitored at four different types of beach (natural or touristic, prone to sedimentation or erosion) on a 100m stretch of beach. For the seafloor, macro debris was collected using a beam trawl, whilefloating debris was collected with a neuston net, by dragging it for 1km.

The degradation product of the plastic litter, i.e. microplastic, was also monitored in these environmental compartments. Sediment for microplastic analysis was collected from the upper sand layer of the beach (5cm) with a shovel, and from the seafloor with a Van Veen grab. The microplastics were extracted from these sediment samples using elutriation followed by a sodium iodide (NaI) extraction, in order to separate the lighter plastic particles from the heavier particles. Microplastic concentrations in the sea surface water were analysed in 10 L samples by means of filtration and a NaI extraction on the settled particles.

Assessment of the presence and the concentrations of microplastics in marine invertebrate species, collected in the field, was performed on the blue mussel *Mytilus edulis* and the lugworm *Arenicola marina*. Both species represent different feeding strategies (filter feeders vs. deposit feeders) in different marine compartments (water column vs. sediment). Collected organisms underwent an acid (HNO_3) digestion procedure to extract the microplastics from the soft tissues.

On the beaches, the quantity of macroplastics found ranged from 0.5kg.km^{-1} to more than 50kg.km^{-1}. In terms of number of objects found, industrial pellets were very abundant at some sites, i.e. up to 92% of all plastics collected on the beaches. The seafloor monitoring revealed the presence of roughly 1,600 to 8,500 items per km². On the sea surface, between1 and26 plastic objects were found per sampled km (i.e. on average 3950items.km^{-2}). Expressed in mass units, this amounts to a range of 0.1kg.km^{-2}to 1kg.km² on the seafloor and at the sea surface from 0.0004kg.km^{-2}to 3.86kg.km^{-2}.

Concerning microplastics, we observed approximately 23kg.km^{-2} in the sediment of beaches (Claessens et al., 2011) and the seafloor and 7kg.km^{-2} in the water column.

Analysis of acid digested mussels and lugworms showed that – at every sampling location - all tissue samples contained microplastic particles. Before digestion, mussels and lugworms underwent a clearance period of minimal 24 hours, in order to allow them to clear their gut. In this way, all microplastics observed originate from the tissue and not from the gut. Tissue concentrations for mussels were around 2 particles.gram^{-1} of tissue. Lugworms contained only slightly higher concentrations: 3 particles.gram^{-1} of tissue. As expected, these tissue concentrations are low compared to the concentrations present in the environment: water contained about 10 particles.l^{-1} and beach sediment 34 particles.kg^{-1} sediment. Although the units are clearly different, these data can be used to illustrate the difference between the environmental and tissue concentrations. The exposure of both species to microplastics varies considerably. When taking into account the filtration rate of mussels (approximately 2L.h^{-1} (Clausen & Riisgàrd, 1996)) and the sediment throughput rate of lugworms (4.7 – 80 cm^3 per day (Cadée, 1976)), mussels are daily exposed to over 60 times more microplastics than lugworms. However, microplastic concentrations in lugworm tissue are higher. While *A. marina* is a non-selective feeder, ingesting sediment in order to feed on the organic fraction, *M. edulis* is a selective filterfeeder, only ingesting algae and particles of the appropriate size and shape. So even though mussels are exposed to a higher number of particles only part of those will be ingested while particles of inappropriate size and shape will be rejected within the pseudofaeces.

In conclusion, this first monitoring exercise of macro- and microplastics in the Belgian coastal zone revealed that macroplastics are mainly found on the beach. In terms of total plastic mass in the water column and in the sediment, microplastics represent a much larger quantity of plastic than the macro debris. Also, the use of field organisms allowed, for the first time, the assessment of the transfer of microplastics from the environmental compartments to the marine life inhabiting these matrixes. Hence, these microplastics should not be neglected in the environmental health assessment of the marine ecosystems.

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POSTER PRESENTATIONS: Nature conservation

APPLICATION OF CELLULAR MODEL TO EL FANGAR DUNE SYSTEM DYNAMICS

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The littoral dunes have importance into an ecological and natural coastal defense point of view. Characteristics of El Fangar (the North hemidelta of Ebro river,Tarragona, Spain) dune ecosystems are conditioned by sedimentary dynamics and these are mostly determined by wind field and sediment properties. This ecosystem provides a nesting place for birds which colonizes the dune field in the spring and summer seasons (Rodríguez-Santalla et al., 2009). The dune field surveying is an important methodology in order to assess if a dune field is increasing or decreasing its volume so it is a good net sediment budget estimator (Andrews et al., 2002; Anthony et al., 2006; Saye et al., 2005; Sánchez-García, 2008; Sánchez-García et al., 2007). When the dunes behaves as aeolian sediment sinks (p.e.foredunes), and the beach is the unique sediment source, it is quiet easy to establish the beach dune interaction. At El Fangar spit dune system, the active dunes behaves as aeolian sediment sinks and sources at the same time, trapping the sand from different sources and transferring it to the littoral drift. The dunes are also eroded by wave action. In this dynamic context, the dune system surveying and the net sediment budget estimated is not enough to characterize the interaction between sediment sources and sinks, being due using modeling alternatives that allow reproducing the dune dynamics and the estimation of sediment flows in and out and then, the evolution of the abiotic system.

Barrio-Parra et al. (2012) reviewed the actual dune dynamics models and concluded that the easiest way to model real dune field dynamics is the application of cellular models(Barchyn and Hugenholtz, 2011; de Castro, 1995; Katsuki and Kikuchi, 2011; Katsuki et al., 2011; Narteau et al., 2006; Nishimori and Tanaka, 2003; Werner, 1995). These models can be resumed in two main processes: saltation and avalanche. The saltation algorithm (Equations 1&2) consist in the movement of a sand height (q_s) in a Digital Elevation Model (DEM) array from a cell (erosion) and its deposition on a downwind cell at a saltation length (L_s) at each time step.The avalanche algorithm represents the slide down processes that occur when a repose angle is exceeded. Then the sand volume that produces an unstable slope in the highest cell is reallocated to the nearest lowest cells in order to obtain a slope that not exceeds the repose angle.

$$h(x,y,t) \rightarrow h(x,y,t+1) - q_s \quad (1)$$

$$h(x+L_s,y,t) \rightarrow h(x+L_s,y,t+1)+q_s \quad (2)$$

The work presented here shows the results of the application of a cellular model to a surveyed area of El Fangar dune system in order to reproduce its morphological evolution and obtain the sediment input and output that generates the observed net sediment budget.

The cellular model had been developed based on the models reviewed by Barrio-Parra et al. (2012) and in the improvements needed for its application to El Fangar dune system mentioned in their text. The model is an *R Script*(R Development Core Team, 2011), freely available by demand, intended to its free use, improve and develop. It incorporates, as a novelty to the cellular models, algorithms that introduce wind data to estimate the variability of the sand flux with the dune height due to the shear stress changes produced in the windward dune profile by aerodynamic processes (Kroy et al., 2002a, 2002b) introducing q_s as a function of the initial height and the wind intensity on a level surface (Momiji and Warren, 2000). The wind data is also employed to evaluate if a cell is exposed to a wind (and susceptible to be eroded) or not due to its relative aspect to the incident wind. The speed up effect (Momiji and Warren, 2000)is introduced as a saltation length function of the dune height (Katsuki and Kikuchi, 2011; Katsuki et al., 2011) and as a function of the wind velocity components.

The aeolian sand flux and the transport threshold velocity are estimated by the measured sand flux-wind velocity correlation found bySánchez-García (2008) in the same site. The algorithm assumes that the saltation length is proportional to the number of times that the observed transport threshold velocity is exceeded. The variability of the sand flux with the dune height is described in Eq. 3. The speed up effect **(Momiji and Warren, 2000)** is introduced with the saltation length dependence with the dune height (Eq. 4)(Katsuki et al., 2011; Katsuki and Kikuchi, 2011). The terms *a* to *d* in equations 3 and 4 are call phenomenological variables (Katsuki et al., 2011) and are the object of calibration.

$$q_s=q\cdot(a+b\cdot h(x,y)) \quad (3)$$

$$L_s= l_0\cdot(c+d\cdot h(x,y)) \quad (4)$$

A small zone of El Fangar dune system was surveyed twice in 15th and 18th April 2012 using DGPS in order to obtain the initial and final stage of dune migration (**Fig 1**). During the survey high mobility of the dunes was observed associated to high wind intensity. The volumes difference between the surveyed DEMs yield a net sediment budget of 194 m^3. The wind direction and intensity data comes from a meteorological station located in the Port of L'Ampolla(about 6 km from the El Fangar dune field). These dataare freely available by the *Red deInstrumentosOceanográficos y Meteorológicos (XIOM) of Generalidad de Cataluña*. The data is provided for every 10 min. The mean wind conditions during the dune survey were 8 m/s speed and 283º North direction.

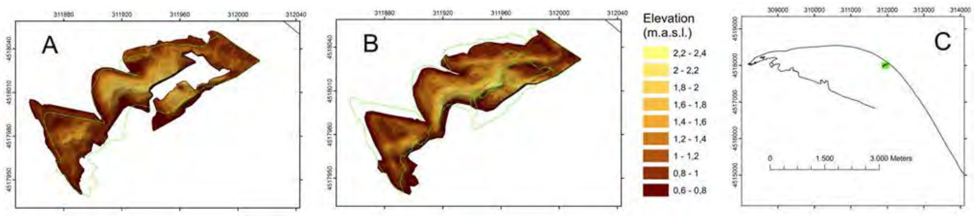

Fig 1. Surveyed dune initial (A) and final (B) states and its location in the North Hemidelta (C)

To assess the role and the sensibility of each model parameter on the morphology produced, a 5X5 factorial design is proposed in which five combinations of phenomenological parameters related with erosion (*a&b*) are faced to five combinations of saltation parameters (*c&d*) (Fig.2). For this issue we pay special attention on witch parameters yields DEM which fits the observed dune final state (i.e. dune migration and crest position) and which yields non desired formations (i.e. sand ripples in the dune windward side, lost of dunar morphology or strong erosion).

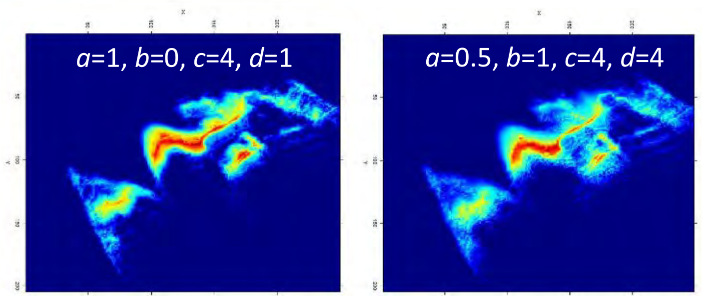

Fig 2. Examples of simulations results

The observed pattern showed a higher migration of the top of the dune, forming a flat region between the original foot and the new crest. The employ of low values of saltation length parameters results in the ripple formation. This formation is rejected as it is a non observed phenomenon at the study scale. The combination of high values of *c* and *b* produces a lost of dune structure, with massive ripples and sand piles formation. The employ of high *a* values results in crest enhancing. The best result reproducing soft slopes, dune migration and observed morphology, is the produced by *a*=0.5, *b*=1, *c*=4 and *d*=4. The result of performing a simulation with the parameters that best reproduce the morphology achieved in a final state is used to estimate the sediment entry and exit that generate the observed sediment budget.The difference between the sand volume in the initial DEM and in the simulation result yield the sediment output of the system. The sediment input is estimated as the sand volume difference between the surveyed and simulated final dune state. The result of these estimations applied to the best morphological reproduction simulation is that that 232.4 $m^3$of sand had leave the system and 426.3m^3 had been trapped by the dune.

The model presented in this paper and the calibration methodology proposed are a very useful tool in assessing the dynamics of a dune system with a very low data entry demand in a wind variable dynamic context.This application will have a great impact in the study of El Fangar dune system as the dune system acts as a sink and a source of beach sediments depending on the dune system region and the transport conditions.

