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MA-001

SHORELINE CHANGE RATE ANALYSIS ALONG THE RAMSAR WETLANDS AT THE MEDITERRANEAN COAST IN TURKEY

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Keywords: *coastline change; coastal erosion; DSAS; LANDSAT; Mediterranean*

ABSTRACT

This research is focused on the shoreline change rate analysis by remote sensing techniques using multitemporal Landsat images and Digital Shoreline Analysis System (DSAS) along the Ramsar wetlands at the Mediterranean coastal zone in Turkey. Two wetlands were selected for analysis; Yumurtalik Ramsar wetland includes the coastal zone located in the Cukurova Delta and the Goksu Ramsar wetland located Goksu River delta. Yumurtalik Lagoons was designated as Ramsar Area in 13.07.94 as TURKEY 3TR011 (Figure 1). The site has approximately 19.853 ha surface and between 0m and 3m elevation. Yumurtalik Lagoons have been under protection as Nature Conservation Site by national act.

Lagoons comprise the whole of the alluvial delta formed by several rivers in the eastern Mediterranean Sea, with a broad array of freshwater and coastal habitat types which support sand dune vegetation, salt marsh vegetation, stream bank vegetation, and ruderal vegetation of roadsides and field margins. The threatened sea turtles *Caretta caretta* and *Chelonia mydas* are supported, and the site is one of the key points where migratory birds on the Palaearctic-Africa route meet, using the site as both a stopover and a wintering site. It is also a key area for fish reproduction. The main uses of the area are irrigation agriculture, commercial and artisanal fishing, and recreation, as it is close to the city of Adana along a beautiful and uncrowded coast.

Goksu Delta was designated as Ramsar Area on 13 July 1994 as TURKEY 3TR001 (Figure 1). The site has approximately 15.000 ha surface and between 0m and 5m elevation. Goksu Delta has been under protection as a Specially Protected Area and Wildlife Reserve by national act, as an important wetland delta located on a bird migration route. Sands and saline steppe cover large areas. The site supports reed beds, marshes, swamps, meadows and, in the surrounding area, agricultural fields. It is a refuge for internationally important numbers of wintering ducks. Up to 327 bird species occur, including the globally endangered Phalacrocorax pygmeus and Pelecanus crispus. Two species of endangered marine turtles nest in the area. Reptiles and amphibians (34 species) form a primary link in the food chain of waterbirds. Human activities include fishing, tourism, and conservation education. Remains of cities from Neolithic times through many subsequent civilizations are found there, including nearby Silifke Castle and ancient Seleucia. Non-point agricultural pollution and proposed dams present potential threats.

Yumurtalik Ramsar wetland has accreted toward the Mediterranean Sea as a result of sediment discharge and transport from Ceyhan River, and Goksu Ramsar wetland from Goksu River. These processes have caused the morphological changes (accretion or erosion) of coastline along Ramsar wetlands at the Mediterranean coast. In this research, shoreline changes of Yumurtalik and Goksu Ramsar wetlands were researched by using radio-

metrically and geometrically corrected multi-temporal and multi-spectral data from Landsat MSS, TM and ETM. Orthorectified and geodetically accurate global land data set of Landsat Multispectral Scanner (MSS), Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM) data have been widely used in coastal research and environmental studies for many years. This is because of it is the only record of global land-sea conditions at a spatial scale of tens of meter spanning over 37 years, multispectral features and easy availability make Landsat suitable for monitoring water quality, glacier recession, sea ice movement, invasive species encroachment, coral reef health, land use change, deforestation rates and coastline change. In this study, NASA's Global Orthorectified Landsat Data (GOLD) set, MSS image acquired in 1972, TM images from 1987, ETM image from 2002 and TM image from 2009 were used as satellite data.

In the image processing steps, mosaicing, subset, ISODATA classification, band ratioing (B5/B2), edge detection and overlay techniques were used to carry out coastline extraction and DSAS (Digital Shoreline Analysis System) was used to calculate rate of shoreline changes. Based on our setting, DSAS program generates 353 transects that are oriented perpendicular to the baseline at a 100 m spacing and 35 km length along the Yumurtalik wetland shore (Figure 2). For the Goksu wetland shore DSAS program generates 264 transects that are oriented perpendicular to the baseline at a 100 m spacing and 26.4 km length.

The results of this study present that coastline changes such as erosion and accretion have caused the morphological changes at the Yumurtalik and Goksu Ramsar wetland in the Mediterranean Sea. Coastal erosion is most significant at the Ceyhan river mouth and Kokar cape in Yumurtalik Ramsar shoreline, with the maximum coastline withdrawal about 765 m (Figure 2). Maximum erosion rate was found in Kokar cape coast line as -20.68 m/yr. This cape was moved about 765 m from east to west.

On the other hand coastal erosion is most significant at the Incekum cape and Goksu River mouth in Goksu Ramsar shoreline, with the maximum coastline withdrawal about 650 m. Maximum erosion rate was found in Incekum cape coastline as -25.99 m/yr. As a result of the analysis, in some parts of research area remarkable shoreline changes (more than 765 m withdrawal and -20.68 m/yr erosion in Yumurtalik and 650m withdrawal and -25.99 m/yr erosion in Goksu) were observed for a 37-year period.

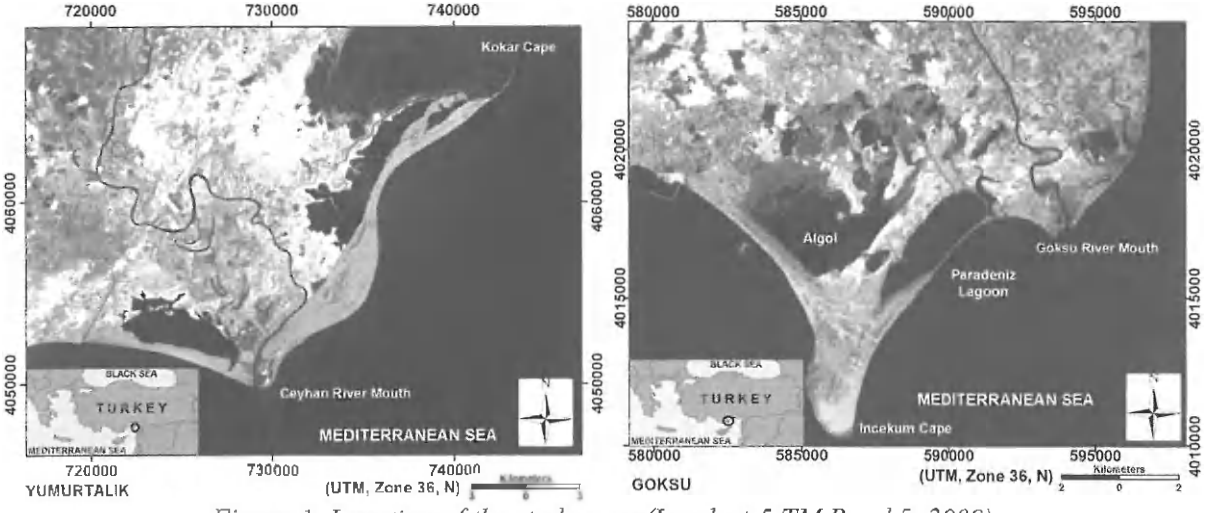

Figure 1. Location of the study area (Landsat-5 TM Band 5, 2009)

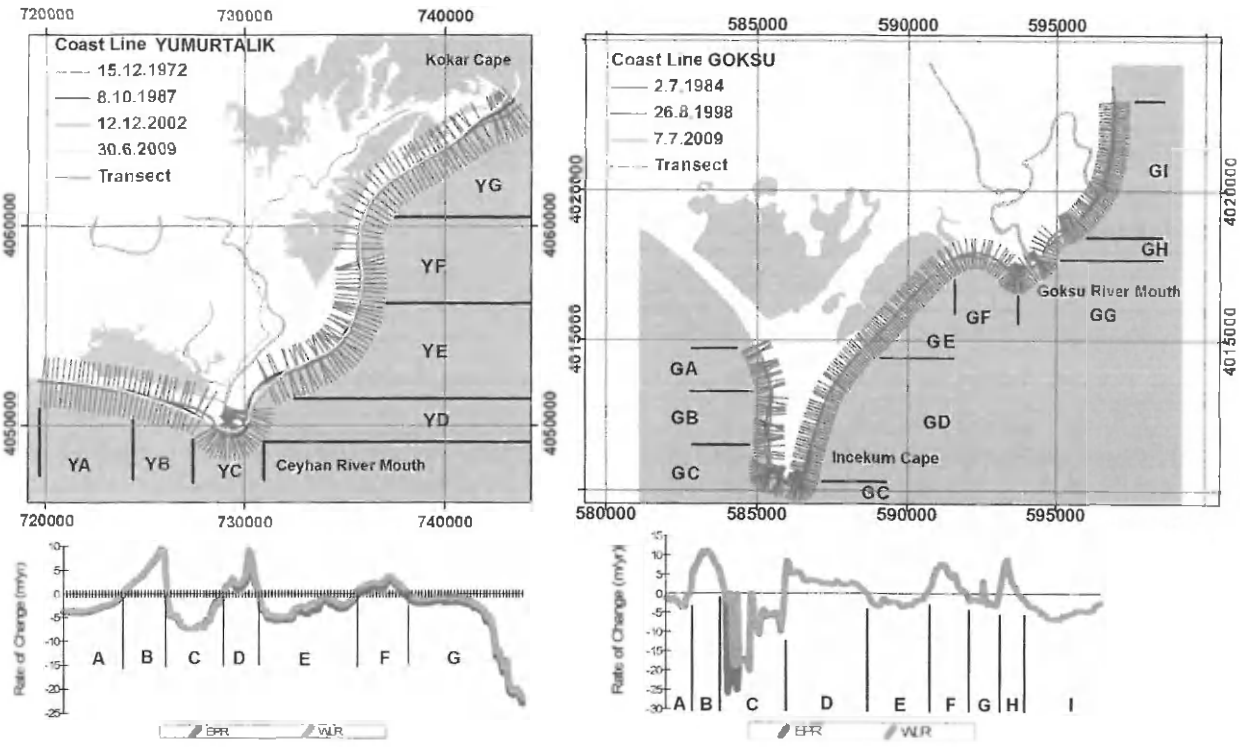

Figure 2. The resulted rates of shoreline changes (erosion or accretion) estimated at each transect are plotted alongshore of the study area.

MODELLING SEABED PHYSICAL HABITAT

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Keywords: *EUNIS, seabed habitat, marine habitat, MESH*

ABSTRACT

The present study is based on earlier work on marine habitats modelling such as the INTERREG MESH (Mapping European Seabed Habitats) and Balance projects that both attempted at describing seabed features in relation to the biology dwelling there. The EUNIS classification is central to this work. EUNIS, the hierarchical classification describing the components of nature, proceeds in the marine realm as a combination of key drivers to benthic habitats, with gradual addition in the lower levels of biological components such as communities and species.

The project addresses the higher EUNIS levels. Each of the contributing physical parameters was split into categories whose cut-off values were determined with the help of benthic ecologists who know the relevance of these values to the biology at the seabed. Where feasible, climatologies were confronted to *in situ* samples and observations to derive the most reliable values. Historic data sets were collated, stitched and harmonised into mosaics as comprehensive as possible to cover the area of interest. In particular, harmonisation was most demanding for substrate maps because they were usually found at various scales in different classification systems.

In this study the resolution of 100 metres was deemed achievable since the main data layers - namely bathymetry and substrate - were available at this cell size for most of the French coastal zone. The model was built in the ArcGIS model builder. Raster data layers were fed to the model at their nominal resolutions and re-sampling to the final cell size was automatically performed by ArcGIS. The model was designed to be as automatic as possible, with a view to enable easy update as new data layers come up in future.

In order to inform users on the reliability of the maps two methods were developed. Firstly a confidence scoring system was set up as a combination of individual scores computed at each cell. Secondly an external validation was also carried out by way of a contingency matrix to yield a more global confidence score. Eight maps at scale 1 / 300 000 were produced using a colour scheme adapted to best showing the sequence of habitats from smaller units at the coast to larger patches on the shelf. Maps were made available to the public through WMS services.

Links
MESH web site: www.searchmesh.net

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[2] EUNIS - http://eunis.eea.europa.eu/habitats.jsp

UNDERSTANDING THE VARIATION IN PHYSICAL PROCESSES IN MANAGEMENT OF THE COAST OF GUERNSEY

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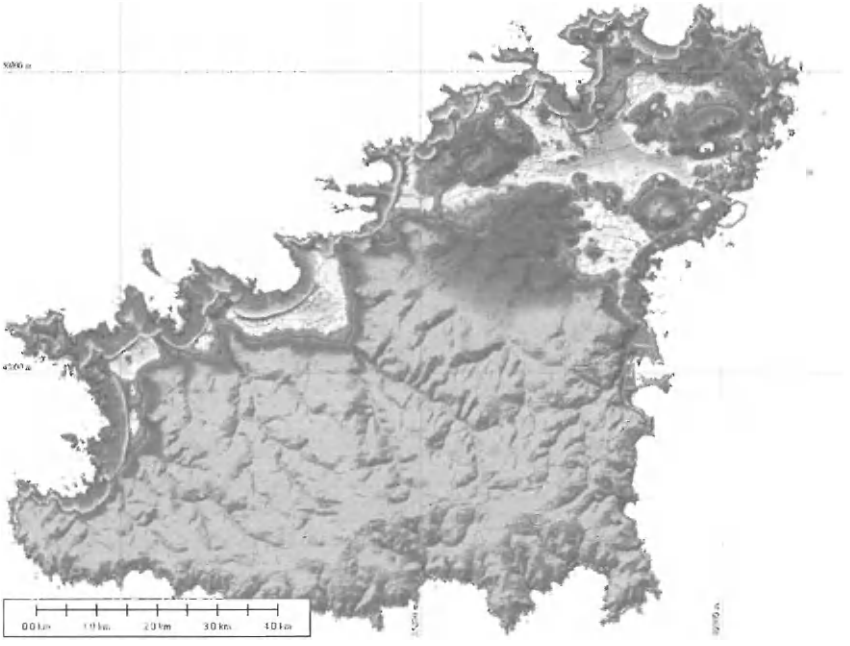
Keywords: *variation in physical processes, management, coastal Guernsey, Channel Islands*

ABSTRACT

Guernsey is a member of a group of islands known as the Channel Islands, located in the English Channel approximately 45km from the coast of Normandy, France. The island is some 13km in length and only some 6km. wide. However, with nearly 60km of coastline, it is easily appreciated that management of the shoreline, the risks associated with flooding and coastal change is of fundamental importance to the economic, ecological and cultural sustainability of the island state.



Over the southern section of the island the coastline is principally hard rock cliffs but, over much of the west, northwest and eastern shoreline, the coast comprises local bays backed by areas of soft sediment infill, backed in many sections by areas potentially at significant flood risk.

Management of the infrastructure generally has, over the last two decade, moved to an approach supported by GIS mapping of important aspects and assets and this approach has been strongly pursued in developing the island's approach to management of its shoreline and risk from erosion and flooding. It is recognised that that the broader scale understanding, enabled by such an approach, allows features of coastal management to be far better managed in a coherent and integrated manner with important aspects of the island's hinterland.

The paper considers one aspect of this move towards a more integrated approach to coastal management, looking at how modelling and mapping of the physical coastal drivers allows a more complete understanding of coastal risk. The need for such an approach was identified as one conclusion from the Guernsey Coastal Strategy undertaken in 2007.

The current study has focussed on certain specific areas of the coast, considering in certain areas the strategic flood risk to the northern section of the island, while also examining in more local detail the potential for realignment and the need for improvement to existing defence systems.

Underpinning these elements of work has been the need to develop a more complete picture of wave conditions and water levels around the whole island. Numerical modelling, together with analysis of tidal record has been undertaken. This has shown a complex pattern of behaviour that can only be fully appreciated through clear interactive mapping.

The paper discusses some of the difficulties in combining datasets in a meaningful manner, relating this to different scenarios for assessing risk. It also discusses the benefits seen in using GIS as a data management tool both in developing the current study and in providing a basis for future analysis into the future. The paper shows how through a strong visualisation of data produced from the study is used to help develop a better understanding of the relevant issues for management and helps to draw together different data sets providing greater confidence in management decisions that may affect the island over the next 100 years.

MA-005

SPATIAL EXPLICIT TOOLS TO SUPPORT AN ECOSYSTEM-BASED MARINE SPATIAL PLANNING IN THE GERMAN EEZ

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Keywords: *generalized additive models (GAM), geographic information system (GIS), German EEZ, marine spatial planning (MSP), nursery grounds, Pleuronectes platessa, spatial management scenario*

ABSTRACT

Ecosystem-based marine spatial planning (MSP) as a process maintains ecosystem health and services by informing about the spatial distribution of activities and processes in the oceans and can be used to assign values to management strategies sustaining the marine environment. The safety and efficiency of navigation as well as commercial and scientific uses are significant objectives of the ecosystem-based German MSP, but the protection of the marine environment and a sustainable development are the most important ones. Conflicts can emerge between these objectives, respectively between human activities and between human activities and their environment. Here we present spatial explicit tools to assess the consequences of spatial management scenarios for both activities and important ecosystem components such as the nursery grounds of *Pleuronectes platessa* in the German exclusive economic zone (EEZ).

Plaice is a fish species of high commercial value, the availability of nursery grounds is a crucial factor determining efficient recruitment. We divided our presentation of tools evaluating the marine spatial management in the German EEZ in three steps, described below.

I. To gain an overview about general conflicts between the objectives mentioned, a conflict analysis of human activities and their ecological footprints was made. The scoring of activity combinations highlighting potential conflicts based on a conflict matrix. Human activities, the calculation of their footprints and the resulting conflicts were mapped using a Geographic Information System (GIS).

II. To investigate the impact of these activities, a risk analysis of human pressure on nursery grounds of plaice was made. Taking into account the relationship between the spatial distribution of juvenile plaice and important ecological variables, nursery grounds were modelled using generalized additive models (GAM). The individual human activities were allocated to generic pressure categories (like abrasion, obstruction, extraction, siltation, contamination, smothering) and their (combined) effect on the nursery grounds were evaluated by accounting for the spatial overlap and sensitivity to those pressures. We evaluated the sensitivity of nursery grounds of plaice by calculating a sensitivity index using the modelled presence and absence data and life-history traits. In this way we were able to calculate an impact score for each activity to gain a spatially explicit risk assessment which was visualized taking advantage of the GIS.

III. In order to assess future conditions, the risk of an implementation of a new activity in the German EEZ was studied in a spatial management scenario. To predict the likelihood of occurrence of new conflicts between activities or conflicts between the new activity and nursery grounds, the implementation of new future offshore windfarms was modelled. Therefore, an enlarged conflict and risk analysis was made and the resulting spatial information mapped using the GIS approach.

In conclusion, MSP supported by spatial explicit tools such as GIS is a powerful tool visualizing future conditions. The GAM is useful in describing the relationship of the distribution of an organism to its environment. Combining these tools on the base of spatial explicit maps could assist in identifying areas of conservation potential, reducing conflicts and thus supporting the implementation of an ecosystem-based management.

THE USE OF SPATIAL NARRATIVES TO PROMOTE STEWARDSHIP OF COASTAL RESOURCES

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Keywords: *spatial narrative, spatial literacy, stewardship, place-based games, coastal heritage tourism, Great Lakes, Wisconsin, Minnesota, St. Louis River, estuary, watershed, National Estuarine Research Reserve*

ABSTRACT

A spatial narrative is a conceptual framework that brings the qualitative experience of place together with the geoscience analysis of space. A meshing of qualitative knowledge with geographic and ecological sciences to synthesize spatial narratives can help us understand human-ecological relationships and enrich coastal planning and management.

This paper examines how spatial narratives are being used to promote stewardship of Great Lakes coastal resources through two projects. The first is a joint Wisconsin/Minnesota Sea Grant project to enhance public awareness and understanding of the scientific research and resource management issues in the new St. Louis River Estuary National Estuarine Research Reserve (NERR) dedicated in October 2010. The second is the Wisconsin Coastal Guide, an interactive web mapping site that promotes coastal heritage tourism associated with the Great Lakes Circle Tour – a scenic driving route around each of the lakes.

Spatial narratives in the St. Louis River estuary and watershed are advanced through a three step process:

1. Development of an open archive of the scientific studies and associated data undertaken in the estuary and watershed. The initial version of the archive includes a web-based annotated bibliography of scientific studies utilizing RefWorks software and a catalog of geospatial data for the watershed and estuary utilizing GeoNetwork software developed by the United Nations. The archive will grow to include access to the data supporting scientific studies conducted in the estuary and watershed.

2. Communication of stories associated with the resource management issues and findings from the scientific research. Sea Grant programs employ communications and outreach staff that work to translate scientific research to help coastal constituencies. This represents the base of an effort to make scientific findings more accessible and understandable to the public. Specific to the St. Louis River Estuary, three dozen interviews have been conducted with stakeholders in the area. Interpretation and synthesis of the interviews creates "vignettes" of local resource management issues such as water quality in trout streams, beach health, restoration of wild rice beds, stormwater

management, supplemental fishing and environmental justice, and restoration of a Sturgeon fishery in the St. Louis River.

3. Creation of place-based games to encourage the public to experience and appreciate the new St. Louis River Estuary NERR. A palette of place-based games and tours are being created to encourage people to visit the estuary. The centerpiece are "geo-quests" created using a new game engine for the iPhone titled "Augmented Reality Interactive Storytelling" (ARIS) developed by the University of Wisconsin-Madison. The geo-quests allow exploration of "contested spaces" in the estuary.

The Wisconsin Coastal Guide (http://www.wisconsincoastalguide.org) encourages those travelling the Great Lakes Circle Tour to leave busy highways and instead explore scenic roads and streets of coastal communities. Layers on the interactive map include the Circle Tour route and secondary loops, local roads, parks, beaches, lighthouses, shipwrecks, historic sites, nature centers, and public boat access. Click on a lighthouse and you can quickly link to one of the many websites that provide photos and detailed information about its history. Click on a shipwreck and learn about the service history and final voyage of the ship, along with details about where to dive. Click on a beach and view public health data about swimming risks. Panorama photos have been taken at the public access sites to the Great Lakes in Wisconsin. Click on one of the photo icons and you can navigate the 360 degree field of view and see the direction you are viewing on a linked vicinity map. The GeoRSS feed from Portal Wisconsin – a statewide cultural arts calendar – provides details about upcoming events in coastal communities. Geo-located "Great Lakes stories" aggregate oral histories, essays, and other multimedia. The result of access to all these map layers is that travellers interested in the Great Lakes Circle Tour can create a personalized itinerary for the coastal cultural heritage experience that most interests them.

Spatial narratives serve as an interactive, web-based and mobile platform to engage citizens in place-based learning and coastal stewardship. With new modes of place-based learning, social media, and participatory decision-making, spatial narratives have the potential to advance spatial literacy and thoughtful dialogue around environmental sustainability in coastal communities.

MA-008

FLOODS IN THE COASTAL ZONE OF TOGO: IS GIS THE BEST WAY OF AN EFFICIENT MANAGEMENT'S APPLICATION?

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Keywords: *coastal zone, disaster, flooding, damage, adaptation, GIS, riposte.*

ABSTRACT

This paper demonstrates the importance of GIS for sustainable floods management in the coastal area of Togo, through the example of urban flooding in Lomé where damage is increasingly enormous. The different treatments applied to satellite data will help establish databases and maps that can serve as a tool for decision support for the authorities.

West African towns bordering the sea have similar characteristics in their urbanization, their socio-economic and political development (Ouédraogo, 2008) as well as sensitivity to extreme weather events including floods and heat waves. More than 770,000 people were affected by floods in West Africa in 2009 (OCHA, 2009). The city of Lomé, Togo's capital, located in the Gulf of Guinea, is no exception to this situation where there is a lot of damage especially during the last decade including 2007, 2008, 2009 and 2010. We note in particular the loss of property and human lives, damage to buildings, the proliferation of diarrheal diseases and infectious diseases, contamination of groundwater subcropping, etc. According to the National Planning Committee of Relief, in 2009, 13 neighborhoods of Lomé-common were affected by flooding with 13 761 affected equivalent to 2660 households including 168 students. Attempts to manage this risk have necessitated the establishment of a number of strategies and tools by the government such as the plan of rescue organization (ORSEC), the National Contingency Plan, the Plan of Action National Climate Change Adaptation (NAPA), the Early Warning System (EWS), the Hyogo Framework, the water code, etc. However, there are still difficulties in the management of floods in Lomé, particularly in dealing with current climate trends marked by torrential rains over short periods.

The coast of Togo, particularly the city of Lomé, presents predisposition that makes it vulnerable to flooding: the lower morphology of the area marked by valleys, depressions on the plateau of bar-clay and lagoon system which receives the waters from hydrographic basin of rivers Zio, Haho and Mono. These rivers drain the water in the lagoons and discharged it into sea water. The water comes back into the soft sedimentary basement of the cords and valleys causing rising of groundwater levels. This predisposition to flooding is reinforced by a strong human influence (350 inhabitants / km ^{2}) marked by large political, administrative and economic clusters of which the Autonomous Port of Lomé, Lomé's big market around which are built intense business relations, the phosphate processing plant and wharf for transshipment of Kpémé. It follows an unplanned occupation of space and even topographical areas at risk of flooding: where the damage mentioned above.

Question the ability of stakeholders to manage and especially to adapt to this situation is primordial. In the context of climate change, it is necessary to anticipate or prevent flooding, to implement the strategies of response to this disaster and to propose strategies for recovery

and adaptation. This requires an availability of accurate maps, digital delimitation of affected areas and the appropriate tools: the geographic information system (GIS) is probably the right tool. Scenarios of current and future trends can be developed for eventual development projects in the city.

The application of GIS for flood management will help establish useful databases for a warning system of risk and make arrangements for anticipation and riposte. The superposition of created layers will help compare situations of different years. It will also help estimate the likely cost of damage.

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SENSITIVITY OF COASTAL FLOOD RISK ASSESSMENTS TO DIGITAL ELEVATION MODELS: CASE STUDY LAGOS STATE, NIGERIA

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Keywords: *DEM, data accuracy, coastal flood risk mapping, SRTM DEM, ASTER GDEM*

ABSTRACT

This work is the result of a thesis submitted in partial fulfilment of the degree of Master of Science at Wageningen University and Research Centre, The Netherlands (Laboratory of Geo-Information Science and Remote Sensing) and in cooperation with Royal Haskoning. Currently I'm working for Royal Haskoning.

Introduction and relevance

Coasts are experiencing the adverse consequences of hazards related to climate change and sea level rise, and will be exposed to increasing risks of coastal flooding (IPCC 2007; Nicholls et al. 2007; Nicholls et al. 2008). Coastal zones and deltas already contain a larger share of the world's population and will get more heavily populated (10% of the world's population is living in the 10 meter Low Elevation Coastal Zone which covers 2% of the world's land area)(McGranahan et al. 2007). This emphasizes the urge for coastal flood risk assessments where many GIS components and mapping can be incorporated.

GIS approach

In greater lines, coastal flood risk mapping can be approached from a widely used concept of flood risk mapping, which is schematically shown in the figure 1 (Martine & Loat 2007). The probability of a hazardous process like a coastal flood can result in potential adverse consequences for socio-economic and ecological assets, which determines the risk of coastal flood. For GIS-based flood risk assessments three types of geo data are needed for building up coastal flood risk models (see figure 1).

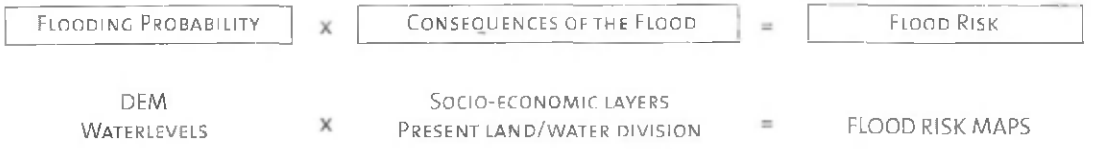

Figure 1: Conceptual risk equation

DEM as critical factor

Most coastal flood risk assessments are based on a conceptual risk approach where Digital Elevation Models (DEM) are used as means to estimate the flood hazard for coastal zones according to projected water levels. The resolution and accuracy of DEM data is critical regarding the results of coastal flood risk assessments, because these data determines whether a location through a flood simulation will be flooded or not. Commonly, publicly available DEMs like ASTER GDEM 30 m. horizontal resolution dataset (METI & NASA 2009) and SRTM DEM 90 m. horizontal resolution dataset (CGIAR 2008) are used for coastal flood risk assessments (Holmes et al. 2000), although the resolution and accuracy of these datasets

is relatively low. Many users end up using SRTM DEM and ASTER GDEM dataset, because it is free and ready to use for modelling (De Roo et al. 2007; Demirkesen et al. 2007; Lugeri et al. 2010). However, the sensitivity of coastal flood risk assessments to the publicly available DEMs, and the effect on coastal flood hazard and flood risk estimations based on these datasets is currently overlooked.

Comparing DEMs - Case Study Lagos State, Nigeria

A case study in Lagos State (Nigeria) has been conducted to show the effects on flood hazard and flood risk estimations by comparing with LiDAR DEM estimations, which was adopted as ground truth. In two case study scales with differing horizontal focusing scales (Lagos State and Lagos City) and differing vertical focusing scales (5 meter Low Elevation Coastal Zone and storm surge water levels) the effects of the usage of the publicly available DEMs have been revealed for the hazard area estimations and population at risk estimations. The results have been supported by error statistics of the used DEM datasets.

Conclusion

In general can be concluded from the case study that both ASTER GDEM and SRTM DEM overestimate the elevation, and underestimate the hazards and risks for almost all projected water levels with a factor larger than 2 in terms of flooded areas and affected people. This applies for both case studies. For almost all projected water levels SRTM DEM gives better results (closer to LiDAR DEM estimations) than ASTER GDEM.

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NON-PARAMETRIC ESTIMATION OF THE SEA STATE BIAS IN JASON-1 MEASUREMENTS AND THEIR EFFECT ON MEDITERRANEAN MEAN SEA SURFACE HEIGHT

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Keywords: *Jason-1, nonparametric model, Sea State Bias, Significant Wave Height, Wind Speed, Sea Surface Height, Western Mediterranean Sea.*

ABSTRACT

The accuracy of Sea State Bias models remains limited and continues to be a topic of research. Sea state bias (*SSB*) is calculated here anew from 6 continuous years of Jason-1 altimeter ocean observations (cycle 001 to cycle 250) using the nonparametric (NP) empirical model as pioneered by Gaspar and Florens (1). The input data are sea surface height (ssh) differences at crossover points, separated in time by at most one repeat cycle. Results are achieved using an enhanced three-dimensional (3D) Sea State Bias (*SSB*) correction model as a combination of significant wave height (swh) and wind speed (u). This work has two main objectives: 1) estimate *SSB* using new altimeter Jason-1 datasets and 2) quantify the mean sea surface height over Mediterranean Sea.