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EDUCATION AS A KEY FOR COASTAL CONSERVATION

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Education and coastal conservation have the perfect relationship. While coastal protected areas provide sites for environmental education, citizens can participate in monitoring programs of the local biodiversity. A background to the basic ecological concepts will give the participants a feel of the coastal environment and the organisms therein. At the same time the Nature and Environmental Education (NME) initiatives strive to develop a lasting and caring attitude towards the marine and coastal environment, and a sense of personal responsibility in each participant, from the young to the senior citizens.

NME considers coastal education to be more than gaining knowledge about the coastal world. Direct experience with the environment is also of prime importance. Wading out into the sea and feeling the wind in your hair or the sand between your fingers and toes are sensory experiences that aid the memory and help to connect the theory to the real world. Environmental education without fieldwork is like science classes without the experiments.

Fieldwork reinforces the value of coastal specialists who help to translate scientific information and interpret coastal issues to educators or directly to the public in general. Marine educators are thus important agents for coastal conservation. An effective educational transformation depends upon how motivated, capable and supported these educators are. So it is critical to pay close attention to how we train and support both new and experienced educators. The new European Marine Science Educators Association (www.EMSEA.eu) is dedicated to provide opportunities for professional development and to facilitate the exchange of best practices in marine education. Europe has much to offer in terms of valuable marine projects and educational materials, but the efforts are often poorly visible, and thus seldom used by others.

Claude Willaert presents the annual seaweek (www.weekvandezee.be) in Belgium as one of the important coastal education events. Claude will guide you through some of the education resources and efforts how to work beyond the country's borders. Join Claude for a short break from the conference on a fieldtrip to the beach.

Evy Copejans puts marine and coastal education on a wider European perspective. She gives also details on the activities of EMSEA and the findings of the first conference on Ocean Literacy in Europe.

THE BEACH NOURISHMENT AS A TECHNIQUE TO STABILIZE THE LYCEE MBA BEACH: SETTING UP A MORPHO SEDIMENTARY MONITORING.

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In the seventies, to fight against coastal erosion in the Libreville coastal zone, many groynes were built and their results are much controversial. Some of them have been the factors of coastal erosion, leaving the whole problems of sea advanced and the loss of the beaches.

For example, the dialogue's groyne erected on the lycee Mba beach has caused the total loss of all beaches downstream. Moreover, all beaches located upstream are affect by a significant thinning down. The case to be more worried about is the lycee Mba beach which is the most attractive of Libreville. Caused by these elements of vulnerabilities, and the lack of data, a sedimentologic and morphologic monitoring has been put in place for two years in order to improve the status of knowledge on the sediments dynamic.

The Grain-size distributions of beach sands were analyzed by a parametric method and by modal analysis. Samples were taken from 11 cross-shore profiles (lower beach, middle beach and high beach), but not evenly distributed throughout the entire sandy coast of Libreville, of an average length of 16 km.

Modal statistics indicate that a mixture of dominant components contributing to the grain-size distribution of the sediments: fine sand (Sedimentary Type I: Modal value: 0.15 mm), medium sand (ST II: Modal value: 0.2 mm); coarse sand (ST III: Modal value: 0.68 mm); and very coarse Shelly particles and gravel (ST IV: Modal value: 2.5 mm).

This analysis allows us to discriminate three mains sedimentary cells on 16 km, and to highlight the impact of the human activities like sand mining on the beach and building on the top of beaches, on the distribution of each ST on the space and time and their origin.

The beach of lycee Mba (average length 800 meters), located at the downstream limit of all sedimentary cells, is characterized by very well sorted fine and medium sand, with uniform modal values (0.15-0.2 mm). Moreover, the sizes of sands are the same as well as on the top and the bottom of the beach, and presents a cross-shore profile very flattened which evokes the weakness of the supplies of sand by the littoral drift.¶ Also, the irregularity of the modal value in the three sedimentary cells was correlated with the rate of the shoreline retreat. In the northern zone, between 2001 and 2012, the shoreline retreat has been estimated around 40 meters, for modal values going from 0.1mm to 2.5mm. In the southern zone at the beach of lycee Mba, for the same period, the shoreline retreat is around 5 meters with values modal going from 0.15 to 0.16 mm. For us, these results will be used as a contribution for the development of a plan for ''sediments management'', and lead us to the choice of the beach nourishment as a technique intending for the stabilization of the lycee Mba beach

This project aims at the study on the physical framework of all conditions required for the nourishment of this beach, and as well as the valorization of this main entertaining space threatened by the thinning down. The methodology of implementation of this project is based on the development of a system of data collect in the field of morphology, bathymetry, sedimentology, overlay with hydrodynamic climatic forcing and factors. These data will make it possible to monitoring, understanding, and preventing any morphological change to adapt as much as possible the nourishment.

MORPHODYNAMIC MODELLING SUPPORTS THE DEVELOPMENT OF TIDAL MARSHES IN THE WATERDUNEN AREA

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The Waterdunen project, a coherent development of coastal design, recreation and nature development aims to achieve a solid estuarine nature area with controlled reduced tides in the coastal hinterland along the Western Scheldt, west of Breskens.
This paper reports on a detailed study by means of hydrodynamic modelling (1D-2D) focusing on a further development/refinement of the final design restoration plan. The study aims to optimize the operation of the inlet configuration and the evaluation of the development of silt and salt marshes in the intertidal areas.

The project Waterdunen is located on the coast of Zeeuws-Vlaanderen, close to Breskens in the Western Scheldt area of the Netherlands. Several years ago, two private parties, The Landscape and Molecaten Zeeland BV, took the initiative for the project “Waterdunen”, as response of both the “weak links” project for coastal protection and the development plan for the region, called “Natural Vitality”. Besides the two private parties, 3 government bodies are involved in the project: the province of Zeeland (leading the project), the municipality of Sluis and the Water Board of Zeeuws-Vlaanderen. The area will be developed as a silt nature area with reduced tidal influence. Antea Group was contracted to carry out a hydrodynamic and morphological study within this project.

The main part of the actual study consisted of a check of the calculated hydro- and morphodynamic parameters in the respective development stages of the marsh hinterland. For this purpose a specific evaluation framework for morphology and ecology was developed in function of the objectively identified (expert) indicators. These defined indicators were directly deduced from the numerical simulations (1D/2D), leading to a direct validation, visualisation and synthesis of the model results. By using an iterative process (through a set of computer simulations), an optimized situation (with respect to the design of the intertidal area and the control of the inlet) was obtained.

The main conclusion of the modelling confirms that the finally proposed design of the Waterdunen intertidal area can be sustainably designed and maintained. With the combination of an inlet, an open connecting canal and the restoration of the hinterland as silt and salt marsh area, as described, the 2D model shows in a detailed way that the area fills in an effective and optimal dynamic way at rising tide and empties at falling tide within the defined natural and operational boundary conditions. In this way, the detailed hydro- and morphodynamic model contributes to the further optimization of design and operation of the integrated sustainable intertidal area Waterdunen.

From the modelled hydrodynamic processes one finds that a clear asymmetry exists between the rapid filling of the intertidal zone at high tide flow and the slower emptying of the system at reduced ebb tide. This hydrodynamic asymmetry is followed by morphodynamics: the potential sediment load in suspension during flood will - given both the low absolute velocities and also the asymmetric lower ebb-load - largely be deposited in the intertidal area. From the morphological point of view, in order to maintain and preserve the ecological potentials one can therefore say that:
· the supply of sediments from the Scheldt should be minimized;
· a maximum retention of the incoming sediment on the Western side should be pursued.
· a minimum flow of sludge material is strictly necessary for the conservation of the natural development of this marsh area, as a compromise with the minimal maintenance efforts (dredging) to preserve the initial state.

For the practical realisation of the project, the following suggestions are made:
· Given the expected sedimentation (as also shown in the sediment sampling campaign), a construction of the intertidal zone with a small overdepth (ten cm) is possible.
· Close monitoring of the intertidal zone allows not only the ecological development but shall at the same time picture (unwanted) morphological evolutions, allowing appropriate (maintenance or management) measures.
· Considering the existing (critical) connection to the Westerschelde (via “Killetje”) on the one hand and the need to limit sediment supply from the Western side on the other hand, a thorough re-design of the access configuration between the Western Scheldt and the tidal diver is a good opportunity.

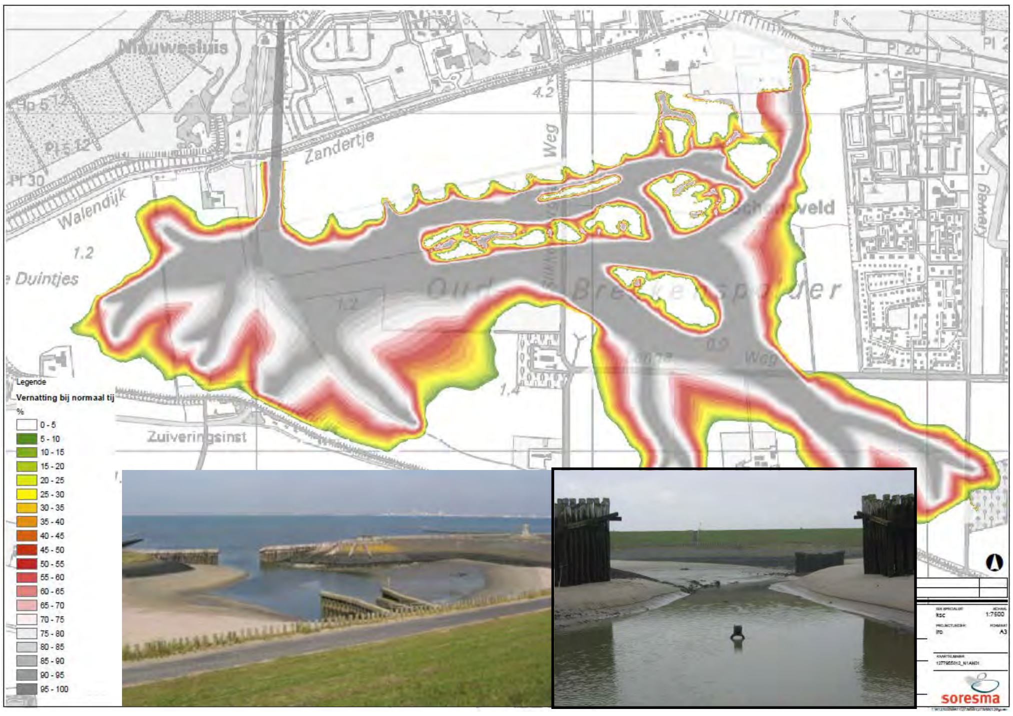

Figure 1 Lay-out of the modelled area

When a choice must be made between different alternatives and variants it can be stated that the variant N1R3 is the best guarantee on:
· a large salt marsh area;

· a significant foraging area for birds;
· sufficient potential as breeding ground for fish species;
· a low dynamic ebb-tide regime that leans pretty towards the natural situation;
· a natural appearance;
· a reduced need for intervention during the construction phase;
· a (presumably) limited need for intervention during the management phase;
· a limited-avifauna disruption during the management phase.