ASSESSMENT OF EUROPE'S COASTAL ZONES - DATA SOURCES AND ANALYTICAL TOOLS

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Keywords: *EU environmental policies, data sources, coastal zones, spatial analysis*

ABSTRACT

Development of European integrated coastal policy framework requires continuously improved support of spatial information, better regional assessments and understanding of trends at European level, providing guidance for implementation at other levels. A number of existing relevant policies affect the coastal zones, but also enable new data sources and development of analytical tools that could be used for assessment of the state of coastal zones.

Human activities on land resulting in nutrient and chemicals discharges can result in marine pollution, particularly in coastal waters. Delineation and status of the coastal water bodies is subject of EU water legislation, including the Water Framework Directive.

Many coastal ecosystems still remain adversely affected by current land-use practices and the ever-growing demand for coastal lands from urbanisation. European trends of coastal land take has been analysed on the basis of latest available land cover change data. There are new emerging opportunities to monitor land change at the coasts, related to European initiative on Global Monitoring for Environment and Security (GMES).

Coastal lowlands across Europe have experienced rapid rates of development. As a result the capacity of natural systems at the shoreline to act as a buffer between the sea and the land has reduced. This increases exposure of coastal areas to sea level rise, in particular during extreme events, such as storms. EU policy for climate change adaptation creates a demand for new risk assessments and mapping of natural and economic resources at the coasts.

Implementation of the EU Marine Strategy Framework Directive provides new opportunities for collecting data on economic activities that are relevant to the coasts. This includes maritime transport, renewable energies or tourism. Data collection for spatial analysis of sea uses has become important work direction in assessment of coastal ecosystems.

Europe has long worked towards more collaborative and integrated approach to decision making involving all users of the seas and coasts. The EU Integrated Coastal Zone Management (ICZM) approach, together with maritime spatial planning and protection of habitat types and species of Community interest, have recently received much attention and will be further contributing to multi-functional and balanced development of Europe's coastal zones.

The ecosystem-based approach to management of human activities is now a key concept of several EU policies. This requires conceptual development and research that can inform

management practices and allows for assimilating outcomes from multiple science initiatives and roll-out of new spatial methodologies and tools.

Such tools include anything from harmonisation of single information layers describing the physical environment to development of coherent habitat and resource maps or even spatial presentation of human activities spanning entire marine regions. These can again be applied for linking ecological information with human activities in order to assess cumulative pressures and impacts in the coastal and marine environments. This also includes experimental tools for coastal ecosystem accounting.

Some of the most recent analytical tools based on spatial information will be presented in the context of the new up-coming assessment of the state of coasts in Europe.

SIARL - COASTAL RESOURCE MANAGEMENT SYSTEM IN PORTUGAL

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Keywords: *coastal integrated management, information systems, open software, geographic information, monitoring, land use, interventions, events and hazards, management plans, constraints, participation, cooperation, convergence, WMS, WFS, INSPIRE, ICZM.*

ABSTRACT

SIARL - Coastal Resource Management System - is an interactive tool supported by geographic information, which enables a global and local perspective, integrates the entities and stakeholders who act on the main land coastal areas of Portugal and allows a continual coast knowledge update.

SIARL is targeted to overcome the fragmentation and lack of information at the time of decision. The main objectives are: to increase the knowledge of the territory; to systematise information and make it accessible; to economise and avoid redundancy; to promote coordination and interaction between agencies and users; to improve the efficiency and the capacity of response.

SIARL

The principle of SIARL is that each organization operates under a network where they can optimize the knowledge and the information without disregarding each agency's autonomy. It is intended to embody the principle of subsidiary and accountability of the public interest where the free flow of information is encouraged.

SIARL is promoted by 15 entities that are central and regional responsible for coastal management in the field of geographical information, water domain, nature conservation, and land use and planning in the mainland of the Portuguese Ministry of the Environment and Spatial Planning.

This system was developed under 2 relevant European policies:

- The European Recommendation on Integrated Coastal Zone Management (ICZM), where integration is the key concept, given the effective discontinuity in what concerns planning and management in certain coastal areas;
- The INSPIRE Directive, which has as main goal to facilitate and promote the access to geographic information and improve the monitoring of the territory.

The system will have, at the beginning, a more institutional character, albeit some information will be available to the public. Later on, it will tend to evolve so that the information may be available to be used by citizens and by the knowledge society, allowing wider participation in the process of coastal areas management and planning.

SIARL will use a geo-portal connected to a database, and foresees the development of information catalogues and data services of interest, which generally involves:

- Data treatment and other geographical services to facilitate access to relevant geographic information for coastal management and performance of the agencies involved, whether current or historical information (webmap services - wms and web feature services -wfs)
- Access to the features of Land Use and Management Plans (wfs);
- Interactive management of the information considering the risk issues (erosion, flooding, sensitive geological areas) and the continuous need for its update (wfs and transactional web feature service - wfs-t);
- Registration of relevant works, studies and other documents (photos, clips, links…) with interest to the coastal knowledge, with geo-referenced documents focusing areas when applied;
- 3 modules for systematic recording of information with geographical expression to be used for supporting coastal management and planning:
- Occurrences in the geological and water domain, such as accidents and hazards (split oil, falling cliffs, extreme events, degradation of infrastructures);
- Interventions in everything that involves public expenditures, namely coastal infrastructures;
- Coastal uses and occupation in order to monitoring land use, allowing a centralized access to the permits of central and local authorities with physical expression on the territory.

As it had been developed on open source software, it is a model with evolution capacity and easy replication, having a high potential for others to benefit from work already executed which, in turn, may contribute to the improvement of the concept itself.

Important dates:

- SIARL tests kick-off: 19 May 2011
- Fully online operational system: September 2011

MA-020

IMPLICATIONS OF ACCESSIBILITY DEGREE IN DANUBE DELTA HUMAN COMMUNITY, ROMANIA

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Keywords: *accessibility degree, biosphere reserve, sustainable development, Danube Delta, Romania*

ABSTRACT

Accessibility and economic potential are associated with regional development. There are many factors influencing the regional development and accessibility to the markets and to the hospitals are some of them. Accessibility is a key factor in understanding relationships between the biophysical and socioeconomic characteristics of the villages studied, especially the interactions between landscape conditions and natural resource management practices associated with different land use patterns. The aim of this research is to examine the potential for using accessibility methodology to assist decision making in sustainable social development. We consider the role of public transport: road transport and fluvial transport. The study focused on the complexity given by the relationship among economic development, transport, land use and biodiversity conservation.

The Danube Delta is located on the east part of Romania and is approximately 493 390 hectares (Map 1). It was declared a biosphere reserve by UNESCO in 1990. The settlements have a population over 14 000, concentrated in one town (Sulina) and seven communes (22 villages). This area has a long history of being peripheral due to poor transport condition. A strong colonial influence the diversity of culture provides for an attractive cosmopolitan atmosphere in a deltaic area. The Danube Delta is home to a rich mix of Romanian, Ukrainian, Russian, Lipovan, Bulgarian, Moldavan, Turkish and Gagauz people, scattered around the delta in small villages.

Geographical dispersion and low population density were induced under the land separation by water bodies. This implies that the areas are comprised of sparsely populated rural, fishing, farming and touristic areas. Danube Delta has a poor road network. It is only accessible by land via Periprava - Cardon. Physical barriers have contributed to the peripheral nature and the particular characteristics of production system. Tulcea city, county capital and major market is located 100 km from Periprava (the farthest village by water). Main transport is focused on the fluvial access available only three times a week. Public passenger boats start Monday, Wednesday and Friday at 13 PM (local time) from Tulcea to the settlements located on the three main arms: Sulina, Sf. Gheorghe and Chilia and return the following morning. In summer when tourist numbers increase the frequency is improved with private catamarans.

Data and Methods

Accessibility analysis encompasses spatial and socioeconomic aspects, requires extensive date and involves amount of computation. We used an integrated GIS tool, Accessibility Analyst, developed by Andrew Farrow and Andy Nelson (CIAT) which was built by integrating a number of well-established accessibility measures with ArcView 3.2. This provides the capacity to estimate the geographic coverage of an existing target (place of interest) such as hospitals, schools and markets. For measure physical accessibility to health

care exist also another ArcView extension called AccessMod elaborated by the World Health Organization. The procedure was based on existing administrative maps and on surveys of the services in charge of roads and fluvial transportation, healthcare and education. The following GIS layers and other information are necessary in order to run the Accessibility Analyst: a coverage of places of interest and a grid where each cells value represents the cost of traversing that particular cell. We need also one or more of themes for creating the friction theme – vector layers (shapefiles) with transport cover, the limit of the analysis, rivers, land cover, a digital Elevation Model or barriers. Population distribution grid, hospital's number of doctor or beds, or number of teachers at a school could be additional characteristics. The next step was to compare the accessibility model results with the data of socio-economic indicators (GDP, population dynamics, unemployment rate and poverty rate).

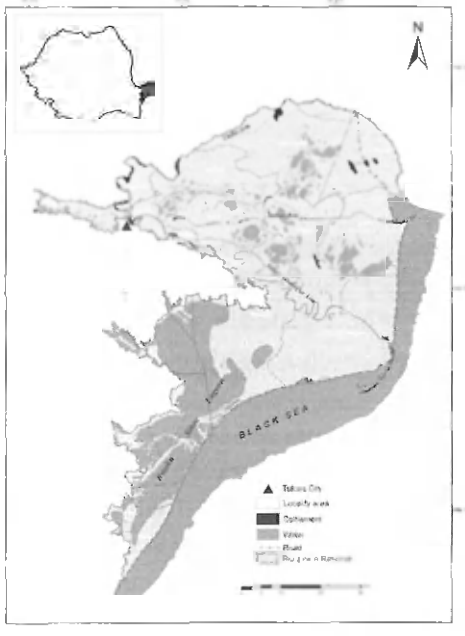

Fig.1 - Study area map

Results and discussion

The outputs provided travel time from all villages to the target destination Tulcea city. Average travel time back and forth is 11-13 h from Periprava, 8-10 h from Sf. Gheorghe and 6-7 h from Sulina. The speed is higher on Sulina arm because it was shortened by correcting meanders and embankments since 1856. In examining the correlations results it is clear that the socio-economic factors are controlled by topography. The most obvious barrier was the water bodies, which acted to isolate the settlements. Implications of accessibility on patterns of rural development are explained in terms of small-scale fish trade, a continuous depopulation, population ageing, a high unemployment rate and also a high poverty rate.

Tourism is the new trend, but a fundamental precondition for the tourism development is transport. The poor number of roads and the frequency of public passenger boats towards Tulcea, the nearest place with a hospital and major markets show that this area is very restrictive and fragile. The geography of the modern accessibility landscape on the Danube Delta is evidence of a "border economic" shift in an area where changes occur slowly. In the 20-year time frame after the socialist period no extraordinary changes in accessibility were seen. Today, the influence of regulatory restrictive factors, both physical and legislative (protected area and biosphere reserve), is necessary to base on the awareness and involvement of the local population, investors, tourists and the competent bodies of Danube Delta Biosphere Reserve Authority (DDBRA, founded in 1990).

Using accessibility as an entry point gives a better idea of what actually happening from the point of view of socio-economic development in many critical areas of Danube Delta. Accessibility measures of access to health and education for each section of the population can therefore help to inform land use planning to ensure that potential sites are protected for new facilities and that the location of new homes protects access needs. Accessibility auditing and analysis also provides an empirical base for integrated planning that can be used together with other inputs such as identified local needs, to ensure the sustainability of capital investments in facilities.

MARINE AND COASTAL DATABASE MANAGEMENT AND GEOGRAPHICAL INFORMATION SYSTEM CONTRIBUTION FOR MARINE RESEARCHES: CASE OF GULF OF GABES, TUNISIA

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Keywords: *Marine and coastal GIS, database assessment and management, metadata, ISO 19139, Gulf of Gabes, remote sensing and modelling.*

ABSTRACT

Oceanographic and marine data require a very wide range of measurements and efficient tools able to provide a huge multidisciplinary dataset. The high cost of oceanographic data acquisition and the difficulty in combining dissimilar data type (spatially and temporally) justify the development of dedicated systems for their integration and interpretation (Wright and Goodchild, 1997; Stanbury and Starr, 1999).

Applications of Geographical Information System (GIS) in Tunisian marine environment are still in its initial stages. This may be due to the large volume of marine data and metadata heterogeneity or absence. The goal of this work is to set up a marine and coastal GIS with a special interest to metadata according to International Organization for Standardization (ISO) so as to build an Interoperable web marine and coastal GIS specific to the gulf of Gabes. This area of study is located in Tunisia's southeastern coast. It is of particular interest to marine scientists because of its unique ecosystem known by its wide continental shelf area, its very high tidal range and its rich biodiversity. However, intensive anthropogenic activities are responsible for marine pollution from phosphogypsum and benthic habitats loss from overfishing (Rabaoui et al., 2010).

For all these reasons, we divided our work into three tasks. The first one was to assess and manage data from 1925 to 2010 composed of: habitat type, seagrass bed, substrate, sedimentaology, sea surface temperature, chlorophyll-a, fishery, pollution, oil and gas permits, wetlands and socio-economic data. This database includes historical data, extracted from public institutions database, remote sensing images from NOAA AVHRR, Seawifs, MODIS, Landsat 7 and hydrological data from MEDAR/MEDATLAS [1] and our national hydrological database HYDROBASE obtained during field cruises. The next task was to improve data access by implementing our database into GeoNetwork which is a user-friendly catalog application able to manage spatially referenced resources. The third task was to define Metadata which helped us to reduce information loss during data exchange. Thus, we devoted the major part of this work for metadata checking based on ISO19139 [2] that gave us a consistent data quality level and Interoperable.

This database assessment and management has significantly increased the ability of interpretation and opened up new scientific applications in the gulf of Gabes; so, we

developed three topics. The first one was about the ecological niche modelling. Our marine and coastal GIS database was used to validate models and draw up potential situation about the distribution of 59 species of fish, cephalopod and crustaceans under climate change effects from 2041 to 2060 and from 2070 to 2099 (Hattab et *al.*, 2011). The second topic concerns ocean color analysis using 153 MODIS satellite images and its validation using our national database (Observatoire de la mer) (Hattab et *al.*, 2011). The result of this study showed us that the bio-optical algorithm MEDOC3 of chlorophyll a is the suitable one for the gulf of Gabes case (RMS = 0.095). The third theme was focused on temporal distribution of seagrass cover by using Landsat 7 within the coastal area of the gulf based on in-situ data of seagrass cover mapping. Further multidisciplinary researches can be developed to study the integrated coastal zone management and fishery and biodiversity ecosystem approaches.

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[1] MEDAR/MEDATLAS is a project that makes available a comprehensive data product of temperature, salinity and bio-chemical data in the Mediterranean and Black Sea.

[2] ISO19139: provides an XML implementation schema for ISO 19115 specifying the metadata record format.

GRIDDING AND ARCHIVING OF SATELLITE-DERIVED OCEANOGRAPHIC DATA FOR ANY REGION ON EARTH

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Keywords: *chlorophyll concentration, total suspended matter concentration, sea surface temperature, MODIS, MERIS*

ABSTRACT

The JELLYFOR project aims to set up a jellyfish forecasting system based on in situ and remote sensing input data. Existing image processing software from the BELCOLOUR project was improved, extended and adapted to process large numbers of MODIS and MERIS images in order to create a gridded dataset of chlorophyll a concentration (chl), of sea surface temperature (sst – MODIS only) and of total suspended matter concentration (tsm). The software focuses on flexibility; the configuration of a new region is as simple as defining the bounding box in latitude and longitude. The software can be easily adapted to producing new and custom products. Additional sensors or datasets can be added if an appropriate reader is available or implemented.

OceanColor MODIS Aqua L2 files from NASA and MERIS RR L2 files from ESA were processed for an eight-year period (01/01/2003 – 31/12/2010) for the three regions in the JELLYFOR project. The necessary datasets are automatically imported, quality controlled and reprojected to a standard grid using a nearest-neighbour approach to retain information on fronts and different water masses. The grid uses an equirectangular projection generated per region, with cell sizes of about one by one kilometre for MODIS and MERIS RR data and of 250 by 250 metre for MERIS FR data. The software for extracting and gridding of the datasets is generic, highly automated and flexible, so that a similar archive can readily be created for any region on earth. The software is also used to process MODIS and MERIS (both full and reduced resolution) data on a near real-time basis.

The tsm algorithm of Nechad et al. (2010) that is used to compute tsm from MODIS reflectance data is calibrated in turbid waters and might provide inaccurate results for clearer waters. The algorithm, however, can be easily adapted with regional specific inherent optical properties (SIOPs). The MODIS chlorophyll a dataset is known to be less reliable in turbid waters (Park et al., 2010), therefore an additional quality control and masking is applied in these waters.

An incredible amount of information can be extracted from the archive, for example eight year time-series for every location within the region and monthly and climatological average maps. In a multi-year dataset of remotely sensed parameters, known oceanographic features are apparent. Using monthly composites and time-series, the inter-annual changes and the evolution throughout the year can be analysed. The archive can be used for a wide range of applications in marine biology, sediment transport, coastal management, etc.

A long-term remote sensing dataset is a useful tool for understanding the oceanography of any region, be it a well-studied or a relatively unknown one. Due to the generic approach and fast processing such a dataset can be readily generated.

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COMPARING PIXEL AND OBJECT-BASED CLASSIFICATION METHODS FOR COASTAL MONITORING: CASE STUDY ISTANBUL-TERKOS/TURKEY

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Keywords: *pixel-based classification, object oriented classification, shoreline detection, remote sensing*

ABSTRACT

Cities of today compete with each other in terms of functions, places and opportunities that they provide. Among these, waterfront activities and physical attraction of such coastal zones play critical roles in urban planning agenda. Especially, cities like Istanbul experience a high pressure on coastal zones and hence, the protection of those areas has become a hard task to solve. With these reasons, change detection of the shorelines and determining of land use types are fundamental to a broad range of interdisciplinary studies undertaken by city planners, civil engineers or coastal managers.

Development models improved without considering environmental issues and only according to economical growing are bring about economical, cultural and environmental disasters. Projects performed without making pre-evaluation and without understanding importance of the soil and field usage planning, are bring about important problems in terms of economical and physical development. It is suggested that the solution is setting up the equilibrium between the ecology and the economical development and providing the sustainable development. For providing the sustainable development, most beneficial way is observing the change. It is possible to observe the changes in the field usage patterns by using remote sensing techniques as much as geodetic techniques which are more costly.

By using remote sensing techniques, not only local but also global changes of coastline can be detected very fast and accurate. The determination of movement direction for coastline is very important problem for coastal managers. For this purpose and continuously monitoring of coastal areas, the satellite imagery is useful data source.

Coastal engineers frequently encounter the problem of changing shorelines, chronic erosion and unexpected deposition due to the sediment transport. Therefore, to understand the level and reasons of the sediment transport is an important factor in shoreline change. One of the ways detecting the shoreline change and levels of the sediment transport is remote sensing.

In this study, pixel-based and object-oriented classification methods have been used and Landsat-TM 2001, 2009 images of Terkos Lake Basin-Istanbul/Turkey classified. The pixel-based and object oriented classification results have been compared and their usage for

coastal zone monitoring and applicability with the additional data, such as geological maps, wind and wave data has been analyzed. Four different land use classes as an urban areas, vegetation, non-urban areas and water bodies have been used for classification.

Pixel bases classification methods (supervised and unsupervised classification) are based on spectral information, in other words, pixel gray value. The basic processing units of object-oriented image -analysis are segments, so-called image objects, and not single pixels.

The pixel-based classification is realized by PCI Geomatica software, the object-oriented classification is implemented by eCognition software and the accuracy assessment results have been given.

Advantages of object-oriented method are meaningful statistic and texture calculation, an increased uncorrelated feature space. The method uses shape (e.g. length, number of edges, etc.) and topological features (neighbour, super-object, etc.), and the close relation between real-world objects and image objects. In the segmentation process, size and shape of desired objects are defined by the calculation of heterogeneity between adjacent pixels, where scale is the main input parameter. Shape factor (colour/shape ratio) and spatial properties (smoothness/compactness ratio) are other variables to define homogeneity of object primitives.

In this study, it has been proved that, object-oriented approach is more flexible, convenient and gives more accurate results comparing to the pixel-based approach. Fuzzy rule implementation possibility makes object-oriented approach more advantageous than pixel-based method. It has been observed that the mixed-pixel problem, which is the main challenge of pixel-based approach, depends on the quality of segmentation. Therefore the experiments of this study show that the exact setting of parameters is very important for object-based classification.

GIS BASED DB BUILDING FOR MONITORING AND MODELING FOR SUSTAINABLE MANAGEMENT OF YEONGSAN ESTUARY

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Keywords: *estuary, integrated DB, spatial data, estuary management system*

ABSTRACT

The environments and ecosystems of the estuaries are significantly influenced from varying water quantity and quality caused by exterior environmental factors such as climate change and indiscreet development. Therefore, it has become necessary to develop an integrated monitoring, modeling and information system for estuary management. To develop such system, this research addresses the construction of a GIS based environmental and ecological database for the estuary of Yeongsan River for systematic and continuous estuary management. The environmental and ecological DB has been classified into monitoring, modeling and GIS elements. Of these, the Monitoring DB is comprised of three different fields: water quality, ecology and floating sedimentation.

The Modeling DB is comprised of input and output data for the stream, basin and estuary. The GIS DB is classified into base map, thematic map and satellite imagery. The composition of each element of the database reflects planning data and research on present estuary data. The various data in the constructed databases can be shared and connected among the fields. Together, the three elements of the database are expected to facilitate systematic and continuous management of the environment and ecology at the estuary of Yeongsan River.

1 Methods and Materials

1.1 Study Area

The Yeongsan River is one of the four major rivers in Korea. Its total basin area is 3,371.4km2 and its basin length is 136km (main stream) (Figure 1). The basin length is short compared to the other three major rivers in Korea, the Han, Nakdong, and Geum Rivers. However, the environment and ecology of the Yeongsan River have changed considerably because it is more influenced by the tide than are the other rivers. The estuary area of the Yeongsan River is also of particular interest due to the sudden change in its environment and ecology that is resulting from the Four-River Restoration Project. Therefore, this research makes it possible to predict change and understand the present condition of the Yeongsan River using the integrated DB.

1.2 Present data research

Actual monitoring data collected in 2010 was investigated for selection of building target about the environment and ecological DB. Based on this, the Modeling DB was built for prediction of variations in water quality. In addition, the GIS DB was built for enhancing the applicability of the integrated DB. The GIS DB can be applied to spatial data related to

modeling input data. Further, it can be supplied to obtain positional information and to attribute data about observed monitoring locations.

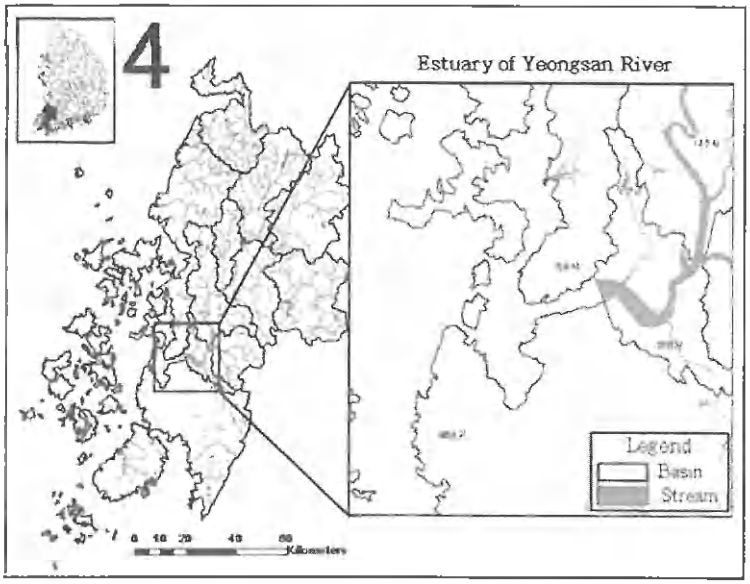

Figure 1. Study area

1.3 Composition of Environmental and Ecological DB

The integrated DB is classified into the three fields of monitoring, modeling and GIS through investigation of the present data condition (Figure 2). The Monitoring DB was comprised of actual monitoring data from 2010. The modeling DB was divided into input and output data. The input data includes existing national monitoring data and spatial data such as a digital elevation model (DEM), a topographic map and satellite imagery, etc. The output data includes numerical data created by each instance of modeling, converted raster maps and various analysis graphs. The GIS DB is divided into graphic and attribute DBs. Redundant attribute data was eliminated. The graphic DB was created with images from within the basin boundary.

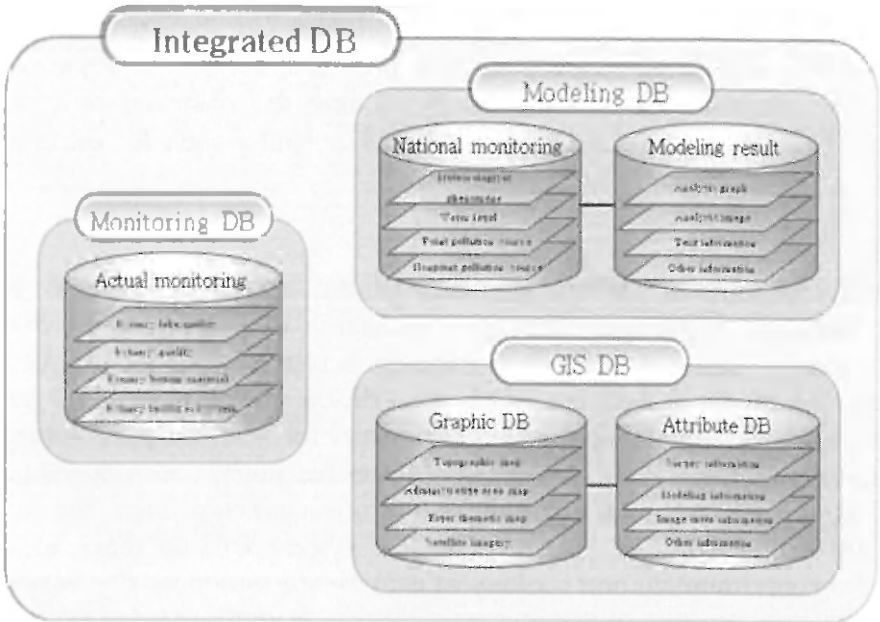

Figure 2. Composition of integrated DB

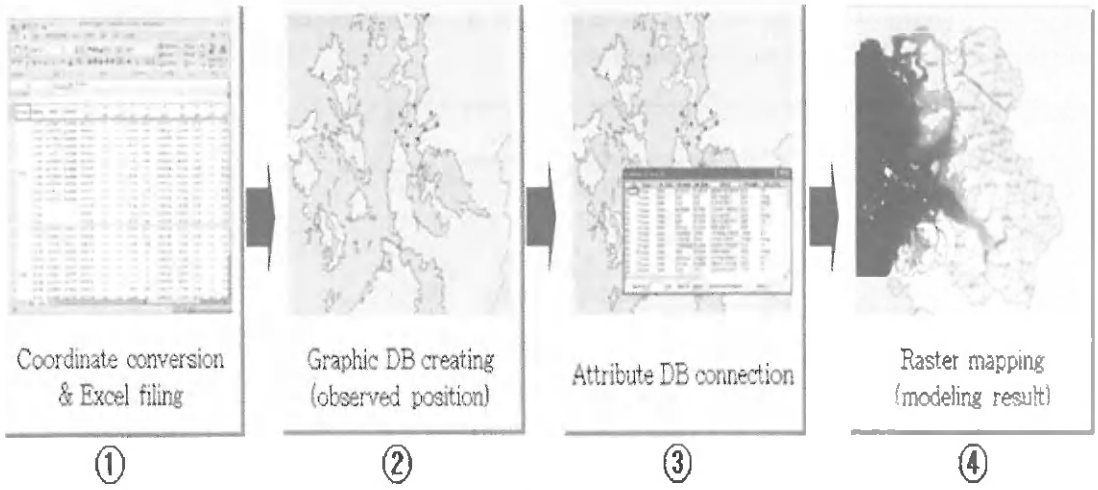

Figure 3. Monitoring & modeling DB building process

1.4 Building the Integrated DB

The Modeling DB was created according to under order, including the process previously stated in chapters 1.1 and 1.2 (Figure 3). Finally, the created table specifications were used to build the attribute DB and input metadata using the software program Access. The Monitoring DB was built in processes □~□ and the Modeling DB includes the additional process. All input and output data were built using the process.

2 Efficient Utilization of Integrated DB

It is possible to verify reliability of the monitoring DB and elevate utilization of the modeling output data through a comparison between actual monitoring and national monitoring. In addition, a raster map of the modeling results was built using a common tool, ArcGIS by ESRI. These results were then connected with numerical data including monitoring, modeling and GIS attribute data. This allows understanding of the change of the environment and ecology at the estuary of the Yeongsan River because users can see attribute data along with graphic data. With the above information, the GIS DB is able to represent the exact topography of the estuary of the Yeongsan River and the observed positions from the monitoring DB. This topographical data can be used as spatial data for the modeling input data.

3 Conclusion

In this research, connectivity among elements of the integrated DB was analyzed for understanding the present conditions and for prediction of environmental and ecological change at the estuary. Based on this understanding, a reliable estuary control plan can be suggested using the graphic and attribute data. In addition, the environmental and ecological DB which was established can be applied systematically for other purposes. However, a total management system for the estuary of Yeongsan River has not yet been developed. In future studies, it will be necessary to develop such a total management system for the sustainable development and conservation of estuaries. Such a system will do much to facilitate the management of the environment and ecology of estuaries as economically as possible if it is developed to reflect the analysis of demand and planning from the integrated DB proposed in this study.