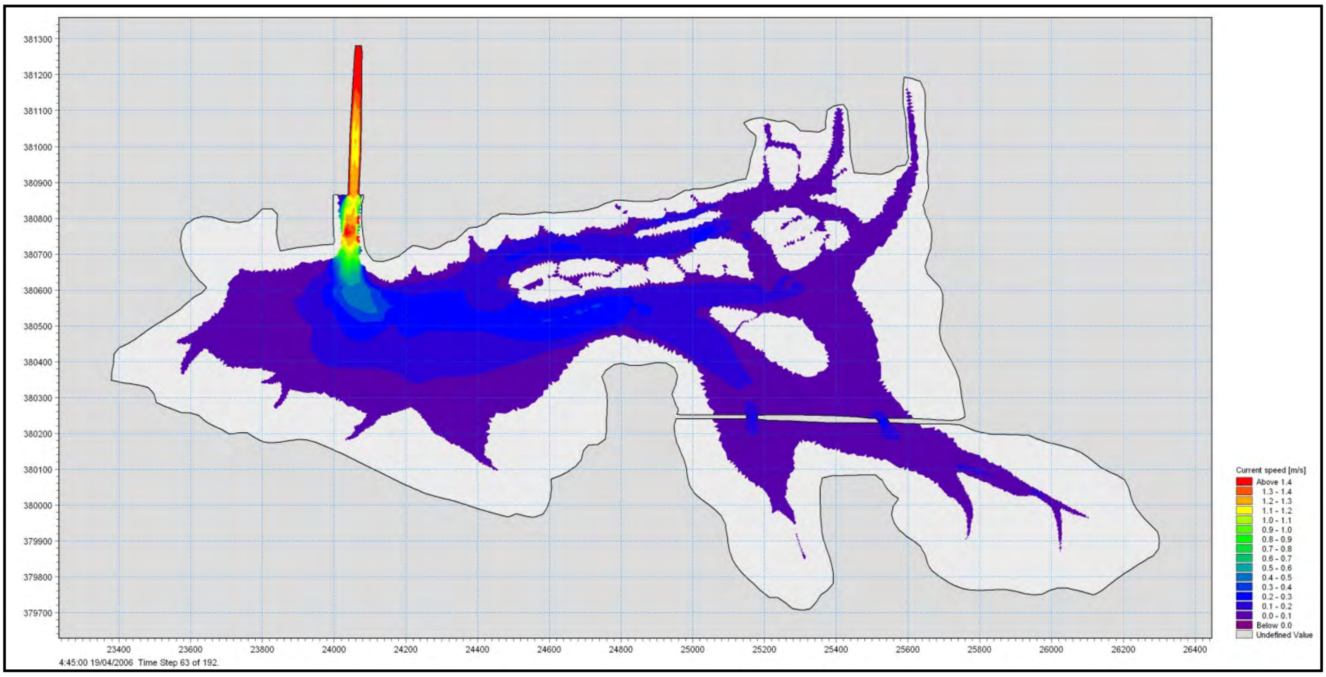

Figure 2 Modelling results: velocity field for scenario N1R3, at maximal inlet velocity, during normal tidal conditions

TOURISM AND SPECIES RICHNESS ON SANDY BALTIC SEA BEACHES – A CONTRADICTION?

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Harbours, coast protection, tourism – How much can our beaches tolerate? Our research group focuses on identifying the effects of human impacts on beach plants. Findings are fundamental for the development of a concept which should agree habitat and species conservation with tourism. Vegetation relevés were carried out on seven beach sections of three categories of disturbance intensity: Beaches completely open for people (A); closed beaches in nature conservation areas (B); beaches with closed backshore and foredunes but with touristic access on the lower beach area and the water side (C). To consider the sea-land gradient, beach sections were divided into ten transects with six 4 m² plots each.

Results show low species richness for all management categories. Species richness was significantly higher with "C" than with "A". Evenness values of "A" were significantly higher than of "B" and "C", which can be explained by increased gaps in vegetation cover due to human trampling activity. Gaps within vegetated areas on beaches are highly vulnerable to erosion. Furthermore, differences in species composition between categories increase with distance from the sea. Annual driftline plants (Cakiletea-maritimae) are significantly promoted by moderate trampling on the lower beach in "C". All disturbed beaches exhibit a higher amount of ruderal species (Artemisetea). The canonical correspondence analysis shows increasing differences in species composition between categories with distance from the sea.

We conclude that plant species richness of sandy Baltic Sea beaches can be promoted by partial closing. This protects the habitatof typicalbeach plantsand allows people to access the water. In the following years of the research project we will investigate the potentials of reintroducing endangered plant species and the survival of animal populations.

THE USE OF HIGH RESOLUTION SAR AND OPTICAL REMOTE SENSING DATA FOR MAPPING AND MONITORING OF INTERTIDAL SALT MARSH VEGETATION HABITATS

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This paper describes research focused on the application for Earth Observation technology in support of Integrated Coastal Zone Management (ICZM). There is much interest in the European Global Monitoring for Environment and Security (GMES) program and the ability of remote sensing technology to deliver operational solutions to many areas of life including environmental management.

Remote sensing of the coastal zone has traditionally focussed on either the terrestrial or the aquatic side. The intertidal zone is not easy to monitor by remote sensing, due to its highly dynamic nature and impact of varying tidal levels on the degree of exposure within the intertidal zone when earth observation satellites overpass. Nonetheless, an unprecedented number of earth observation satellites are (to be) launched, providing temporal as well as spatial resolution that will enable environmental monitoring on habitat scale.

Integrated Coastal Zone Management seeks to find a balance between human use and sustainable functioning of coastal zone ecosystems. Coupled with general interest in ecosystem services, this research explores methods for characterising intertidal salt marsh habitats in terms of the environmental benefits and affordances they confer, thereby providing important information in support of the management of coastal zones. For example, one of the most important services intertidal coastal ecosystems can provide is mitigation against coastal flooding and erosion. However, many intertidal ecosystems are under threat from degradation, habitat loss and human development.

This study proposes a methodology for aspects of Integrated Coastal Zone Management, by applying remote sensing techniques to characterise intertidal salt marsh habitats. It explores to which extent a combination of radar (SAR) and optical remotely sensed data can provide useful applications to (1) classify salt marsh habitats according to common habitat classification schemes like Habitat Directive Annex I and BAP Priority Habitat, (2) use SAR to map vegetation characteristics by estimation of vegetation density and vegetation cover and (3) use multi-date imagery to define vegetation dynamics over multiple years. Multi-frequency SAR images will be investigated to examine intertidal habitat classification potential, as well as structural analysis as fluctuations in vegetation structure and flooding regimes. Monitoring of changes in time will be through analysis of appropriate time series data (seasonal and tidal) from high resolution optical data. To achieve these aims, this research develops a multi-annual time series of optical remote sensing data, using high resolution optical imagery (Landsat, DMC and SPOT) to develop bio-physical products as NDVI and LAI.

The research area is the Llanrhidian salt marsh complex on the southern coast of Wales in the estuary of the Burry Inlet. This area is a designated Habitat Directive sites and provide some of the UK's most researched and well-managed examples of salt marsh habitats. Previous ecological field surveys, as well as field work planned for the summer of 2013 are used to provide ground reference data.

This research seeks to improve understanding of the impact of external fluxes such as erosion and sea level rise on habitat dynamics. The combination of a multi-sensor and multi-temporal remote sensing approach gives more insights into long-term dynamics of intertidal land cover and ecosystem functions associated with intertidal habitats and ecosystem services they provide.

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INTEGRATED HARBOUR DEVELOPMENT IN FLANDERS: A DELICATE EXERCISE

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The Flemish Land Agency (Vlaamse Landmaatschappij, VLM) aims to preserve open space in an increasingly populated Flanders and improve environmental quality by means of projects in rural and peri-urban areas. With this aim, VLM is also participating by several projects to the integrated development of the international harbours of Antwerp, Ghent and Zeebrugge.

Projects include a.o. the development of new nature areas to compensate loss of European protected natural habitats and bird areas (Natura2000), land banking for farmers to mitigate loss of land as a result of harbour and related nature development, the development of nature and landscape buffers to enhance the liveability of residential areas in the proximity of harbour industry. Others projects are intended to mitigate the environmental impact of harbour related infrastructure, such as railways, highways and waterways.

As an important aspect of integrated development, VLM projects are multidisciplinary approached and include intensive consultation and participation of all stakeholders, imperative to obtain the necessary local social support for harbour development and related measures.

The presentation will elaborate on some project cases and their results, including experienced drivers and obstacles for integrated development in related coastal areas.

BACK TO NATURE: ARTIFICIAL DUNE AS ALTERNATIVE FOR DIKE

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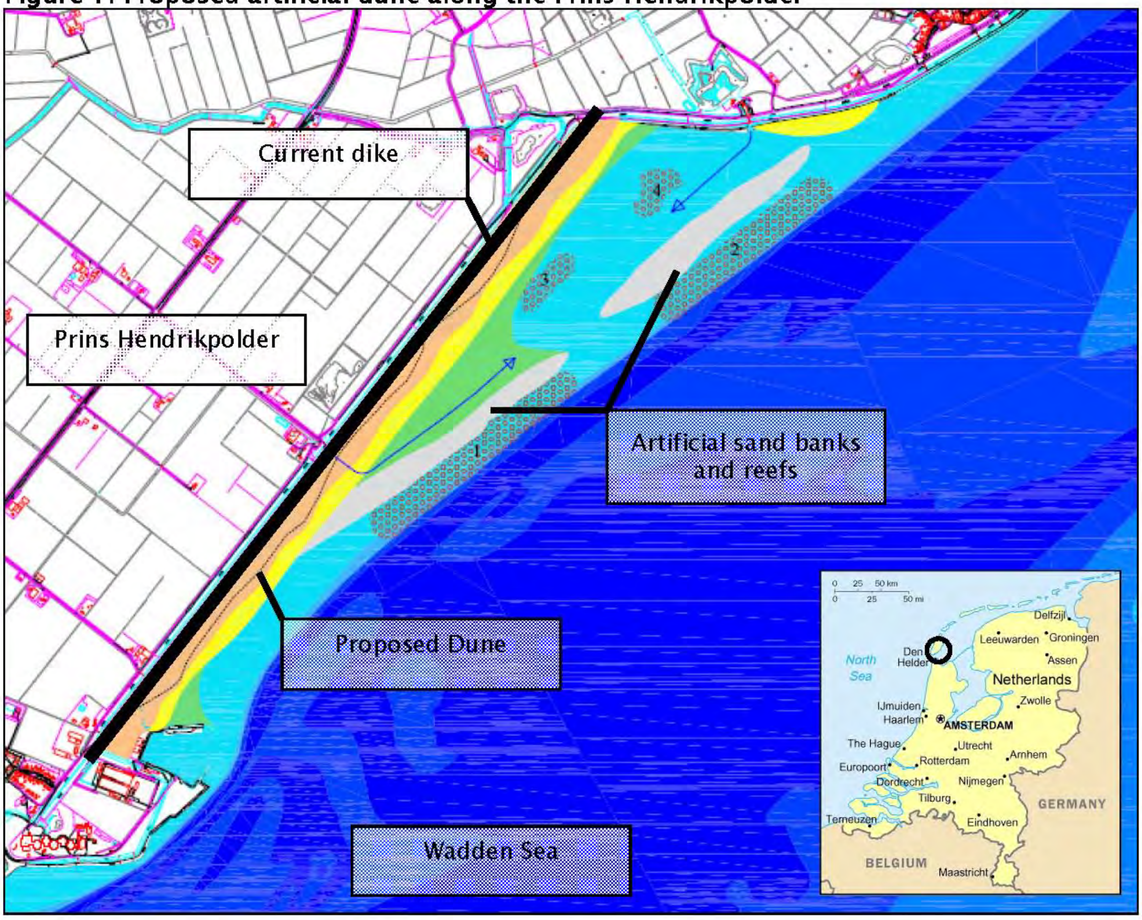
As large parts of the Netherlands lie below sea level, coastal protection along the Netherlands coasts is important. Without a good and reliable coastal defence, large parts of the country will be flooded frequently.

Every 5 years the safety of the coastal protections along the coast is evaluated. After recent evaluations, the safety of the dike along the Wadden Sea coast of Texel was found below legal requirements. This section therefore has to be improved.

Figure 1. Proposed artificial dune along the Prins Hendrikpolder



Coastal defence improvements traditionally result in the construction or improvement of dikes; solid line structures characteristic for the Netherlands landscape. As an alternative a soft ecological solution was proposed for a section of the Wadden Sea coast of Texel: an artificial sand dune. This artificial sand dune will completely replace the current coastal protection, which is a dike protected by pitched stones, asphalt and grass.

The artificial sand dune will increase both the safety level for the protected land, in this case the Prins Hendrikpolder, and the ecological value of the area. Safety levels need to meet a minimum level as defined by laws. The ecological potential is determined by the design freedom. Is this a base for an opportunity or does it lead to conflicts?