NT-001

APPLYING SPATIAL DATA INFRASTRUCTURE TO MARINE SPATIAL PLANNING

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Keywords: *marine evidence, Marine Spatial Planning, Spatial Data Infrastructure, SDI, INSPIRE*

ABSTRACT

Marine spatial planning (MSP) is a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that have been specified through a political process (Hull, 2010). During recent years, MSP has been the focus of considerable interest throughout the world, particularly in heavily used marine areas. Numerous attempts have been made to define the scope and nature of marine spatial planning but few have discussed putting it into practice. When they do, the lack of definitive reference data and the importance of robust data management practices are often highlighted.

Accessible and definitive reference data is key to achieving a successful outcome to MSP. Data and knowledge acquired and created throughout the MSP process may remain underused without good data management. Documentation and metadata should be standard procedures during spatial data management that describe tabular and spatial data (products and source data) and include projections, scale accuracy, data types, confidence levels, sources and contacts. Many papers on MSP identify the types of data required as input to MSP (e.g. Ehler *et al*, 2009) but are circumspect about who is responsible for preparing or collating this evidence or how this can be achieved.

This paper explores what is meant by marine evidence, the data and other information it might contain and, in general terms, the methods and systems required to create and manage it. The types of information required, who is responsible for it and how to assess and address gaps and overcome uncertainties are all major challenges, especially when much of the information required has been obtained historically for other purposes (e.g. safety of navigation). Identifying sources and capturing 'intelligence' on marine activities and concerns at a local level, and collating it into a national synopsis that can be used as input to the planning process, is a key requirement but how?

Within the geographic community generally, there are a number of data related initiatives that can help with this challenge. These include the EU's INSPIRE Directive, the Australian Spatial Data Infrastructure (ANZLIC) and the American Federal Geographic Data Committee (FGDC) National Spatial Data Infrastructure (NSDI) programme. Each has a set of spatial data management principles, which when applied consistently and robustly across all data stakeholders, should resolve many of the problems. However, the changes in culture, budget allocation and the amount of detailed work that has to be undertaken and coordinated should not be underestimated (Osborne and Pepper, 2008).

Gap analyses between the idealised input to MSP undertaken by the author whilst developing the data and GIS strategies for the English Marine Management Organisation (MMO),

underlined many relevant but, for those with knowledge of marine data management, depressingly familiar problems.However, by applying SDI principles and putting in place a robust data management framework involving process, technology, architecture and standards, organisation and governance, effort and risk can be mitigated and resources improved as the marine planning process evolves.

In addition to best practice data management and the shared development of common standards and resources, such as those now provided in the marine domain by the pan European SeaDataNet initiative, there is growing need for all public bodies to take on the duty of improving and publishing data for which they are the competent or responsible authority. By taking a collective approach and adopting open standards for data and licensing, these datasets can be identified, published electronically and provide essential reference input to the evidence base. Public bodies are not only able to meet their compliance obligations, respond more easily to information requests and contribute to public sector efficiency and consistency in decision making, but also ensure the best possible information is provided as input to the planning process, so their interests are taken into account from the very beginning.

Of course not all data will be of suitable quality or standard immediately and, in any case, will need quality assurance, confidence and security levels assigned and enacted. However, through a programme of data 'strengthening', targeting and freeing up the results of research more quickly and consistently, and by ensuring funds are available for long term support and maintenance of key reference data, we can ensure the decisions and plans that are produced are based on the best possible and consistent evidence available.

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NT-002

MAPPING UK SEA SPACE

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Keywords: *data capture, mapping, marine legislation, Spatial Data Infrastructure, SDI*

ABSTRACT

Over 70% of the Earth's surface is covered by water but less than 1% has been seen or explored by humans. Globally, only 10% of coastal states have more than 50% of waters (at depths less than 200m) surveyed to modern standards required by the majority of stakeholders. Until recently, there has been a reliance on paper charting to represent the real world view of our oceans and seas. A chart presents a cartographic interpretation of the real world in a way that meets its primary purpose – to safely guide ocean going vessels across the globe in support of the UN Convention on Safety of Life at Sea (SOLAS). Although the carriage of charts is considered mandatory by the International Maritime Organisation for commercial vessels over 500 GRT, there is no such requirement to do so by leisure sailors or smaller work boats.

Accuracy and precision of nautical charts presents a challenge when one considers that the average navigational chart shows less than 5% of the information that might exist in any given area. This selection of detail coupled with a limited understanding of oceans caused in part by a lack of high quality source information means that this particular way of presenting an accurate picture of the seabed is somewhat subjective. However, the chart continues to serve the mariner well with Electronic Navigational Charts (ENC's) and electronic navigational aids.

Increasing pressure to better understand and exploit the seabed in order to ensure that effective decision making and asset management takes place requires changes in charting. Recent EU and UK legislation mandates the need for robust and effective marine governance. The Infrastructure for Spatial Information in Europe (INSPIRE) Directive requires that 34 themes of UK public sector geospatially referenced information conforms to legally mandated data harmonisation, interoperability, access and sharing conditions, all by 2019. The UK Location Programme goes even beyond the commitments required in INSPIRE. Most UK marine mapping data and associated environmental data are now governed by these two initiatives.

This presentation looks at the needs for mapping the sea around the UK and how this can be accomplished.

DATA MANAGEMENT: CREATING A LEGACY FOR MARINE RENEWABLES PROJECTS AND MARINE SPATIAL PLANNING

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Keywords: *data management, Marine Spatial Data Infrastructure, SDI, marine renewables, Geographic Information Systems, GIS, data access and dissemination*

ABSTRACT

The emergence of the marine renewables industry has produced a step-change in the range of geographic and non-geographic data collected to support development. The acquisition of relevant data underpins the lifecycle of the marine infrastructure, through the project phases of feasibility, development, engineering, construction, operations and maintenance, decommissioning and post decommissioning. Data is necessary for decision support throughout the project lifecycle. Environmental considerations and obligations are becoming increasingly imperative in the context of site monitoring and marine spatial planning. The marine renewables developer can support these considerations and obligations through good data management practices.

Data acquired is still presented in chart format by marine contractors; however, provision of digital data formats for assimilation and analysis is increasingly commonplace. Technologies such as Geographic Information Systems (GIS), web and 3D visualisation are used to access the digital data.

Marine renewables developers and operators normally commission a consultant to manage, analyse and disseminate (to other stakeholders) the data collected, which is from many different sources and of differing quality, volume and format. Due to the increasing size of lease areas, the management, storage and archiving of this data is critical as development contractors collect and analyse ever increasing volumes of data and data types. Renewables lease agreements have certain obligations for environmental data provision to government bodies e.g. the Crown Estate, UK and offshore wind farms. In turn, this data is used to further inform the marine spatial planning process and future policy decisions.

INSPIRE, MEDIN and COWRIE offer legal frameworks, policy and best practice approaches to structuring and sharing of the digital geographic data to support environmental policy and marine spatial planning. They provide a blue print for storage, management and dissemination of the data; the 'Spatial Data Infrastructure' or SDI. They also support the 'collect once, use many' ethos for data, to achieve economies.

The International Association of Oil and Gas Producers (OGP) provide a GIS (Geographic Information Systems) database standard for the management and supply of offshore survey deliverables. This standard can equally be applied to survey data collated for marine renewables projects, and provides an example of data modelling for geographic databases to store and manage acquired data long term.

The standardisation of data exchange can be used by the developer when dealing with their contractors between successive phases of the offshore wind project, in turn achieving efficiency gains and supporting effective project communication. The practical implications for the data owner and the implementation of each of these facets are discussed, along with how data is further utilised to support decision making. Also considered is interfacing with the non-geographic data i.e. the text based project management systems used by an organisation.

Using offshore wind farms as an example, a review of the renewables development and post development phases is undertaken to determine the different data types, formats and volumes expected during those phases. A review of INSPIRE, MEDIN and COWRIE is undertaken to inform how external contractors, successor operators and government bodies can be readily provided with the data they require. A review of technology options to support these aspects is also undertaken.

The paper concludes by summarising how good data management supports the ongoing management of the project site and infrastructure, facilitating monitoring of change over time, supporting robust analysis and decision making, and saving time and money by improving efficiency, through underpinning effective document control on behalf of all stakeholders and presenting the correct versions of data to contractors. An assessment is also made for future directions in marine renewables data management policy and practice.

A GEOSPATIAL FRAMEWORK TO SUPPORT ECOSYSTEM BASED MANAGEMENT AND MARINE SPATIAL PLANNING FOR THE TRANSBOUNDARY GRENADINE ISLANDS

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Keywords: *marine spatial planning, participatory GIS, ecosystem-based management*

ABSTRACT

Marine resources are of vital importance to the people of the transboundary Grenadine Islands, but increasing pressures from tourism development and the non-sustainable use of these resources are making the planning and management increasingly complex. A heavy reliance on marine resources and increasing numbers of marine resource users calls for an integrated ecosystem-based approach to the management of the Grenada Bank marine environment. It is recognised that in order to address the uncertainties associated with complex, diverse and dynamic systems, this approach should be adaptive, addresses issues of multiple scales, allows for inter-sectoral cooperation and promote broad stakeholder participation. Despite this appreciation, it is increasingly clear that governments and stakeholders lack the practical tools needed to make ecosystem based management (EBM) operational, particularly in the marine environment. Marine spatial planning and management (MSPM) is a strategic way of improving decision making and delivering an ecosystem-based approach to managing human activities in the marine environment. Notwithstanding the central role of human agency in the concepts of EBM and MSPM, the scope of 'human dimension' information included often falls short in comparison to its actual importance and complexity. Likewise, it is recognised that many times marine management has not been effective in part due to a failure to use all available sources of information and knowledge, particularly the local knowledge of the resources' users. Despite the known value of these types and sources of information, they may not be appropriately incorporated in MSPM.

We propose the application of a participatory geospatial (Participatory GIS) approach as a sound basis for practically incorporating EBM within MSPM initiatives. Including stakeholders in the development of a technical representation of spatial knowledge can allow for improved understanding of the social characteristics of natural resource use patterns. This not only demonstrates the relevance of information provided by stakeholders, but also supports EBM by using multi-discipline and multi-knowledge information sources in management initiatives. A further tenet of a PGIS approach is that information is created in a format which is understandable and accessible to stakeholders, thereby facilitating an equitable, transparent and collaborative decision-making environment. Therefore benefits of using a systemised spatially referenced multi-knowledge PGIS database for MSPM includes: (1) effectiveness in data management and the identification of information gaps; (2) the promotion of spatial thinking and increased understanding; and (3) definition of existing areas of importance for conservation, human activity and threat to guide management and allow for increased stakeholder understanding required to for deliberation and consensus needed to collaboratively generate a scientifically appropriate and socially acceptable marine space-use plan.

This paper shows the ways in which the application of a collaborative geospatial approach can be of use for improved understanding and planning the multifaceted transboundary Grenada Bank marine resources. A PGIS, the Grenadines Marine Resource and Space-use Information System (MarSIS) was developed to provide a holistic framework for ecosystem-based MSMP by compiling, integrating and sharing interdisciplinary and multi-knowledge information in a transparent and comprehensible manner. We illustrate the potential of a PGIS approach and the use of a geospatial database to improve MSPM, specifically the various ways in which information can be brought together, visualised and analysed to create the diversity of baseline inventories of information on the existing marine resources and associated human activity required to prepare a marine space-use plan for the transboundary Grenadine Islands. Specifically, the MarSIS is utilised to: visualise the distribution of various space-use patterns and give insight on human-environment interactions; summarise the amount of existing marine habitat and assess each country's progress towards marine conservation targets; identify the location of representative reef habitat; and to generate cumulative impact surfaces for conservation, human use and threat to provide baseline information required to prepare a marine space-use plan for the transboundary Grenadine Islands.

THE COLOMBIAN WEB-BASED MARINE ATLAS: A CONTRIBUTION TO THE DISSEMINATION OF REGIONAL ICAM INDICATORS IN THE SOUTHEAST PACIFIC

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Keywords: *marine atlas, ICAM, ICZM, indicators, Colombia, Southeast Pacific*

ABSTRACT

The information about the status of coastal resources must be provided in the appropriate format to be understood and used by decision-makers and civil society. Present project has been carried out in the framework of a regional project "Southeast Pacific Data and Information Network in support to Integrated Coastal Area Management - SPINCAM", which is seeking the consolidation of Integrated Coastal Area Management (ICAM) practices in the Southeast Pacific countries: Panamá, Colombia, Ecuador, Peru and Chile. The SPINCAM project is being supported by Intergovernmental Oceanographic Commission IOC/UNESCO and the Flanders Government, and it is coordinated by the Permanent Commission of South Pacific-CPPS. In Colombia, SPINCAM project has been developed by Ministry of Environment, Housing and Territorial Development and the Marine and Coastal Research Institute (INVEMAR). Main objective of this research is to improve the delivery of information on the status of coastal resources and their management for the use by all coastal stakeholders. It requires the development of web-based information system at national and regional level, which supports both the development of the indicators and their spatial representation, and the dissemination of ICAM resources and experiences. One of main results is the establishment of ICAM indicator framework in each country, focused on environmental and socioeconomic conditions within the context of sustainable development. The application of a harmonized methodology and the development of a set of indicators among the participating countries have permitted the calculation of five common indicators at regional level: marine protected areas, population density, water quality, management planning instruments and marine biodiversity. Colombia has proposed six additional indicators: population affected by natural disasters, costs of natural disasters, fishing mortality, fishing production and fishing economic value. Selection and establishment of the indicators was performed through national and regional workshops and the creation of a Group of Data and Information Management (GDIM). Other relevant outcome of this research is the first version of the Colombian web-based marine atlas, which has been conceptualized as part of the Environmental Marine Information System (SIAM) and it is consistent with other international initiatives of environmental indicators. The marine atlas is conceived as a distributed system and it is offering users information access from three perspectives: spatial representation, tables and graphs. Metadata and document management (e-repository) are also integrated into the system in order to provide users complete ICAM resources. The development platforms are: ArcGIS Server for mapping application, Geonetwork for metadata management and Ocean Docs for e-repository. The main interface is an interactive Geo-Visor that enables visualization of indicators data layers, as well as a related databases, metadata and documents. The development of this project has helped strengthen inter-institutional linkages within countries and to build national capacity for indicators development, data and information management, metadata and implementation of integrated applications.

NT-007

US ARMY CORPS OF ENGINEERS ECOASTAL PROGRAM FOSTERS AN ENTERPRISE APPROACH TO DATA MANAGEMENT

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Keywords: *GIS, eCoastal, Navigation & Coastal Data Bank, coastal mapping, USACE*

ABSTRACT

As the US Army Corps of Engineers (USACE) addresses such issues as coastal flooding, navigation, regional sediment management, coastal structure conditions, erosion, and hurricane damage, Corps districts like the Mobile District headquartered in Mobile, Alabama collect unique data to support operations, engineering, environmental, and economic decision making. To improve data sharing and acquisition, the Mobile District developed the eCoastal program. The program utilizes Corps spatial data standards and implements national policy to provide a customized framework for spatial data standards, geodatabase structure, and GIS applications to support the development of enterprise GIS in and across coastal divisions. The program focuses on accessing data in each district, preferably in a geodatabase.

Regardless of which project data was collected for, the eCoastal architecture allows for data to be properly indexed and archived. This standardized architecture allows people to find the data they need, even if they didn't input it themselves. The program also addresses the requirements of districts that do not have GIS experts in-house. It gives districts the analytical tools, lessons learned, and a data structure they need to effectively use their geospatial information. The eCoastal program also isolates pertinent data models from the Department of Defense's spatial data standard known as the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE). In addition to providing these data models, eCoastal includes a suite of custom tools, some of which are an online map viewer, data picker, surface generator, dredging histories and the Coastal Structures Condition Assessment (CoSCA) tool.

ECoastal will lay the ground work at the District level for a national program called the Navigation and Coastal Data Bank (NCDB). The need for easy access to USACE coastal data has never been greater—to support the daily operation and maintenance of projects as well as to develop new tools and models for regional management. Currently, coastal data are scattered between many USACE District offices. Because data are collected by many different sources, there is little standardization, and they can generally be difficult to access. Other common problems include occurrences of duplicated data and a lack of knowledge about the existence and location of datasets.

The NCDB is accessed through an Internet portal where users can efficiently search for and use all types of coastal data, information, and tools. The site will connect to a collection of servers throughout the country that maintain coastal data and information with a focus on USACE coastal data—both spatial and temporal. Its organizational structure allows users to access data more efficiently and to upload new data easily as it is collected. The architecture currently being developed for the data bank relies on the existing infrastructure established within the eCoastal program. In addition, NCDB will participate as a data access center in the NOAA Integrated Ocean Observing System (IOOS). Initially NCDB will concentrate on

coastal mapping data (predominately from the USACE National Coastal Mapping Program), channel condition surveys, disposal sites, channel framework, and USACE tide gage data. The Mobile District freely shares the eCoastal documentation and source code with other districts as well as entities outside of the Corps such as states, universities and the public. Much of the material is available on the web site at http://ecoastal.usace.army.mil.

NT-008

INFORMATION MANAGEMENT AND ANALYSIS OF THE GEOGRAPHICAL SYSTEM OF SHORELINE MANAGEMENT IN THE WEST OF WALES

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Keywords: *Geographical System, GIS, shoreline management, West of Wales, floods, coastal erosion*

ABSTRACT

During the 1990's the initial Shoreline Management Plans (SMP) were developed for the entire coast of England and Wales. These plans developed upon the emerging understanding that flood and coastal risk management, at the local scale, had to be built upon a far broader and geographically larger framework for management of the shoreline. These initial plans consolidated thinking about coastal management from this broader perspective.

Although providing a significant step forward in management, it soon became apparent that, at this higher level of management, the 50 year time horizon, typically the life of a defence, was too short and prevented true long term strategic issues of risk management, in conjunction with the broader issued of coastal zone management, being developed.

It had always been envisaged that the SMPs would be reviewed within the following decade and this provided the opportunity to look again at the scope and extent of these plans. The result of this has been the development of the second generation of SMPs (SMP2) looking generally at larger sections of the coast and looking forward over a period of 100 years, with the aim of setting out a sustainable path for management into the future. At the same time, it was understood that this opportunity for a high level review of flood and coastal erosion risk needed to bridge the gap between risk management and that of forward planning and coastal zone management.

Essential to development of such a long term vision is the need for good data management; not just as a tool for displaying information but as an essential element of analysis of complex interactions and interdependencies associated with the coast and in extending information to consider uncertainty scenarios and scenarios for management.

This paper takes as a case study the West of Wales (WoW) SMP2 to highlight aspects of use of GIS within the SMP2 process. This area is one of the longest stretches of coast covered by the SMP process, extending along more than 1000km of shoreline from St Ann's Head in the south to the Great Orme in the north and including the Isle of Anglesey, itself including over 200km of important coastline.

The coast contains many sections of hard rock cliff line, with other large sections of interactive softer frontages where impacts of local management may impact over many kilometres. Despite the overall length of the study area, many of the issues occur at a much smaller scale, affecting small communities and areas of local coastal value. These areas are, never the less, of significant strategic value as well, being an essential part of the overall

cultural and environmental mix that makes up this spectacular and special part of the Welsh coastline. Understanding these individual issues and values, mapping them and assessing them in terms of future coastal risk and change, has been a fundamental element of the SMP process, and quite possibly a task that might not have been able to be sensibly undertaken without the use of GIS.

The paper looks at the way in which GIS has been applied to the issues and difficulties of developing an SMP over such and extensive but also intimate area of the coast. Particular aspects considered within the paper are:

- the basic GIS function of data management dealing with a substantial wealth of quantitative and qualitative information.
- The use of GIS in mapping and allowing adjustment of mapping of flood and erosion under different sea level rise uncertainty scenarios.
- The use of GIS in assessing the impact of this risk on different features of the coastline and in providing the spatial context within which to understanding the strategic significance of such impacts, both in relation to the natural and human environment.

The authors of the paper bring specific experience of the actual mechanics of developing GIS, the experience of the coastal engineer and the understanding of the issues and values of such an approach to the local communities and the coastal managers. Through this perspective the paper demonstrates the strong characteristic of the GIS approach in bringing together different disciplines and allowing effective and productive communication. The paper goes on to consider how in take forward GIS we need to moving away from considering it as specialist tool and the real benefits in terms of good interaction throughout project teams supported by the GIS platform for data management.

ICES WEB GIS, A SPATIAL DATA INFRASTRUCTURE TO SUPPORT THE AREA BASED SCIENCE AND MARINE SPATIAL PLANNING INITIATIVES AT THE INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA (ICES)

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Keywords: *Spatial Data Infrastructure, SDI, metadata, open source, GeoServer, GeoNetwork, INSPIRE, GIS*

ABSTRACT

The wider usage of data outside "traditional" uses and the diverse scientific topics needed in the support of marine spatial planning and integrated area based science, increases the need for distributed data systems capable of easy access to updated data resources in multiple / flexible output formats. The growing search for relevant spatial datasets to be used within marine spatial planning and integrated area-based science and management, also makes good discovery services and standardized metadata descriptions for these datasets increasingly important. Fulfilling the need for easy and flexible access, standardised metadata descriptions and well functioning discovery services, will increase use and usability of spatial datasets for multiple purposes and in this way add increased value to existing datasets.

Being founded in 1902, ICES has a long tradition for supporting science and advice in the marine area. For many years ICES has maintained marine data collections on fisheries, oceanography, contaminants (and their effects) and biological communities. ICES holds marine data centre functions for regional environmental actors such as EEA, OSPAR and HELCOM. The data collections provide critical input to the advisory processes and science initiatives within the ICES expert groups and by regional actors, but are also used for other purposes outside these communities (e.g. providing species presence data for iOBIS).

In the last decade the need to support marine spatial planning and integrated area based science has been steadily growing. This development is also promoted by the implementation of the INSPIRE Directive (2007/2/EC), establishing the spatial infrastructure in Europe and and the Marine Strategy Framework Directive (2008/56/EC) that necessitates an integrated, area based ecosystem approach. Marine policy is looking increasingly to performance measures and indicators for marine management, and spatial data are an essential element of this need. Increasingly, integrated area-based science and the spatial management and planning of human activities are seen by many as the framework to move towards sustainable development in the marine environment.

In order to support the developments towards marine spatial planning and integrated area-based science, the ICES Data Centre in cooperation with STZ Geoinformatik in Rostock, has developed a web GIS system that can capture spatial layers including metadata and make them discoverable and accessible for all users. The spatial layers and metadata will be

generated primarily by the ICES community, but it can also be generated by other users. Three main kinds of spatial datasets/layers have been identified so far.

1. Spatial reference layers. This includes both maps that are maintained by ICES (e.g. ICES statistical areas and ICES ecoregions), but it can also be maps that are maintained outside ICES (e.g. OSPAR regions)
2. Spatial layers and metadata generated by expert groups in the ICES community. An example of this is the collation of marine habitat study areas generated by the ICES Working Group on Marine Habitat Mapping. The expert groups in ICES produce various kinds of spatial products that are included in reports etc. In many cases the usability and value of these layers can be increased by making them discoverable and accessible in a spatial data infrastructure. Other examples of this are the distribution of deep sea corals and indicator maps like the fish disease index.
3. Spatial layers generated as topic/indicator views from existing data collections held in ICES

The system is a web application with open access for all users, but in order to upload data and metadata the user will have to be registered. The collection of spatial layers can be searched based on geographic extent, keywords, category, title, etc. The GIS viewer allows layers to be viewed one at a time or in combination with the possibility to explore the attribute information of the spatial objects in the layers. All layers can be accessed as web map services or downloaded for use in various GIS applications and map viewers.

It has been important to use best practices and widely accepted standards in the system. The metadata are stored in the ISO19139 format, but the required information has been kept to a minimum due to the wide scope of layers and uses expected in the system. The developed system builds on GeoServer (web map services) and GeoNetwork (metadata handling) that are both open source projects. The system integrates their functionalities and creates the important linkage between the spatial datasets and their metadata.

The new web GIS system increases the use and usability of spatial layers being generated by ICES expert groups and it promotes increased exchange of spatial data between ICES expert groups and the marine community in general.

NT-011

COASTAL DATA EXCHANGE: AN EXAMPLE OF SUCCESSFUL DATA SHARING

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Keywords: *Dataportal, realtime data, monitoring, north east coast UK, WMS*

ABSTRACT

The North East Coastal Monitoring Programme covers the coastline from the Scottish Border to Flamborough Head. This is sometimes referred to as 'Coastal Sediment Cell 1' in England and Wales. The programme provides an overarching framework to ensure a general consistency of approach to data collection, data management, and data analysis. The framework comprises: Real-time wave data collection offshore from Whitby and Newbiggin Ness, aerial photography, data management and website updates, and Cell 1 Overview Reporting.

The website is the focal point of the data collection and data sharing, using open source components and web services. It features a secured management section, to contribute data and manage the website. Everyone is able to download the data using the map or one of the search options to find data. One of the key factors of success of this programme is the dedicated continuing effort being put into it by several staff.

Coastal Data Exchange: an example of successful data sharing

The Programme

The North East Coastal Monitoring Programme covers the coastline from the Scottish Border to Flamborough Head. This is sometimes referred to as 'Coastal Sediment Cell 1' in England and Wales. The aim of the North East Coastal Monitoring Programme is to provide better understanding on the coastal processes and the locations, rates and mechanisms of shoreline change at key locations between the Scottish Border and Flamborough Head. The programme has specifically been designed to address the issues raised and recommendations made in both the *Northumberland and North Tyneside Shoreline Management Plan* and the *River Tyne to Flamborough Head Shoreline Management Plan.*

The intention is that by collecting and analyzing coastal monitoring data our understanding of the way in which the coast functions will improve and the resulting information will be used to provide effective and sustainable coastal management decisions into the future.

Within the programme, there are three main components: cell-wide Regional Framework and Activities; Strategic Monitoring: Scottish Border to River Tyne and Strategic Monitoring: River Tyne to Flamborough Head. The regional framework ensures a general consistency of approach to data collection (e.g. standard specifications), data management (e.g. metadata documentation), and data analysis (e.g. annual cell-wide overview reporting).

This also provides the basis for cost-effectively undertaking those activities which extend across the whole of Coastal Sediment Cell 1, such as aerial photography and wave data collection and analysis, and website development and maintenance. This aspect of the

programme comprises real-time wave data collection offshore from Whitby and Newbiggin Ness (since 2009); aerial photography (since spring 2010 and at suitable intervals thereafter); data management and website updates (ongoing) and Cell 1 Overview Reporting (annual).

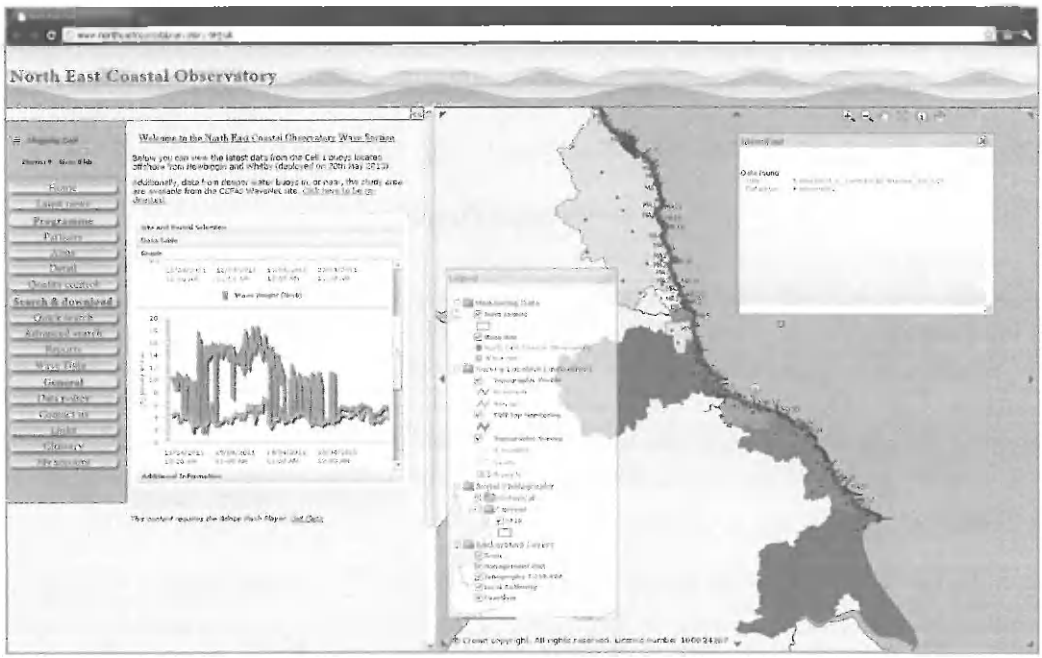

Fig. 1. The website features an interactive map, search options and real time wave data

The data portal

The website www.northeastcoastalobservatory.org.uk is the core of the data portal. It enables the visitors of the website to view and download several types of information, besides providing background information on the programme. Throughout the website, the interactive map is present, providing a geographic overview of the extents of the available data, projected on several background layers. All information is grouped in datasets and the extents of each dataset are visible as a red rectangle on the map.

The data is made available by the administrators. Data types available are for example topographic surveys with geographic data, reports and photographs, aerial photographs, bathymetric data, beach profiles and cliff top recession surveys. Of all data, reports and metadata are available and all kinds of other reports can be downloaded, e.g. analytical reports and survey reports.

Besides these geographic data, real time wave data are available. Two offshore buoys collect information on wave height and wave length and other parameters. Visitors are able to specify start and end date and view graphs and tables on these parameters.

GIS techniques and data management

By using distinct data types, the contribution process is highly automated. Depending on the specific data type, the application behind the data portal stores the data and establishes the extent of the dataset. The extent is added to an index feature layer, so it will show up on the map. The dataset particulars are added to several indexes in the database to enable searching

for it in the website. All geographic data that show up in the search results can be used to zoom to in the map.

The map component of the website is an open source Flash application, called Flamingo. It has been developed by and for Dutch governmental organisations. It is highly configurable and uses Web Map Services as the source for the display of the maps.

One of the key factors to the success of the data portal is the active role the administrators of the website have. They keep the website up to date and play an important role in providing new datasets. They also trigger new initiatives with the participating governmental organisations (several boroughs, cities and counties in the region) to ensure that the data portal adapts to changing circumstances and changing insights.