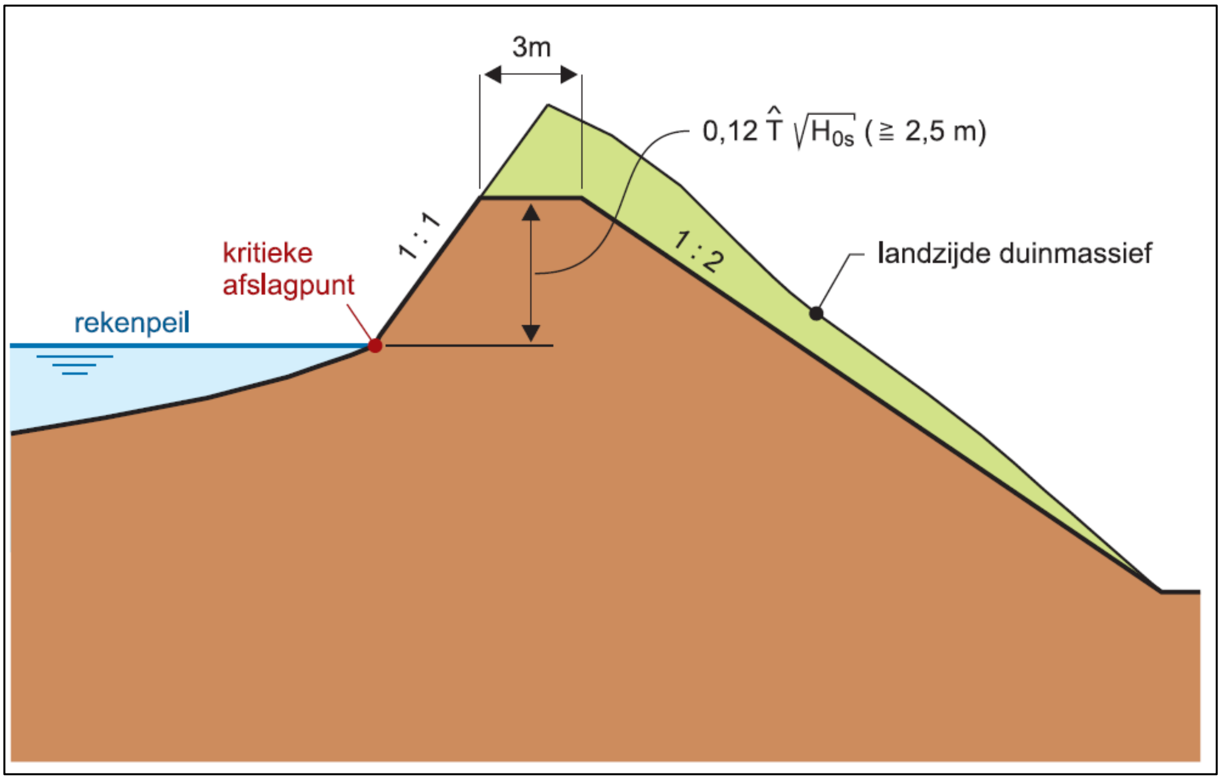


Figure 2. Safety levels need to meet minimum requirements defined by law

A soft ecological alternative for a coastal defence on a coast dominated by solid hard protections for centuries is usually not the most obvious (or economical) solution. A soft solution on this side of the barrier islands is therefore regarded unconventional and innovative. The technical feasibility and the added ecological (and recreational) value are imported issues in the soft solution. Besides the legal issues play an important role.

Design standards in the Netherlands are made for the design of hard constructions like dikes and are therefore not applicable for the design of soft solutions like sand dunes. Does this lead to opportunities for a feasible alternative and does it create additional ecological value? Or are existing standards limitative and does it result in a preference of hard protections above soft alternatives? How to make sure that an artificial dune is capable of protecting the hinterland for a certain timeframe?

The ecological, legal and technical issues are assessed in a comprehensive study. The soft solution turned out to be a more costly alternative. The study answers the question if the extra costs can be justified by ecological and recreational added value.

POSTER PRESENTATIONS: Innovative infrastructure

INNOVATIVE MULTI-PURPOSE OFFSHORE PLATFORMS: PLANNING, DESIGN AND OPERATION

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In the near future, the European seas will be subjected to a massive development of marine infrastructures. The most obvious structures include offshore wind farms, constructions for marine aquaculture and the exploitation of wave energy. The development of these facilities will increase the need for marine infrastructures to support their installation and operation and will unavoidably exert environmental pressures on the marine ecosystems. It is therefore crucial that the economic costs, the use of marine space and the environmental impacts of these activities remain within acceptable limits. Hence, offshore platforms that combine multiple functions within the same infrastructure offer significant economical and environmental benefits.

In order to tackle these challenges, the European Commission launched in 2012 the research project MERMAID: Innovative multi-purpose offshore platforms: planning, design and operation. MERMAID is one of three EU-FP7 funded projects in response to the multi disciplinary call Oceans of Tomorrow on multi-use offshore platforms. The project will develop concepts for the next generation of offshore platforms which can be used for multiple purposes, including energy extraction, aquaculture and platform-related transport. MERMAID does not envisage building new platforms, but will theoretically examine new concepts, such as combining structures and building new structures on representative sites under different conditions (Fig. 1).

Fig.1: Scheme of the project concept: the innovative design has to preserve the ecosystem and enhance species biodiversity; to assure device operation and survivability; to produce 'green' energy and local storage allowing operation of existing platforms and facilitating transportation; to face social perception and needs.

Four offshore study sites which represent different environmental, social and economic conditions have carefully been selected. The sites, are located in four different seas: (i) the Baltic Sea - a typical estuarine area with fresh water from rivers and salt water, (ii) the trans-boundary area of the North Sea-Wadden Sea - a typical active morphology site, (iii) the Atlantic Ocean - a typical deep water site and (iv) the Mediterranean Sea - a typical sheltered deep water site (see fig 2). Based on the results of these studies, a verified procedure will be created to select the most appropriate design options for a given off-shore area. This procedure should be generic so stakeholders and end users can use it for marine planning strategies.

The objective of these cross-cutting pilot studies is to:

- focus research on solving problems in a manner suitable for immediate use,
- to provide real sites with real and specific problems against which tools, techniques and decision support systems may be tried, tested and validated,
- to provide feedback into the research and development process from industrial partners,
- to ensure that MERMAID deliverables are of real value, practicable and usable..

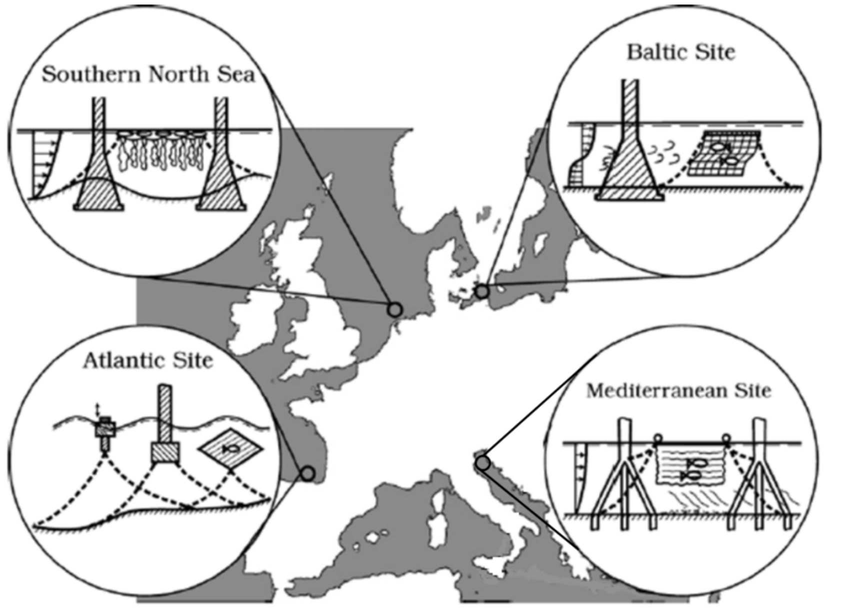

Fig. 2 Location of the four sites and scheme of design options.

A series of possible design options and industrial interaction will be scoped and implemented on a site by site basis. The extent and focus of this interaction will vary from site to site and will depend upon the existence and / or flexibility of policies and social, economic and environmental management schemes or constraints. For more information, go to http://www.mermaidproject.eu

THE BATTLE AROUND THE SEA DEFENCE IN THE NETHERLANDS: THE PARADIGM SHIFT FROM SEEING DAMS ONLY AS ICONS OF SAFETY TO DEVELOPING DAMS AND THEIR ENVIRONMENT AS ICONS OF SAFETY AND ENDURABILTY

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INTRODUCTION

After centuries of building dams and dykes for the purpose of safety only in the last two decades there are voices which state we have “gone too far” with the great sea defense dams. The effects on the valuable ecosystem of the Delta, the water quality and the fishery capacity were underestimated and therefore an interesting number of proposals for “repair” are brought out into the open now and often already have been carried out.
The leading idea is developing the dams and their surroundings from icons of safety to icons of durability.
Central themes are:

- Betterment of water quality is a dominant motive; enhancing the quality of sweet waters behind the dams is necessary in a number of places. We found out that therefore sweet and salt water are not absolute enemies;
- Where possible (partly) restoring a more fluent transition between salt and sweet waters by creating brackish water zones and fish passages. Making the dams more flexible and sometimes “permeable” (for fish).We are starting to rediscover that the Delta waters and the IJsselmeer are feeder lines for the North Sea and the inland rivers ecology.
- Experiments with durable (shell)fishing methods are under way but demand “negotiating” between the fisherman and ecological organizations.
- Restoring Delta nature, which has been badly damaged in the “dike building” era, is a “trending topic” these days! Deterioration is fought by realization of a great number of nature building projects to create a more robust delta ecosystem and finding a new balance between safety and the resilience of the natural system.
- Proposals and experiments for using the growing possibilities for tidal and blue energy are brought forward.
- Utilizing better the possibilities for tourism and (water) sports of the flourishing estuarine nature areas is often a regional spearhead.
- Intensive monitoring of birds and aquatic life has become regular. However still difficult for the aquatic flora and fauna.
- The whole process of thinking out innovations, assess them, finding support and money and carrying out the works take considerable time. Periods of 10 to 20 years are “normal”. During this time the process is vulnerable from change of views in the political world and lobby work from countervailing powers. Also the acceptance of the “new paradigm” by scientists, politicians and the public takes effort and time.

The above processes will be demonstrated with the innovations in thinking on the future of the Blue Heart (the IJsselmeer area) > the Afsluitdijk and the Markermeer< and with the major developments in the Zeeland Delta.

The IJsselmeer dam (Afsluitdijk) and the Markermeer.

- After more than 40 years of debate the Afsluitdijk was completed in 1932. Major achievement of the Dutch hydraulic engineering and major ecological disaster in one. The people around the inland lake Ijsselmeer were safe for the first time in centuries, but a large and fruitful intertidal area was cut off from the sea, with disastrous effects on fish (herring, ale, and anchovy) and fishery. Around 2000 discussion started about the possibilities of making the IJsselmeer a more lively part of the Dutch estuary landscape. In 2007 the government asked a number of organizations and companies to propose ideas for opening up new horizons for the Afsluitdijk >> enlarge safety in combination with creating a more gradual salt/sweet water transition and generous fish passages. But also possibilities for durable energy and tourism. A number of proposals were presented. Not al "ripe", but nevertheless it could have been the start of an interesting discussion of making this iconic dam, also an icon of durability. But the government got cold feet, paralyzed by the Euro crisis as it is and decided not to engage in an integral discussion on the future of the dike. It restricted the decision making to safety matters (a sustainable dam) and handed over the integral discussion to the provinces. Which are working on a plan now for "green" energy, sweet/salt water transitions, fish passages and tourism. This gives also room for initiatives of green organisations to make proposals. One of them is a plan for fish passages promoted by the Wadden society.

- In the southern part of the Ijsselmeer area, the so called Markermeer, intensive studies are undertaken to better the water quality and to build large nature areas in the lake. Either by creating long stretches of moorish "land "adjacent to the dikes or as an ensemble of raised islands. Also the (inland) dikes itself and the surrounding areas will get a more "natural" appearance and more ecological value. This will be very specially favorable for the thousands of migrant birds that stay in the area in spring and autumn. One of the greater projects, The Marker Wadden, originates from and is promoted by our "National Trust" (Natuurmonumenten) and is sponsored by a great lottery company.

The Delta dams and the areas around The Haringvliet Complex

In 1971 an enormous array of 17 vertical sliding doors was built in the mouth of the Haringvliet. Where the waters of the Rhine and the Meuse meet the sea. After the construction the Haringvliet gradually became fresh and without tide. The effect on the intertidal shores was disastrous as was the effect on the possibilities for fish like salmon to swim up river in the mating season. After a long debate the government decided in 2011 to open the sluice complex a bit to introduce a salinity gradient thereby enabling migratory fish species to swim in and out. There was strong opposition from the sweet water users, farmers and drinking water companies. But there were also international duties obliging the Dutch to facilitate fish migration to Germany and France.

The prospect of renewed river (tidal) dynamics induced the Province of South Holland to undertake a very ambitious program called "Delta Nature". The program contains about 24 projects in a large area around the Haringvliet, with a total of 2400 hectares of new "wet nature". It brings the sweet water intertidal nature back into the Delta. Which is unique in Europe! In this ,also European, project a BALANCE is sought between building new nature and finding recreation possibilities for the nearby citizens.

The program is carried out and supported by a broad coalition of the State, regional authorities and green NGO's. One of the top projects was the conversion of the agrarian island Tiengemeten, 10 km2, into an organized wetland "wilderness", with touristic impact.

The Grevelingen

This sea arm was closed in1972. Became tideless, but remained salt!

In the past the saltwater lake suffered from oxygen depletion in the deeper layers. The construction of an opening through the Brouwersdam > de dam closing off the original opening to the sea < has partially resolved this problem. Nevertheless the Grevelingen is still a fragile aquatic ecosystem in which the natural dynamics are insufficient to maintain a healthy balance. In 2002 a proposal for betterment was launched by a small "think tank" called Delta Synergy. Of which I was a member. Basis assumption was partly restoring tidal dynamics, by making a much greater opening in the dam. In the opening could be placed a tidal energy power plant. The idea got appraisal, but was not picked up easily. Around 2006 the regional authorities got enthusiastic, raised funds en started extensive studies. Which recently resulted in an environmental assessment report (MIRT Grevelingen). Based on no less than 25 studies. The results are promising:

- A tidal stroke of 50 cm is enough to restore water quality, especially by bringing oxygen in the deeper layers. It is an optimum between existing nature values and development of new intertidal nature.
- With the (modest) reintroduced tidal stroke there is potency for the development of 650ha new tidal nature. Alas does this also mean that areas of very valuable "dry" nature get lost and that breeding grounds for coastal birds are in danger to and have to be protected.
- The possibilities of a tidal energy plant are extensively researched and have undergone a "market scan". The results are very positive, and got an interested, sometimes enthusiastic reception. The assumption is that tidal energy here can provide electricity for 30.000>50.000 households. (Almost) decided is now that that new techniques are going to be experimented. This pilot will take place in a "Grevelingen Tidal Test Centre", which is part of a European experimental project. In which several other tidal regions will participate. As it seems subsidies will be needed to get a competing energy price. But that is the same with wind energy, which up till now is heavily subsidized.
- The various interventions are calculated. And will be "embedded" in an integral development scheme for the region as such. With meaning for tourism, agriculture and land-water relations etc. >> "a salty bay of world class once more in balance" is here the leading motto.

The Oosterschelde

After a "furious" debate Dutch Government decided in 1976 to build an open barrier instead of a closed dam in the Oosterschelde. To preserve the unique salt water quality of the environment and the favorable (shell) fishery conditions. The open barrier contains a number of 65 vertical sliding doors that only close during heavy storms and high water levels. The storm surge barrier was completed in 1986 It has changed the dynamic equilibrium in the tidal basin leading to the threatening disappearance of the intertidal areas, as their sediments are redistributed to fill in the deeper channels. Not enough sediment is brought in to fill the "sand hunger" of the system. Finding a long term solution to this problem is the greatest challenge to preserve the ecological and economical values of the Ooster Schelde. In the coming time trials will be undertaken with sand suppletion on several banks.

Around the shores of the basin interesting projects have been undertaken or are under way to compensate the loss of nature (especially salt marshes) in the basin and enhance the ecological values of it. And making the island of Schouwen "Climate Proof". With the Plan Tureluur (project Redshank) a considerable inner-dike area in the south of Schouwen is given a brackish character of which many birds profite. The total project contains 44 spots where dunes are created and also sweet water and brackish moors

In that region there is also a proposal for an aquaculture project which is located inside the dike, but with a connection with the basin. Here also a lottery company is the financial facilitator.

All these projects are started from the philosophy of the so called Green Deal > a strategy of combining economic and ecological goals.

The Krammer-Volkerak and the Veerse Meer.

The Veerse Meer became a sweet water "sea-arm" closed of around 1960. It developed as a large scale recreational area, with harbors, camping's, summer houses etc. But the water quality declined during the years. Some years ago a small inlet was made to, during flood time, let salt water in from the Oosterschelde flow into the basin. This improved the water and ecological conditions considerably.

The Krammer Volkerak, in fact originally the most northerly brackish part of the Oosterschelde basin was cut off and made sweet around 1995. With the most "intelligent" lock, that can divide salt and sweet waters almost completely. This was mostly done to get sweet water for the farmers on the Brabant shores. But the "generous" use of manure by these farmers polluted the waters in a way that in summer there mostly is a "green soup" instead of healthy waters. So now studies indicate is that it is best to make the Krammer salt/brackish again to restore the water quality.

Fish immigration through the Northern Dikes

For the Northern provinces exists a policy document called "Fish Immigration in the Northern Netherlands". This vision is based on the betterment of possibilities for fish to migrate from coastal waters to the inland. Preferably in combination with the recovering of a salt/sweet gradient. Since 2006 the mapping of bottle necks for fish migration is obligatory for water boards. This policy results on this moment in a number of proposals for adding specific fish migration facilities to the "classical" pumping stations and for a specific fish migration friendly regime for the pumping activity itself. For instance the Waterboard Noordzijlervest, near Delfzijl.recently presented its proposals.

The attitude of the (national) government and the role of private actors.

- We can speak from a "clash of civilizations" > from a society focused on safety and profit to a society based on principles of a durable civilization > the paradigm shift brings different actors, with different values and new roles for science and monitoring.
- The attitude of the national government is changing from key note player to linesman. Safety and water quality have become the "only" government tasks as it seems now. Integral responsibility is considered to be not any more a national task
- The regional government (the province) is taking the lead now. In the Delta the three provinces steer the process through the Delta Council and have in fact the lead now.In the Ijsselmeer area the provinces are searching to fill in their new role.
- European subsidies helped in different cases and will be necessary in the future.
- Water boards which traditionally took great care on safety matters now combine this often with care for water quality and ecology.
- The power of "green "organizations in developing ideas and organizations grows fast. There is room for bottom up initiatives. These grass roots initiatives are greatly influencing the "agenda", sometimes supported by great lotteries. A new planning/action model seems to be in the making!
- But with all this the question remains who takes care of the blue treasures in an urbanized society where other values are dominant? Countervailing powers are growing stronger: lack of inspiration, other interests prevail, lack of government ,lack of money.

IMPACT OF HYDROTECHNICAL STRUCTURES ON THE DYNAMICS OF SANDY SHORE ACCORDING TO THE EXAMPLES OF THE MAINLAND PART OF THE LITHUANIAN BALTIC SEASHORE

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The south and eastern coastline parts of the Baltic seashore are prominent for sandy coast prevailing there. Thus the problem of unstable matter seashore erosion is under considerable attention in the countries adjacent to the Baltic Sea. The major part of south-eastern Baltic sandy seashore has been influenced by erosion and recession of varying intensity. Though Lithuanian coastline length doesn't exceed 100 kilometres, the area is attractive for its fine sand beaches and costal protective dunes. The discussed area stretches more than 40 kilometres from the Port of Klaipėda to the state border with Latvia.

In 1960-1964 on the basis of the data of long-term research near the Klaipėda dumping place and in some other areas, Rudolfs Knaps, a Latvian hydrotechnician, found out that the near shore streams carrying sand had the northward direction, and that a yearly amount of it was 250-500 thousand cubic meters (Knaps 1966). It was detected by using marked sand and automatic current recorders. Later prof. V. Gudelis stated that a yearly amount of transported sand was 300.000 cubic meters (Gudelis 1998). It is important to mention that the hydrotechnical structures mentioned above stabilize the shore well only in calm periods. During strong gales and hurricanes (the definitions are given after the Beaufort scale) a very high sea water level causes precarious situations. Strong waves, currents and wind result in the deflation processes on the shore (Gudelis 1998). The recent investigations of the Lithuanian mainland coastal area show the decreased volume of the sediment transport. The studies of Žilinskas et al. (2003) showed that the budget of continental coastal surface sediments (in a time frame 1993-2003) was negative. The annual loss of sediments from the Lithuanian mainland coast is about 48,000 cubic meters of sand on the average. According to Kriaučiūnienė et al. (2006), during the average year the Lithuanian mainland beaches could accumulate 100,000 cubic meters of sediments.

The aim of the study was to survey new tendencies in coastal erosion using some examples observed on the Lithuanian mainland coastal area. Hydrotechnical intervention into the natural processes always causes some upcoming changes. The most dynamical situation appears to be at resort town of Palanga. Due to the groyne that was put into action there in the period 1888-1910, the shoreline moved seawards by 500 steps (each 0.7 meters long) (Karwowski, 1913), and by 1947 it had additionally moved 100 meters (Knaps, 1966; Gudelis,1998). A promontory near the Palanga coast has consequently formed due to the implementation of the hydrotechnical means. In 1997-1998, after the removal of the under-pier groyne in Palanga, aggressive coastal erosion occurred there. An exclusion of any segment out of the system, being characterized as of stable dynamic equilibrium, results in sequential regressive changes in the system. When forcing the coastal and near the coast area with the invasive hydrotechnical means exerting influence on the dynamic equilibrium, it is necessary to implement auxiliary means enabling to keep looking after the construction. Due to regular extreme impact of hydrometeorological factors the groyne constructed at the Lithuanian marine coast in Palanga will undergo more or less significant damages. Prevailing stormy winds of southwest direction cause the cyclonic character of currents and sediment transport in the south eastern and eastern coastal area of the Baltic Sea. In 1997-1998, after the exclusion of the hydrotechnical construction from the balanced sea-and-coast system the aggressive erosion processes occurred on the coastal part of the newly created cape shaped promontory in Palanga. First removed, later the groyne was brought back into the system. The reconstructed groyne is smaller in its parameters than the previous one. Still, its influence on the coastal zone is evident. Approximately an average beach area in the dynamically most active zone of the Lithuanian seacoast in Palanga has widened by 40 percent. The final dynamical equilibrium of the seacoast line in the investigated zone has not formed yet and the character of this changing situation will be defined by the scale of extreme cyclonic atmospheric structures and their recurrence in this region.

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LONG-TERM AUTONOMOUS MORPHOLOGICAL TRENDS OF THE BELGIAN SHORE

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Bathymetric and aerial topographic surveys spanning 2 to 3 decades of morphological evolution have been processed into volume time series for the 254 sections covering the Belgian shore (fig. 1). During these decades, numerous human operations, involving the supply of millions of cubic metres of sand in order to maintain the resort beaches and the coastal safety level, have been conducted.

An analysis of these long-term trends is necessary for various reasons: (a) evaluation of the effect of nourishment (e.g. quantification of possible acceleration of erosion trends), (b) evaluation of hard structures like groins, (c) estimating the total longshore sediment transport and (d) the calibration and validation of numerical morphological models.

The amounts involved were backstripped from the volume evolution time series in order to obtain corrected trends per coastal tract (group of sections with a length of about 1km, showing a similar morphological evolution). The corrected time series can be considered to better reflect the autonomous morphological evolution, i.e. what would occur in the absence of human interventions. The trends were determined by linear regression of volumes per metre coastal length over homogeneous trend periods. The significance of the trend is expressed by the regression coefficient. Separate trends were computed for the “below low-water” part (shoreface and seabed in an about 1.2km wide nearshore area) and the about 0.3km wide beach (foreshore, backshore and dune front) (fig. 2). The analysis of the trend figures per section and section tract was supplemented by the patterns of morphological change revealed by successive height difference maps and contour line shifts (fig. 3) through time.