SUPPORTING MARINE SPATIAL PLANNING WITH A MULTIPURPOSE MARINE CADASTRE

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Keywords: *marine cadastre, Marine Spatial Planning, decision support tools, Marine Spatial Data Infrastructure, SDI*

ABSTRACT

The Multipurpose Marine Cadastre (MMC) is a multiagency effort to build a GIS-based marine information system for U.S. waters that provides authoritative geospatial data and supporting information to inform decision-making on a range of ocean issues. The MMC contains marine cadastral data, which encompass the spatial extent, usage, rights, restrictions, and responsibilities of marine areas, as well as other framework data needed to support planning, management, and conservation of submerged lands and marine spaces. The combination of marine cadastral, biological, geo-physical, ocean use, and legal authority data provides users with the spatial context needed to address issues such as alternative energy siting, aquaculture, submerged lands leasing, marine conservation, and marine spatial planning (MSP). This paper will demonstrate how spatial data are being organized and integrated in the MMC; and how the MMC can be used to support MSP.

Background

Human uses of ocean resources are increasing dramatically, outgrowing the laws, policies, and human resources needed to manage them. Development of offshore renewable energy is one example on a list that also includes commercial and recreational fishing, maritime commerce and trade, national security operations, etc. that demand ocean space, and increase the potential for use conflicts. At risk is the health of our ocean ecosystems and the benefits they provide to coastal communities and national economies.

To support interest in offshore energy development and make sound decisions that limit space use conflicts in the ocean, policy developments such as the Energy Policy Act of 2005, have mandated the development of a mapping and information system. In response, as co-leads of the U.S. Federal Geographic Data Committee (FGDC) Marine Boundary Working Group the U.S. Bureau of Ocean Energy Management Regulation and Enforcement (BOEMRE) and the National Oceanic and Atmospheric Administration (NOAA) jointly developed the Multipurpose Marine Cadastre (MMC). The core data and functionality of the MMC are now being leveraged to support development of the National Information Management System. This system was called for in the framework for effective coastal and marine spatial planning being implemented under President Obama's July 2010 Executive Order establishing a National Ocean Policy in the US.

Similar to the nation's land-based parcel system, a marine cadastre enables the boundaries of maritime rights and interests to be recorded, spatially managed and physically defined in relationship to the boundaries of other neighboring or underlying rights and interests. The MMC's purpose is to serve as a planning and screening tool that provides the spatial context needed to inform decisions that minimize conflicts between incompatible ocean uses.

Multipurpose Marine Cadastre Components

Key components of the MMC include the following:

Partnerships
Many federal agencies have been working collaboratively through the Marine Boundary Working Group over the past decade to organize, standardize, and make readily accessible national marine boundary data—also referred to as the U.S. Marine Cadastre.

Authoritative and Trusted Data
The MMC contains the official U.S. Marine Cadastre and is the only place users can visualize all the official U.S. marine boundaries on one map. The following data themes are included in the MMC framework:

- *Georegulations* - geographical extent of federal laws and policies
- *Agency regions* - geographical extent of federal agency regions and planning areas
- *Navigation and marine infrastructure* - common navigational and infrastructure data such as shipping fairways, wrecks and obstructions, and oil platforms
- *Human uses* - active and proposed oil and gas and alternative energy sites
- *Marine habitat and biodiversity* - biological data tied to U.S. federal statutes, such as the Endangered Species Act
- *Physical and oceanographic* - bathymetric contours, wind energy potential, seafloor geology, and sediment types

Data in the MMC originate from sources designated by a legal authority to develop or manage data for a specific business purpose. To ensure that MMC content is current and up-to-date, data are periodically collected from the source based on an update and maintenance plan and stored in a centralized geospatial database. The vision, however, is to build a distributed web mapping system that utilizes web services to consume spatial data directly from the source. Realizing this vision will enable interoperability and enhanced use of these data across multiple platforms.

Data Standards
Two federally endorsed content standards have been used in the construction of the U.S. Marine Cadastre database. They are the Cadastral Data Content Standard and the Governmental Unit Boundary Data Content Standard. The resulting data have also been made available in Open Geospatial Consortium endorsed transfer standards, including Web Map Service (WMS) and Keyhole Markup Language (KML). All data contained in the web map viewer include metadata using the FGDC Content Standard for Digital Geospatial Metadata, as well as data sheets which provide a laypersons overview of each data set.

Data Visualization and Analysis
A comprehensive Web mapping application was built on the ESRI ArcServer platform that enables viewing, analysis, and map-making. Some of the custom functionality includes

point, line, and polygon buffering; measuring tools; coordinate input; screen capture; and freehand drawing.

The Multipurpose Marine Cadastre as a Decision Support Tool

The NOAA National Marine Fisheries Service Habitat Conservation Division (NMFS) uses MMC to comment on license applications for offshore renewable energy projects. The tool is used to evaluate potential impacts to ecological resources. For example, one proposed project would have impacted numerous endangered salmon and marine mammal species; was within designated essential fish habitat; and situated within the migration corridor for several commercially important salmon species. Four conservation divisions worked cooperatively to provide comments and recommendations to the applicant using a variety of maps created with the MMC.

The MMC has been utilized in BOEMRE led state wind energy task force process to identify lease blocks where conflicts between wind energy development and other existing or future uses can be minimized. The MMC helps illustrate potential user conflicts and information gaps, and provides an interactive tool the task forces can use to discuss and visually illustrate concerns and issues. Based on the results, BOEMRE ultimately identifies "Wind Energy Areas" in an effort to increase efficiency in site selection and regulatory processes.

The Mid-Atlantic Regional Council on the Ocean (MARCO) Mapping and Planning Portal, developed by The Nature Conservancy under a contract with the Virginia Coastal Zone Management Program, contains a compilation of state and local data used for regional coastal and marine spatial planning. Instead of manually compiling federal data, the MARCO Mapping and Planning Portal directly consumes federal data that are produced, maintained, and made available through the MMC.

The utility of the MMC to the above applications is a reflection of the strong multi agency partnerships that have contributed to its development. The tool was envisioned as a platform to share and visualize data in support of marine spatial planning, and specifically, offshore renewable energy development. The MMC project continues to explore new data, design features, and functionality that will better serve its growing community of users.

MARINE AND COASTAL SPATIAL DATA ANALYSIS AND MANAGEMENT WITHIN WEB-GIS SYSTEM FOR DATA ACCESS AND SUSTAINABILITY ON ROMANIAN BLACK SEA COASTAL ZONE

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Key words: *Web-GIS, Remote sensing, Integrated coastal zone management, Vulnerable areas*

ABSTRACT

The marine and coastal spatial data management actions in the Romanian Black Sea institutions, developed towards implementation of Coastal GIS standards/QC-QD procedure/web-services, are supported by complementary systems, among others areas, in order to provide a modern scientific and technical instrument to support the development of the policies, coastal strategies and management.

The paper presents the certain national consortium actions that are developing as implementing activities of certain international/European Web-GIS practices in the use of marine/coastal data and metadata. In connection with these, Web-GIS services are at the moment one of the most growing sectors in geographical information system science, and one of the goals of this work/paper is to evaluate its implementation in correlation with a Web-GIS system as a support tool for ICZM implementation process in the Romanian Black Sea area.

The results presented on this work are related to the developments of a Marine & Coastal GIS able to accommodate the data exchange and integration, from several sources/teams, which associated in databases, can constitute the engine of a dynamic and efficient decisional system.

Introduction

Integrating and transforming the existing data and geographic information for the determination of the flow of primary and processed data in order to extend a geographic database for the study of the long-term marine and coastal zones changes includes the inventory of all mapping (historic or recent) data, teledetection data (satellite or photogrammetric) and monitoring annual/seasonal water-quality/shoreline monitoring data available, in parallel with the direct investigation of the specific geomorphologic and geodynamic characteristics of the Romanian coastal system.

The final results will contribute to the establishment of the support database for marine and coastal processes, enabling the integration of sustainable solutions for their protection/restoration in their existing environmental conditions. As base methods, the photogrammetric and remote sensing information processing is revealed as effective when the components of the equipment software, staff and data system, which otherwise define the level of cost for various products, are sensibly structured and sized.

GIS Component on the long-term shoreline variability

In order to examine the long-term morphological changes produced in the marine coastal zone, mainly historical maps and satellite images of different resolutions were used, selected in a time frame wide enough to observe any morphological changes, while, in order to show the current / short term trends, for the past 3 years (2008, 2009, 2010) GPS measurements were used, namely mapping the shoreline in the GIS precision and geodetic class, including the current monitoring data of the shoreline - annual and seasonal, as well as the morphological analysis on some representative profiles will be added to the database concerning the morphological variation - completing this way the existing annual information.

The study involved the systematic processing of the land GPS / measurements, as well as spatial data processing, mainly from open or remunerated sources: NASA / ESA, USGS, ANCPI, GEOSPATIAL Portal and the Ministry of the Environment Portal, NIMRD monitoring&surveillance coastal erosion data. At this stage, a detailed study for each type of spatial data and information of the coastal area was required.

METHODS

The morphological analysis of the shoreline changes was realized by comparing historical maps, satellite imagery, aerial-photograms from different periods. The process involved two steps: moving images in the same coordinate system based on benchmarks identified in images and historical / military topographic maps, orthophotoplans or measured directly in the field (GPS) and classifying the images in two classes using the spectral intervals method with specialized software (ERDAS, DEFINIENS) or by digitalizing.

The graphical representation obtained based on raster data was realized in an application of the 10 ArcGIS data assimilation system, including historical maps, topographic measurements, GPS, aerial photos etc. The ArcGIS spatial analysis techniques were developed on representations of spatial data (GPS data / data obtained by digitization) in a plane model / referenced configuration, which allowed the assessment of the geomorphologic dynamics of coastal areas, the results being represented / overlay, for comparison with the data based on the historical map from the past century.

The photogrammetric images / aerial photographs (1980-1985, scale 1:45.000 - 1:1.500), the Landsat, SPOT, ASTER, ERS and, for some sectors, IKONOS satellite imagery, generally from open source and only rarely with a fee (especially for the orthophotomaps purchased in various projects within NIMRD) have been used / processed and vectorized in order to detect the changes in various medium and short time scales, with the view to obtaining a sufficiently large data collection for the assessment of the variability of the shoreline.

The Change detection - changes in the Black Sea shoreline in the first decade of the century - was done by extracting the shoreline at dates when images were recorded, and the change detection algorithm provided by the ERDAS Imagine software is based on the arithmetic difference between the "new" image and the "old" image.

The interpretation of results that is the increase / decrease of the spectral reflectance depend on the context and the specific case under consideration. In the Southern part of the littoral, where we are interested in the limit between water / land, we must consider the specificity of

the area: water is very low reflecting, while sand has a very high reflectance. This difference is advantageous in detecting the difference between water / land and, of course, in detecting changes. There are situations in which the beach is very narrow, with the sandy strip missing, but, even in this case, the very low reflectance of the sea water allows the highlighting of the shoreline.

The GPS measurements used to determine the position of landmarks of the tagged base on the Romanian littoral, the configuration of the water / land contact line and the vegetation line, the wave limits during storms, field positioning, the annual (seasonal) monitoring of the shoreline, of vegetation, had as measuring equipment the (D)GPS devices from the geodesic class: Trimble R3 and GIS: Trimble ProXH2007 GeoXH2005, carried by the operator or transported by ATVs, motorcycles or bicycles.

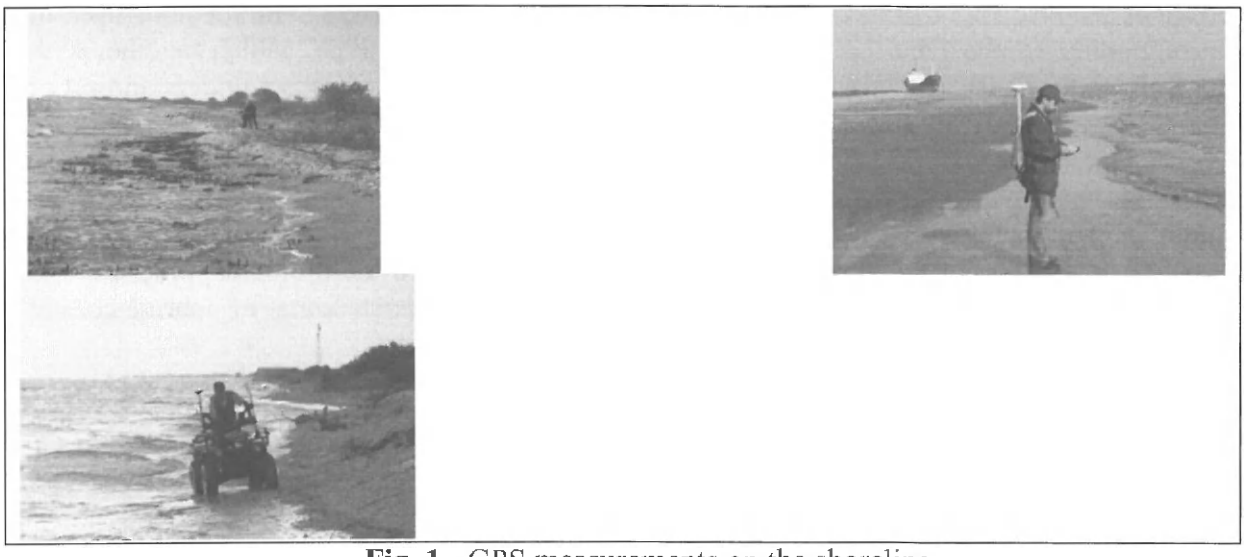

Fig. 1 - GPS measurements on the shoreline

The data collection software were Digital Field Trimble, TerraSync, ArcPad and Trimble Business Center and Trimble Pathfinder Office for data post processing, which allows the export of data in local datum and coordinate systems. Among these, the Stereographic 70 system with 7 parameters transformation was selected.

RESULTS

The final result of comparing the shorelines obtained by differentiated processing during multiple time horizons is a map, with highlighted areas that are undergoing morphological changes evident in the range studied - more than 100 years. The historical maps, redesigned in Stereographic system of coordinates and subsequently vectorized were used to evaluate the shoreline withdrawals, corresponding to surfaces that have undergone significant changes during this period, thus highlighting different periods of shoreline evolution.

Due to erosive process intensification, the execution of certain protection measures was required at very short deadlines and a necessary fundamental research according to the necessities and the existent concrete situations in the areas was almost impossible. The temporal behavior and morphological effects over the nearest/adjacent zones agreed with to the forecasts in different proportions, and the acquired results after detailed research for the quantification of induced geomorphologic modifications entailed some corrections for optimization.

CONCLUSIONS

For change detections were used several methods, the main one for shoreline changes detection was comparison/contrast method, emphasizing very well the modifications at sea-land interface. Changes detections were necessary in this case for anthropogenous impact evaluation and for project approaches consideration in several vulnerable areas.

In general, the effects of hydrological and meteorological factors, especially of storms, it is not limited only to the natural shore. They are extended to areas governed by anthropogenous factor, were the impacts of winter storms are more visible and consequences become more dramatic on short terms, due to strong wind/waves magnitude, or its durations.

The magnitude of shoreline retreat is proportional with average seasonal and annual sea-level rise. The continuous shoreline and sea-level monitoring permits the extension of efficient specific shore protection solutions on specific shore sectors. The methods used in present study emphasized the general characteristic of shore response, which together with the followed numerical modeling works; it will make possible the correct understanding of the phenomena at different space and time scales.

After the analyze the results regarding the variability of beaches area for different sectors (obtained by direct measurements or maps), due to variability of geomorphologic changes and erosion causes, the conclusions are that it is necessary to deepen the problems, practical and theoretical, in the modeling stage to reach to a correct understanding of marine/coastal processes and impacts at Romanian shore in new climatic conditions.