The volume trends of the beach on the one hand, and the nearshore area on the other hand, are both mostly within the range of –20 to +20$m^3.m^{-1}.yr^{-1}$. A slight predominance of accretion near the French border (updrift with respect to the longshore sediment transport) gradually shifting to mild erosion near the Dutch border (downdrift) is an overall characteristic of the recent morphological evolution of the Belgian shore. Superposed on this general observation, stronger trends are often related to morphological adaptations near important structures.

In Koksijde, a decade of beach and shoreface growth was observed after the construction of two long groins in 1986-1988. Accretion continues at a lower rate up to now. The groins may also have induced a slight seaward shift of a local nearshore flow channel.

Over the 22 km long shoreline tract from Nieuwpoort to Bredene, the 6 to 7 m deep (below LLW) longshore channel “Kleine Rede” tends to shift landwards causing erosion at the shoreface toe. The correlative erosion observed at the beach is countered by yearly small-scale and local large-scale sand nourishments. Redistribution by natural processes of the sand volumes trucked and pumped in effectively compensates the shoreface toe erosion, so that the longer-term evolution of the channel is stable and even some shallowing by 0.25m is observed over the last decade. Locally, off Westende, shallowing by over 0.5m is related to dumping of dredged sand from Nieuwpoort harbour entrance.

A recent channel bed shallowing occurred off Oostende centre after 2004: a relatively large net import from the beach nourished there in 2004 and kept since then by maintenance nourishments, is suspected. The corrected trend of Oostende beach since 2004 is $-42m^3.m^{-1}.yr^{-1}$ and is at present the strongest erosive trend observed at the Belgian coast.

The beaches around De Haan suffered strong and repeated storm erosion in 1989-1993. A rather abrupt scouring of the longshore flow channels was observed here in 1988-1993. This seems to have been a natural process that may constitute one explaining factor of the strong beach erosion observed then in the area. Important nourishment works with coarser sand have been carried out in response in 1990-1997, including the construction of a submerged "feeder berm". After this, the beach and shoreface in the area appear to be in a state of equilibrium, with the eastern part of the nourishment area even showing beach growth of around $+10m^3.m^{-1}.yr^{-1}$. The last years showed an eastward shift of the shallow seabed area separating the nearshore channels "Kleine Rede" and "Grote Rede" east of Bredene. There may be a relation to the Oostende harbour works going on (new harbour channel dredged and new dams under construction), but a direct link could not be shown and therefore, the shift appears to be a natural phenomenon.

Wenduine occupies a cape position of the Belgian shore. The longshore flood channel "Grote Rede" shows a trend of deepening in this area. After the De Haan nourishments, that trend was temporarily reversed, but it resumed since about 2000. Some parts of the channel bed are now 0.5m deeper than in 2000, while the shoreface toe shows local deepening between 0.5 and 1m since 2000. The significantly erosive corrected trend of Wenduine beach of $-27m^3.m^{-1}.yr^{-1}$ is thought to be related to this offshore evolution.

Further east, a part of Blankenberge beach suffers a mean yearly erosion of $-31m^3.m^{-1}.yr^{-1}$. Here, the maintenance dredging works in Blankenberge harbour entrance area may explain the erosion, as these works deplete the beach of the longshore littoral drift transport.

A few kilometres on to the east, Zeebrugge's outer harbour dams block virtually all of the littoral drift. Since their completion in 1979, linear accretion is observed at the beach west of the dams. The accretion zone is gradually extending more westward and now approaches Blankenberge. Beach accretion rates are over $65m^3.m^{-1}.yr^{-1}$ near Zeebrugge and increase from 10 to $30m^3.m^{-1}.yr^{-1}$ between Blankenberge and Zeebrugge. Also the nearshore area here shows important accretion, though rates have dropped from over $60m^3.m^{-1}.yr^{-1}$ to below $50m^3.m^{-1}.yr^{-1}$ since 2007. Possibly, the nearshore morphology is approaching a new equilibrium state adapted to the harbour configuration.

The beach immediately east of Zeebrugge is depleted from the littoral drift. Its corrected volume trend is $-23m^3.m^{-1}.yr^{-1}$. Further eastward, at the protruding parts of the beaches of Knokke, where several replenishments were necessary, rates of erosion reached values of $-40m^3.m^{-1}.yr^{-1}$, but the corrected trend has dropped to about $-15m^3.m^{-1}.yr^{-1}$ since 1991. Nearshore accretion areas, related to morphological adaptation around Zeebrugge outer harbour also at its east side, are extending gradually eastward and recently impinge on the ebb channel "Appelzak". This may be one reason for the milder recent beach erosion figures at Knokke-Zoute.

The above description is necessarily succinct. The results of the analysis presented here are described in full detail and with the necessary background data in a report in Dutch, "Morfologische trend van de Vlaamse kust in 2011" (Rik Houthuys, 2012), available on demand at kust@vlaanderen.be.

Fig. 1. Map of the Belgian shore with names cited in the text.

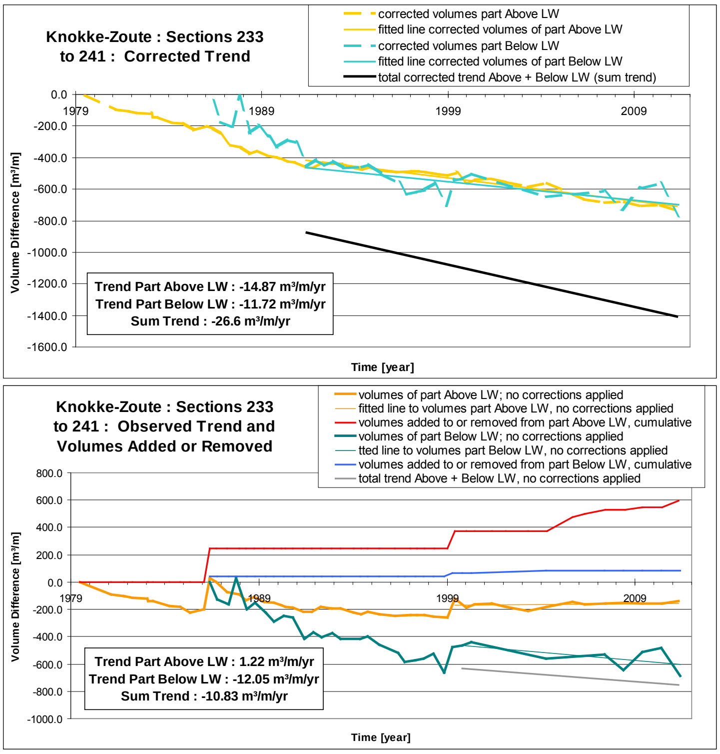

Fig. 2. Example of volume graphs for the tract at Knokke from section 233 to 241.

Fig. 3. Map showing 1997 (red) and 2011 (black) height contours, with 1 m interval. Black arrows indicate sense of growth or displacement of morphological features (they do not represent sediment transport paths). Area shown is the ca. 10 km long part of the Belgian shore between Zeebrugge (left) and the Dutch border (right). Mainland is below and seawall and groins are indicated.

SURFACE CURRENTS REMOTE SENSING BY HF RADAR. DATA ANALYSYS AND PRACTICAL APPLICATION. THE TRADE AND THE SIMOC PROJECTS.

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Since 2008 the Portuguese Hydrographic Institute (IHPT) is involved in using surface currents remote sensing by High Frequency RADAR and its respective data analysis and application. That purpose is being achieved by means of two main projects: SIMOC (Coastal Currents Monitoring System) and TRADE (Trans-regional RADars for Environmental applications). The SIMOC (from 2008 to 2012) endeavoured an initial approach by conducting a pilot experimentin 2008 around Sines Harbour followed by three six months periods (from 2010 to 2012) where the stations were deployed in Sines, Nazaré and Lisboa areas respectively. For each of these four periods data analysis were conducted as well as data comparison with different systems for currents and for sea state. These two stations are now in the final six month period and in September 2012 are supposed to be transferred from the actual Lisbon positions to their final destination, still to be established.The TRADE (2012) is a partnership between Portuguese and Spanish entities, aiming to cover the Iberian southern margin from Sagres to Gibraltar. Once the hardware chosen is the CODAR OS 12MHzantenna, the radial coverage is until 90Km per station achieving about 40Km off coast. These stations are now deployed in the Gibraltar area (two ground monopole with one bistatic) and other two are being installed in Huelva (Spain) to Vila Real de Santo António (Portugal) area. In terms of applications the IHPT,Puertosd'el Estado, Cádiz U7niversity and Qualitas Instruments are developing tools for merging data, visualization and coordination as well as more operational applications as drift models with some oil spill action capacity as well as wind back and forecast analysis.

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LOOKING BEYOND THE DREDGES – THE CONSIDERATION OF ALTERNATIVES IN THE PLANNING AND CONSENTING OF PORT DEVELOPMENT

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Abstract

Seaports in their role as 'hubs to the world' are under an immense pressure to further develop in order to be able to cater for ever larger container ships and thus stay competitive. However, ports are often located in densely utilised and ecologically very valuable coastal areas, and it is not uncommon for several ports within close geographical vicinity to independently pursue similar development targets. As a result, there is increased public concern about the side effects, rate, necessity and scope of such development. Vivid examples for this are the ports of Hamburg, Germany, and Tauranga, New Zealand. In both countries, an integrated approach to port development is missing, so that the development of individual ports takes place in a rather uncoordinated manner leading to overcapacity and unnecessary losses of environmental and financial resources. There are indications that environmental legislation could take over this coordination task, in particular through assessing alternative port development scenarios as part of the statutory planning and approval processes of individual projects. This PhD research therefore examines, assesses and compares the extent to which the existing legislative provisions governing port development in Germany and New Zealand take into account alternatives. It is anticipated that this assessment will yield in some more general insights about the contribution of the instrument 'alternative assessment' in achieving a more sustainable development of large infrastructure projects such as ports.

1. Background and problem statement

With more than 90% of all globally traded goods currently transported by sea, ports form an integral part of the worldwide transport chain. As such they are constantly pressurised by the highly competitive structures present in the maritime transport sector and by constant technical innovations to further develop in order to be able to cater for increased volumes of turnover and ever larger container ships. However, further growth is restrained as port development does not come without conflict. The construction of port facilities and access routes heavily impedes upon its adjacent coastal environment, destroying valuable natural habitats and endangering both flora and fauna. In addition, ports are usually located in areas that are already densely utilised by other forms of coastal usage and any port development activity competes for space with fisheries, tourism, recreational and other activities. While these side-effects are already the cause for major public protests and user conflicts, the necessity of such developments is increasingly also questioned on the grounds that several ports within close geographical vicinity frequently follow similar development aims without any kind of coordination taking place, producing overcapacity and leading to a questionable use of environmental as well as (often public) monetary resources.

The problematic nature of port development is well reflected in the proposed activities of the Port of Hamburg, Germany, and the Port of Tauranga, New Zealand. Both of these ports aim at deepening and widening their shipping channels in order to be able to cater for the next generation of container ships and have only recently, after years of amending and defending their development proposals, been granted consent. The existence of such lengthy and costly statutory approval processes for port development and the growing number of legal disputes accompanying it indicate that existing statutory structures might fail to appropriately resolve inherent conflicts (Durner, 2011; Steinberg, 2011). An initial investigation into the legal frameworks governing port development in Germany and New Zealand has exposed the fact that neither of the two countries has legal provisions in place that explicitly coordinate the development of its ports from a more strategic point of view. This explains why the expansion aims of both the ports of Hamburg and Tauranga were approved despite similar developments currently undertaken at other nearby container ports (JadeWeserPort/ Port of Auckland), and additionally stresses the need to investigate current statutory governance structures. There are indications that the existing environmental legislation, in absence of strategic guidance for port development, could at least to a certain extent take over the important coordination task through the obligation to assess alternatives to the individual project as part of the planning and project approval process, and thus prevent user conflicts and the wasteful use of environmental and financial resources (Winter, 2012).

2. Literature discussion

The idea of assessing alternatives in order to make good choices is not a new approach. Conceptually rooted in rational decision-making theory, the importance of considering several options has also been recognised as an essential part of precautionary administrative and environmental decision-making (Winter, 1997; O'Brien, 1999; Steinemann, 2001). Internationally praised as the "heart" of environmental impact assessment (Holder, 2004), the tool has also gained considerable momentum in German discussions regarding the planning and approval of major industrial and infrastructure developments (Friedrichsen, 2005; Durner, 2011; Wulfhorst, 2011; Winter, 2012). While in New Zealand, the issue of alternatives has not been explicitly discussed in detail, it has gained some attention within the assessment of the country's framework for strategic and project-related environmental assessment (McGimpsey & McMullan, n.d.; Memon, 2005; Young Cooper, 2005). Alternative assessment has the purpose to examine whether alternative options to that proposed exist that, while still achieving the same objective, do so with less negative impacts. The range of alternatives that are commonly subject to such an assessment are different types or scopes of development (conceptual alternatives), undertaking the activity at a different location (spatial alternatives) or not undertaking the project at all (zero alternative). Supporters praise alternative assessment as a smart instrument that, instead of focusing on the problem, stimulates the search for an optimal solution and thus prevents a premature focus on one option (Winter, 2012). Extensive public participation throughout the assessment process furthermore helps to decrease user conflicts and reduce risks, and may also function as a motor for innovation (Tickner & Geiser, 2004). Critical voices argue that extended requirements for alternative assessment would lead to more costly and lengthy approval processes, thus overburdening both project applicants and approval authorities.

3. Research method and rationale

It is the aim of this PhD research project to assess the potential of the tool 'alternative assessment' to improve public decision-making regarding ambitious infrastructure developments in absence of clear strategic guidance. Taking a comparative approach, the multi-tiered planning and approval processes governing port development in Germany and New Zealand are analysed with regards to obligations to consider alternatives, followed by a comparison of the findings and their review against the prevailing lines of argumentation in academic writing.

4. Preliminary Findings

Both Germany and New Zealand have multi-tiered planning systems in place that, broadly speaking, consist of a strategic/ comprehensive level that aims at coordinating all kinds of activities and protection requirements, and the approval level of individual (port) projects. While the actual statutory requirements for alternatives differ, authorities in both countries enjoy a certain discretionary freedom when deciding about whether and which alternatives to consider.

In Germany, a number of statutory provisions require alternative assessment during the planning and approval of port developments. During the development of infrastructure and spatial plans authorities are obliged to consider alternatives that are "reasonable at the respective state of planning" (§§ 14g(1), 16(4) UVPG), while "reasonable alternative locations" need to be considered during regional planning and route determination procedures (§15(1) ROG, §16(1) UVPG). In addition, the statutory requirement to weigh affected matters among and against each other during decision-making about the final approval requires the authority to consider "reasonable alternatives", i.e., according to the Federal Administrative Court, those "that present or impose themselves on the merits of the case" (BVerwGE 69, 256). Further substantive standards for alternative assessment are set in sectoral law, such as the needs to consider "other possible solutions" proposed by the proponent as part of environmental impact assessment (§36(4) no. 3 UVPG) and "reasonable alternatives" to the project as imposed by conservation law (§31(2) no. 2 BNatSchG).

In comparison, requirements for alternative assessment under New Zealand law are rather sparsely sown. Thus, there is no explicit requirement for alternatives to be taken into account when developing transport policies, and while authorities developing environmental policies and management plans are obliged to assess whether proposed management measures are the "most appropriate to achieve objectives" (RMA s 32), this does not necessarily translate into a requirement to assess different development scenarios. On the approval level, New Zealand consent authorities need to consider alternatives within their jurisdiction that are "relevant and reasonably necessary to determine the obligation" (RMA ss 88, 92 & Sch 4). However, the Environment Court in *Meridian Energy Ltd v Central Otago District Council* has clearly stated that the decision should be made on the merits of the case and that "the consideration of alternative sites should not be pushed too far."

While the present research is still in progress, the necessity and justification for an expansion of the requirements regarding alternative assessment during the planning and approval of major infrastructure projects in both Germany and New Zealand has already become clear. Matters that need to be paid particular attention to in Germany are the limitedness of the range of alternatives that need to be considered and the general dominance given to the proponent during alternative assessment that is criticised in the literature (Durner, 2011). New Zealand's environmental management regime, too, can be expected to benefit from strengthened statutory requirements for alternative assessment in particular as part of strategic environmental assessment of transport plans but also on the approval level, as existing statutory guidance is vague and leads to major implementation problems as well as unsustainable practices (McGimpsey & McMullan, n.d.; Memon, 2005; Ward et al, 2005). It can be expected that the in-depth comparison of the two approaches to be undertaken in the months to come will yield further valuable insights.

5. Conclusion

The research undertaken so far highlights the general potential of assessing alternatives during statutory planning and approval processes governing ambitious infrastructure projects such as ports. In particular in absence of higher level strategic guidance, the tool can provide an important contribution to a more sustainable development of ports in coordinating individual projects and thus decreasing the number of conflicts and wasteful use of environmental as well as financial resources. This, however, necessitates a clear and specific implementation of the requirement to assess alternatives as early as possible in the statutory planning process and under wide participation of all affected right from the start. In the final approval process, alternative assessment might work as some kind of 'security device' to prevent overly destructive projects from being approved. However, it cannot be considered as the optimal location for the application of this tool as there are limits to the range of alternatives that can or should be considered at this stage without running the risk of 'overburdening' the whole final approval.

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PORT CENTRICITY: MAXIMISING SUSTAINABILITY THROUGH VALUE ADDED ACTIVITIES

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Changing awareness of the environmental and economic impacts of ports on the hinterland has led to the strengthening of the idea of port centricity (Pettit et al 2009). By focusing attention on the local area to facilitate trade and add value to imports and exports the idea of a cluster, and the benefits of these associated activities, start to impact on port sustainability (De Langden 2004). These 'local communities of practice' (Hall 2003) evolve to support and facilitate a mutually beneficial supply chain through which local economies can grow and develop the workforce and skills whist reducing the impact of transport and logistics in an already congested area (Robins 2011). Port centricity, to be effective, requires the support from local businesses; which can only be gained once policy appreciates the benefits of cluster activities (Notteboom et al 2012). By drawing in the local policy makers, and providing the basis for policy intervention, local port authorities can develop port centric practices that benefit all main stakeholders.

The Channel Arc Manche Integrated Strategy (CAMIS) INTERREG IVa EU funded project is a partnership of 19 local authorities and universities along the northern coast of France and southern coast of England that aims to develop a sustainable and integrated maritime strategy for the Arc Manche region. As part of this project the transport and logistics knowledge and best practice will be identified and disseminated to partners in order to increase the potential development of cross border partnerships and collaboration. Port centricity is a main feature of the project as the niche ports and smaller ports learn to adapt to the changing economic and technical landscape. By identifying stakeholders and highlighting the centrality of interactions between actors and a port, this study aims to understand the conditions necessary for port centricity to occur and to facilitate the development of cross border 'port-centric clusters'. Each port will exhibit differences in ownership, geographical features, economic and demographic infrastructure from a micro level but will also have the added limitations of proximity to current shipping and land based transport infrastructure. Understanding the path dependence and geographic limitations of space (Martin 2006), coupled with the constraints of property rights and differences in ownership and responsibility cross border, will add to the complexity, but enrich the understanding of, both the potential for, and limitations of, port diversification.

Using a case study approach, three ports from both sides of the channel will be studied for their specific attributes and ability to develop through cluster activities. Semi-structured questionnaires, developed around eight interlinked themes will be used for data collection.

1. Business development within and surrounding areas of ports – the idea of cluster activities between local companies adding value to imports and exports

2. Port-centric logistics – refining relationships between logistic providers to provide reduced, sustainable, yet sufficient transport provision

3. Cross channel trade – cross border collaboration to enhance local communities

4. Infrastructure developments – intermodality and sustainable routes

5. Open innovation – technical innovation on operational enhancements

6. Competitiveness – collaborating to increase markets and customer bases without impacting on competitive advantage

7. Human resources – workforce development and skills

8. Image of Ports – public and policy image of the activities of ports

One of the major aspects of port centric cluster formation would be the development of local businesses that may have potential to add value to imports and exports of ports and develop technologies to deal with environmental and energy issues related to ports and their stakeholders. This strategy on local business development may have positive impacts on route sustainability since it might reduce unnecessary road haulage. Furthermore, port-centric cluster formation might result in improved port-centric logistics, which may enable achieving efficiency in port operations and intermodal transportation. On the other hand, cross-channel trade may promote port-centric diversification as well as have positive impacts on trans-European route sustainability. In order to reap these benefits it might be important to develop relevant infrastructure, implement competitive port strategies, involve open innovation, address human resource concerns and resolve potential issues associated with the current image of ports as closed industrial hinterlands. Hence, it is believed that these eight themes will enable investigating how to facilitate port-centric cluster formation, which will result in maximising productivity, reducing congestion and increasing sustainability.

Once completed, the research will be disseminated to both ports and policy makers in both countries to facilitate the understanding of the potential areas for sustainable growth at the local and cross border level. Understanding the limitations and barriers to port centricity and the specific attributes necessary for individual activities to occur will enable stakeholders to choose from a menu of activities that will suit each individual requirement.

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MANAGEMENT OF DUNE DEVELOPMENT ON A SEAPORT DIKE, DUNKIRK SEAPORT, FRANCE

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The city of Dunkirk is located on the northern coast of France, a few kilometres from the Belgian border (fig.1). Dunkirk Seaport development since the end of the 1950s has resulted in major shoreline changes. Harbor infrastructures were expanded on reclaimed land, resulting in the development of a 15km long artificial shoreline, oriented WSW-ENE, limited by two jetties (fig. 1A). The eastern part of this coast is backed by a 6km long sand dike coated with asphalt called "digue du Braek", peaking at 12m above mean sea level, and overtopped in places by low elevated aeolian dunes. On this coast where net sediment transport is directed towards Belgium (Cartier and Héquette, 2011), the mean spring tidal range is 5.60m. The beach, 500m wide at low tide, is characterized by fine to medium, well to very well sorted quartz sand. Winds are dominantly blowing longshore to obliquely offshore, essentially from south to west-southwest, followed by an obliquely onshore component from the northeast (fig.1A). Aeolian sand transport on the upper beach has resulted in dune development on the dike as well as sand deposition on roads and in a maritime basin behind, requiring costly removal and dredging operations (fig.1B & C). Previous studies have revealed that aeolian sand transport over the dike under oblique onshore winds is facilitated by a wind speed-up, and *in situ* measurements have shown that transport rates could reach until 95kg.m^{-1}.h^{-1} on the windward slope during strongest winds (Tresca et al., 2012). Our knowledge on aeolian sand transport on dikes and their influence on port infrastructure is still limited. In this context, the aim of this study was to analyse coastal dune development and dune types on the "digue du Braek", and to test the efficiency of windbreaks usually installed on the upper beach on asphalt in order to control wind blown sand on the dike. Although effects on fencing on dune formation are well documented (Grafals-Soto and Nordstrom, 2009), no studies have been carried out on their efficiency on seaport dikes.

Figure 1. (A) Study site and location map of Dunkirk seaport, wind conditions (1991-2007) and ground photographs of (B) dike toe dunes and (C) aeolian sand accumulation landward the dike.

Study of dune development on the dike is based on a diachronic analysis of aerial photographs from 1988 to 2009. Aerial photographs have been ortho-rectified, and dunes have been delimited using vegetation limits and digitized as polygons using ArcGIS software. For each year, the cumulated area covered by dunes was calculated, and a margin of error of 28% was applied.
Windblown sand accumulation on the dike was tested using wooden slats and synthetic fabrics with a height of 1.2m and a porosity of 50%. Chestnut posts inserted into concrete blocks were used to fix them on the ground. In February 2011, ten experimental structures were erected on the dike at different locations: dike toe, dike landward and seaward slopes. Sand volume was monitored every month until December 2011, within as well as around each structure, using a Differential Global Positioning System. Digital Elevation Models (DEMs) were generated using standard terrain modelling software based on point interpolation techniques. A 10cm empirically derived margin of error, covering both operator and interpolation errors was applied to the raw data. The overall wind conditions that prevailed over the survey periods were determined from MétéoFrance wind records from Dunkirk station, located 1km east of the survey area.

Results show that dune development can be very rapid on a dike. The "digue du Braek" was built in 1963, and in 1988 dunes were covering an area of 7900m^2. By 2009, the cumulative surface area of dunes was reaching 74000m^2 (fig. 2A, B & C). Dune formation is initiated by *Ammophila arenaria* colonisation of numerous perpendicular cracks in the dike. Vegetation favoured sand accumulation and formation of nebkhas. Their coalescence resulted in the development of continuous dunes. Five different "dike-dunes" types have been identified. Dike toe dunes (1) have developed at the beach/dike contact in the most eastern part of the site, where a 750m long jetty is interrupting net sediment transport. These partly vegetated dunes are 3 to 4m high, reaching in place up to 10.5m above mean sea level, and cover an area of approximately 13000m^2 (fig. 2D). Under oblique onshore winds from the northeast, sand passes over the dike and accumulation prevails in the lee side of the dike where wind velocity decreases, enhancing the formation of landward slope dunes (2) and basin dunes (3) on the embankment of the maritime basin. At some places, landward slope dunes developed and reached the top of the dike forming dike crest dunes (4). It is also possible to observe low elevated shadow dunes (5) scattered on the seaward slope of the dike behind obstacles (boulders, rubbish…).

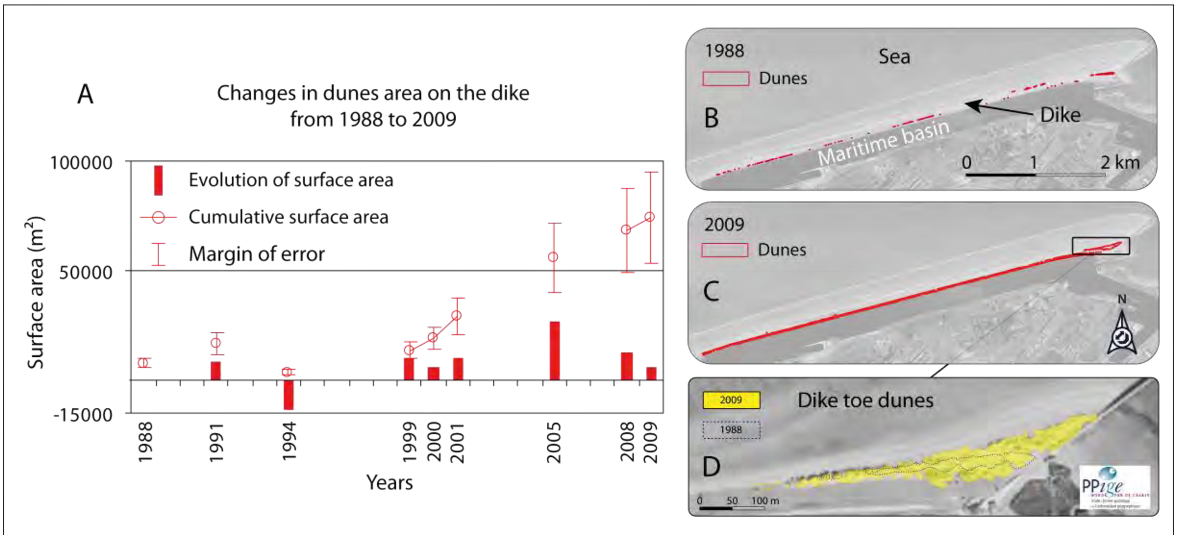

Figure 2. Changes in dunes area on the dike and at the dike toe from 1988 to 2009

Windbreaks were tested at different locations on the dike in order to solve uncontrolled aeolian sand transport problems. DEMs and net volume changes on three of the ten experimental structures are shown in figure 3. All of them were located out of reach of maximum water levels. It is obvious that each of them played a significant role in sand accumulation within the three areas, showing that sand fences usually installed on the upper beach are also able to trap sand on asphalt. Over a 310 days survey (from February to December 2011), the most efficient structure was D1 (fig. 3), a square of 10m x 3m made with wooden slats. A net volume of almost $100m^3$ was recorded within and around this structure. On the upper beach, embryo dunes parallel to the windbreak developed and were rapidly colonised by vegetation. This partly explains the greater amount of sand trapped in this area relatively to those located on the dike, which were not in contact with upper beach or dunes. Sand fences installed on the upper seaward slope of the dike captured a lower volume of sand due to run off towards the dike toe during wet weather. Indeed, structure D2, consisting of a cross-shaped structure made with synthetic fabrics, trapped only $17m^3$ of sand. The linear fence D3 (synthetic fabrics) was located at the toe of the landward slope, and this structure trapped $29m^3$ (fig. 3). Nevertheless, this number is not representative of the total amount trapped, because this structure was along a road where trucks regularly removed sand deposits.

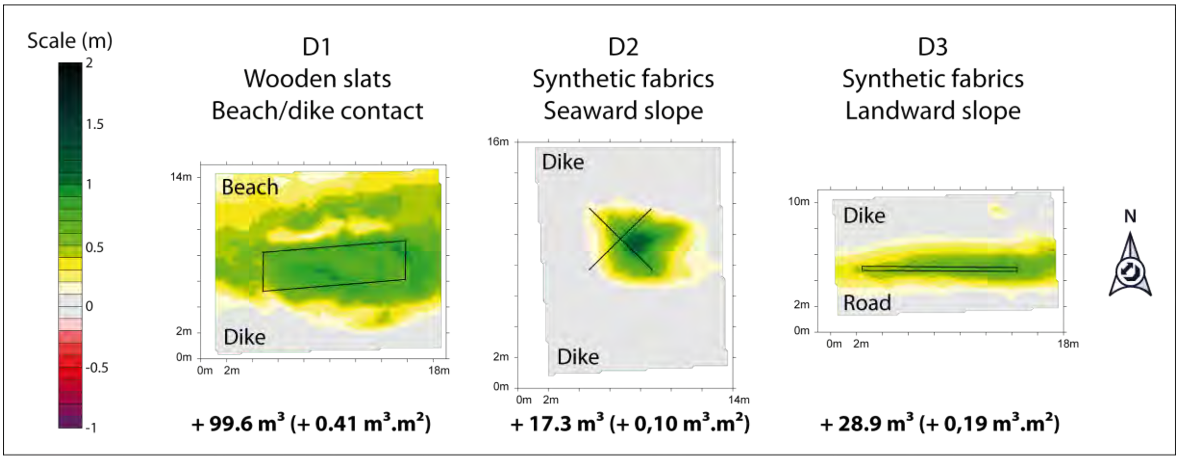

Figure 3. DEMs and net volume change between Feb. 14th and Dec. 21st 2011 on three experimental structures

This paper is an example of how harbor infrastructures can give rise to new kinds of aeolian landforms. In Dunkirk, dune development spontaneously happened on a seaport dike, resulting in a specific dike-dunes typology. It seems important to control aeolian sand transport in order to prevent sand encroachment on infrastructures. It is therefore why experimental windbreaks have been tested on asphalt. Differential volume maps have shown that they were efficient to trap sand on that kind of substrate, but their efficiency seems to have been influenced by their location on the dike, more than by the type of fencing materials. Windbreaks erected at the beach/dike contact were more efficient to trap sand than those installed in the middle of the dike seaward slope, affected by run off during rain periods. The location of the structures well above high water levels makes them dependent of the wind regime exclusively, unlike sand fences usually erected at the dune toe, where erosion can happen due to wave action (Ruz and Anthony, 2008). The results of this study may not only help to fix some aeolian sand transport problems, but it could also help to improve the diversity of landscapes on harbour infrastructures. Indeed, in Dunkirk seaport, dune development has favoured natural development of a new kind of habitat where protected species like *Eryngium campestre* develop. This study will enable Port of Dunkirk to build a management plan of its shoreline, in order to preserve the diversity of landscapes, habitats and species.

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FLEMISCH COAST – VLAAMSE BAAIEN DEVELOPMENT PLAN 2050

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Introduction

The Flemish Coast is situated in Belgium between the French and the Dutch border and has a length of 67 km. In the course of the past century, the Flemish Coast has passed through a number of evolutions that have defined its present character. The natural sea barrier, consisting of sandy belts of beaches and dunes has in many locations been covered over by the construction of dykes and/orbreakwaters, without taking into account the dynamic nature of those sandy zones. In many areas, the beach in front of the seawall eroded and the safety level is only about once in 100 year stormevent.

However the required safety level is 1 in 1000 year. To reach this level the Flemisch Authority is working on a double track policy: an integrated masterplan for coastal safety for the short term and integrated long term vision up to 2050 for the coastal area.

Masterplan Coastal Safety

For the short term the Flemish Authority approved a masterplan Coastal Safety that brings the minimum safety level up to once in 1000 year. The total cost of the plan amounts 300 million euro. The implementation of the plan will last until 2015-2016 and will need about 11 million m³ of sand. See reference.

Vlaamse Baaien Development plan 2050

By the long term development plan a lot of parameters remain unclear and therefore uncertain. How drastic will be the rise of the sea level? How will the economic development play out,…? Yet, these uncertainties need not to be impediments to develop a flexible vision up to 2050. The plan has to fulfil five important criteria: safety: the minimum safety level of once in 1000 year should be guaranteed at all time; natural: more space for nature development should become available; attractive: the coastal zone should become a more attractive area for inhabitants and tourists; sustainable: in the plan special attention should be payed to solutions for marine renewable energy and developing: providing space for economic development in the coastal harbours.

The vision currently developed for the Flemish Coast is built up around a series of possible projects under the following concepts: Coastal Zone Management, Developing Seaports and Islands.

Figure 1 – Zeebrugge area

An important part of the plan is the Port of Zeebrugge. The future expansion of the Port of Zeebrugge goes together with the development of natural and recreational facilities in the adjacent coastal zones of Knokke-Heist and Blankenberge.The beach front can be widened. There is sufficient area for the introduction of marinas, bird sanctuaries and new tourist facilities in the lee of the breakwaters of Zeebrugge II. In the direction of the Westerschelde a protected navigation corridor can be created for the so-called inland estuary traffic.

Under the concept islands, several projects are studied. By raising the existing sandbanks wave conditions in the area between the banks and the coast can be improved thus facilitating coastal protection.

Figure 2 shows a belt of raised banks in front of the coastline giving protection against NW-storms.

Figure 2 - Belt of raised banks in front of the Coastline

In the long term this banks can be developed to real islands used as test facility for renewable wave and tidal energy, as port of refuge, as station for offshore services or port of transhipment.

CONCLUSION

In the long term the Flemish coastal landscape will provide a safe and sustainable environment that can be adapted to changing needs as required. The development of an integrated plan represents the core of the vision: the transformation of the current squeezed coastal region into a broad, natural area that consists of beaches, dunes, sandbanks and islands where the elements of safety, the natural state, attractiveness, sustainability and economic evolution are bound up with common ties and social interests.

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Be prepared to Adapt
"Climate of Coastal Cooperation" Workshop

LITTORAL 2012: Coasts of Tomorrow

International Conference 27th- 29th November 2012, Oostende, BELGIUM

Sharing experiences in integrated coastal zone management will contribute to sound development of coastal resources and to find resilient, adaptive responses to climate change"

by Robbert Misdorp, CCC Editor and Co-author

Rationale

Preparing innovative/resilient/no-regret adaptive options should involve young professionals at an early stage through familiarising ICZM concept and tools.

Aims of the workshop

To present an integrated coastal zone management frame for the three cases:

To present three sets of adaptation by students, using holistic frames and integrated GIS based spatial planning tools, as demonstrated in "Climate of Coastal Cooperation" – CCC Book and Internet Publication;

To familiarise participants and College students by doing.

Description of Activities

Introduction of ICZM approaches and CCC results, concepts, training manuals and tools;

The three cases of Adaptation to a 1m SLR during the 21st century for Belgium coast, for the Holland coast and for the Wadden Sea coast by College students from HKBO - Oostende, University of Applied Sciences Zeeland - Vlissingen and the Van Hall-Larenstein University of Applied Sciences – Leeuwarden;

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