NT-014

THE OREGON MARINE MAP PROJECT: AN ONLINE TOOL TO ASSIST IN MARINE SPATIAL PLANNING

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Keywords: *marine spatial planning, public involvement, data visualisation, KML, open source GIS*

ABSTRACT

The Oregon MarineMap tool provides data visualization and analyses relevant to resource managers, scientists and the public and is a powerful means of involving stakeholders in the process of collaborative marine spatial planning decisions. Built on an open source base, the tool allows users to visually interact with marine data in KML format using the Google Earth browser plug-in, as well as to create query reports from data stored in PostGIS. This report includes lessons learned from eight months of deployment in the public process to amend the Oregon Territorial Sea Plan for the inclusion of marine renewable energy.

The Oregon Marine Map Project: An Online Tool to Assist in Marine Spatial Planning
In January 2011, the state of Oregon launched the Oregon MarineMap (OMM) tool (http://oregon.marinemap.org). The project was built upon the open source MarineMap system previously developed and used in California to involve the public in marine protected area decisions pertaining to that state's Marine Life Protection Act (MLPA) process. The Oregon project adapted the California tool for more generic geo-visualization purposes, while retaining many of the original data sharing, privacy and query capabilities. Ultimately, the new tool is intended be used as the primary public visualization mechanism employed in Oregon's ongoing marine spatial planning processes.

First and foremost, the OMM tool enables the online visualization and analysis of a wide range of coastal and marine data in ways that facilitate public involvement in the various public processes relating to the Oregon Territorial Sea. The most current of these processes is the amendment of the Oregon Territorial Sea Plan for the inclusion of marine renewable energy. The tool showcases a comprehensive database of ocean information assembled over the past three years, and also incorporates a suite of newly collected information on human uses within Oregon's Territorial Sea.

This paper will give a basic overview of the design of Oregon MarineMap, its evolution from the California original, and will discuss lessons learned over the first eight months of public deployment. Topics covered will include the development of multiple thematic modules each with a different analytic focus, "Pros and Cons" of some of the technical aspects of MarineMap, as well as issues of ease of use from both the public user and the hosting agency perspectives. Also covered will be challenges encountered with hosting in the Amazon "cloud" and optimizing data in the KML format for display via Google Earth browser plug-in.

SEAZONE HYDROSPATIAL II: A MARINE MAPPING TOOL FOR INTEGRATED COASTAL ZONE MANAGEMENT

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Keywords: *Marine mapping, Integrated Coastal Zone Management, Spatial Data Infrastructure, INSPIRE, SDI, ICZM, CZM, HyrdoSpatial, BLAST Project*

ABSTRACT

This paper describes how the SeaZone HydroSpatial, a marine mapping product used widely within UK marine industry, can be used as a mapping tool which supports effective decision making and accurate data analysis for Integrated Coastal Zone Management (ICZM).

SeaZone HydroSpatial is the marine industry's most widely used marine base mapping product in the UK and is designed specifically for applications within the marine environment, including engineering, renewable energy, utilities, environmental, aquaculture and licensing consent and evaluation. It provides users with access to definitive marine data and information; 'best available' data that is authoritatively sourced from Hydrographic Offices and other data agencies.

SeaZone is implementing numerous improvements to its HydroSpatial data product, ready for HydroSpatial II launch in 2011. These new developments will allow data users to more easily implement the INSPIRE Directive and Implementing Rules in their marine data use, and support the data requirements of the BLAST[1] Project (Bringing Land and Sea Together).

HydroSpatial is a complex and informative data product that is designed to meet Spatial Data Infrastructure requirements. It has over 500 marine related feature types across topics such as bathymetry, hydrology, geology, infrastructure, habitats, heritage and environment. Enhancement of the HydroSpatial Product Specification in version II, delivers to BLAST a data model better suited to the research and development conducted in the other BLAST Work Packages, with the overall aim of enhancing Integrated Coastal Zone Management and Maritime Safety Planning.

SeaZone has created a product specification which identifies the mapping of every feature to an INSPIRE feature type within public data specifications. This means that users can easily query and filter data according to the required INSPIRE themes and packages. This in turn can allow data to be more easily shared across European Member State boundaries, in line with INSPIRE implementing rules. In a user's area of interest, analysis and assessment of marine data can be streamlined to INSPIRE spatial data infrastructures to ensure relevant and effective decision making.

Advances in data products like HydroSpatial will support business requirements to maximise project efficiencies, improve data procurement time and cost savings and improve decision making as organizations increasingly recognize marine geographic information as a valuable asset in their operations. In short, using a data product such as HydroSpatial can help support the Europe 2020 Strategy for Smart, Sustainable and Inclusive business growth.

[1] Bringing Land and Sea Together – an EC Interreg IVB North Sea Region Programme (www.blast-project.eu), part of the European Regional Development Fund.

OCEANIDS: MEETING THE NEEDS OF DEVELOPING STATES TO EXPLORE, ANALYZE AND SHARE OCEAN DATA

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Keywords: *public marine data, mapping, developing states, visualization, data sharing, portal, geoportal, OCEANIDS*

ABSTRACT

The global community, with developing states and small island developing states (SIDS) in particular, requires credible, science-based marine data and information for purposes that include support to scientific investigation, spatial planning and environmental and natural resource management in an overall effort to promote the sustainable use of the coastal areas and oceans. There is now a multitude of data portals and data viewers facilitating data exploration, use and sharing, but these remain most useful to the users experienced in handling and working with a variety of data formats and specialized software and tools.

UNEP/GRID-Arendal coordinates the UNEP Shelf Programme, which is the access point to a collaboration of international organizations with expertise in marine geosciences and maritime law, assisting developing states and SIDS in delineating their continental shelf as defined by the United Nations Convention on the Law of the Sea (UNCLOS). OCEANIDS builds upon the successful development and implementation of the UNEP Shelf Programme's One Stop Data Shop, but with new technical development designed with the non-GIS expert end-user in mind. The aim with OCEANIDS is to provide an easy mechanism for users to find and examine public marine scientific datasets, and facilitate their engagement by allowing them to visualize and combine datasets as they wish, make their own maps, and even perform basic comparative analyses. Furthermore, registered users are able to easily upload their own data, enabling a range of possibilities for data visualization, analysis and sharing. The goal is to create rich interactive visualizations to solve problems without any, or limited, experience using traditional mapping tools. The OCEANIDS platform will be used during training activities on integrated marine and coastal zone management in the Sustainable Seas capacity development programme of UNEP/GRID-Arendal.

The development of OCEANIDS is motivated primarily by the following target uses:

- Mapping of benthic habitats and marine and coastal ecosystems to support marine spatial planning;
- Providing developing states with qualitative evaluations of non-renewable marine resources;
- Prospectively mapping for deployment of marine renewable energy systems with jurisdictions of developing states;
- Assessing the state of the deep sea environment inside and outside areas of national jurisdiction;
- Using data compilations to support proper valuation of deep sea ecosystems facing the impacts of human activities

By facilitating access to marine scientific data held by international institutions, researchers and the public, and by building the capacities of national experts, UNEP/GRID-Arendal, in

conjunction with other major capacity and data providing agencies, seeks to 1) ensure that developing states have the abilities and information necessary to make their own, independent marine management decisions and 2) that the vast volumes of available marine scientific data are used to their full potential by all stakeholders.

GRID-Arendal is hereby seeking to inform current data partners and potential new partners of the development plans for OCEANIDS and invites all holders of relevant data to contribute their basic inventories and metadata. Access to the data inventories of partners will be accomplished using Open Geospatial Consortium protocols

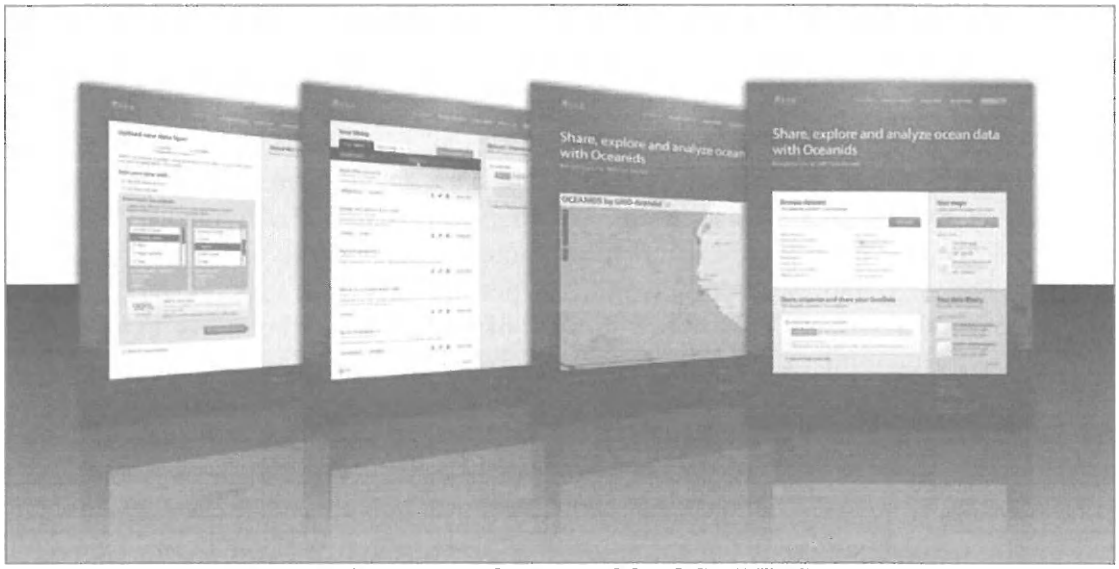

Figure 1. Some example views of the OCEANIDS system

THE CASE OF MISSION INTERSERVICES MER ET LITTORAL (MIMEL)

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Keywords: *Spatial Data Infrastructure, SDI, organisation and collaboration of government services, anti-pollution fight, maritime regulations, Integrated Coastal Zone Management (ICZM), INSPIRE*

ABSTRACT

Mission Interservices Mer et Littoral (MIMEL) was founded by the Interministerial Committee on Spatial Planning and Development (CIADT) on 14 September 2004. Within the framework of administrative testing it *aimed at strengthening coordination and transversality of government services and public institutions, towards apprehending coastal and maritime issues.*

In this context, the GEOMER laboratory (Brest section of UMR 6554 LETG of CNRS) was entrusted with the study "Geographic Information and Integrated Coastal Zone Management", which sought to establish a Sea and Coast geomatics centre, in the regions of Lower and Upper Normandy, as a key prerequisite for Integrated Coastal Zone Management (ICZM) processes and for government administrations' collaborative work.

This two-year study implied the analysis of organisational and functional terms of use of geographic information in government services, within the framework of their assignments on the coast. Based on a number of surveys in all services, the aim was to understand geographic information collection, use, exchange and dissemination methods. According to the assessment thereby provided, a workgroup was set up in order to develop a number of technical and methodological recommendations available as data sheets and used for a GIS workshop. The organisation method implemented stimulated the exchange between partners towards complementing and improving their geomatics skills and, furthermore, their operational effectiveness.

Practical applications also led to seeking services that produce geographic information and to testing modalities of data exchange and update in order to provide the geomatics centre therewith and sustain it:

- The first implied the study of modalities for geographic information production and update, describing maritime regulations, as well as an optimised methodological framework proposal. The statutory instruments (orders, decrees…) collected among the services and professionals were structured and used in order to produce matching layers of geographic information on the basis of which an atlas of maritime regulations was published.
- In the second, geographic information collected among government services was used to produce the Polmar-Terre atlases of the three coastal departments of Normandy (Manche, Calvados and Seine-Maritime). Established according to standardised methodological

principles, these atlases gave rise to paper and digital publication. An interactive version is also available from the online mapping server CARMEN.

The data used were subjected to normalised structuring in accordance with the principles considered by the workgroup (format, layer names, projection system, standardised metadata…). They are listed on Ifremer server SEXTANT in order to facilitate awareness and dissemination thereof.

While the work carried out provided an inventory of geographic information available in government services, it mostly led to identifying owners and officials, making the connection between them and prompting the established network's facilitation. This work contributes to the improvement of awareness, access, dissemination and use of public geographic information in accordance with the Aarhus Convention and INSPIRE Directives. The study ended in October 2010, yet the results obtained provide a strong basis towards the further development of the Sea and Coast geomatics centre, the running of which now falls to the share of the Interregional Directorate for the Sea (DIRM) of Manche-Mer-du-Nord.

COLLABORATIVE GOVERNANCE OF MARINE PROTECTED AREAS AND PUBLIC PARTICIPATION GEOGRAPHIC INFORMATION SYSTEMS (PPGIS) IN MARGOV

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Keywords: *Geographic Information Systems (GIS), Public Participation Geographic Information Systems (PPGIS), GIS Web Applications (WebGIS), crowdsourcing, Marine Protected Areas, MARGov*

ABSTRACT

The overall objective of the MARGov Project was to establish a communication channel among local users of the Marine Park Professor Luiz Saldanha, which is located about 50 Km south of Lisbon (Portugal) and part of the Arrábida Natural Park, aiming to foster the participation and collaboration of all communities for the sustainable management of Marine Park.

In order to pursue this goal a Public Participation Geographic Information System (PPGIGS) was developed, allowing the interaction, discussion and public participation of the stakeholders and actors involved. This PPGIS emerges as a crowdsourcing tool, with the purpose in assisting the georeferenced contributes from the local users of the Marine Park, regarding several relevant subjects, such as pollution, economic activities, opportunities and threats of the Marine Park.

Collaborative governance of marine protected areas and Public Participation Geographic Information Systems (PPGIS) in MARGov

The MARGov Project began in October 2008 and it won the first edition of the Gulbenkian/Oceanário Prize "Sustainable Governance of the Oceans". The MARGov team includes a group of experts with a diverse range of backgrounds and academic/professional experiences, from various entities, such as the New Technologies Laboratory (LabNT) of the Institute for Statistics and Information Management of the New University of Lisbon (ISEGI-UNL), the Faculty of Science and Technology also from the same University (FCT-UNL), and the Institute of Marine Research (IMAR). The involvement of such a variety of entities and the activities developed within the project are critical to address the complex and multidisciplinary problem – the building of new forms of governance for the Marine Protected Areas.

The aim of the MARGov project was to strengthen the eco-social dialogue of empowering agents in order to achieve sustainable ocean governance. The active participation of local communities and other stakeholders was also an objective in the process of strengthening the human and social dimension in the management of marine protected areas. To maintain the

entire collaborative process and to provide a repository of information/knowledge, a Public Participation Geographic Information System (PPGIS) (see figure 1) was designed and developed which supports the development of management actions over a long term.

The MARGov Project was structured into 3 components:

- **Governance** that incorporates participation, collaboration and decision-making aspects, ensuring active and effective involvement of key actors;
- **Citizenship**, which aims to raise awareness, sensitization and training of citizens and organizations;
- **Spatial-Dynamic Structure** that ensures a spatial-dynamic registration of information, supporting the knowledge collected and created throughout the project, this structure is developed during the collaborative process.

    - **Information:** Sustainability indicators (socio-economic, environmental and institutional / governance), categorized according to the Pressure-State-Impact-Responses model, viewable in a WebGIS platform (figure 1);
    - **Modeling:** Construction of a system dynamics model coupled to a model of information management in WebGIS;
    - **Management**: Use of the spatial-dynamic model as a tool for potential effective management of the Marine Park, allowing simulations associated with different action scenarios.

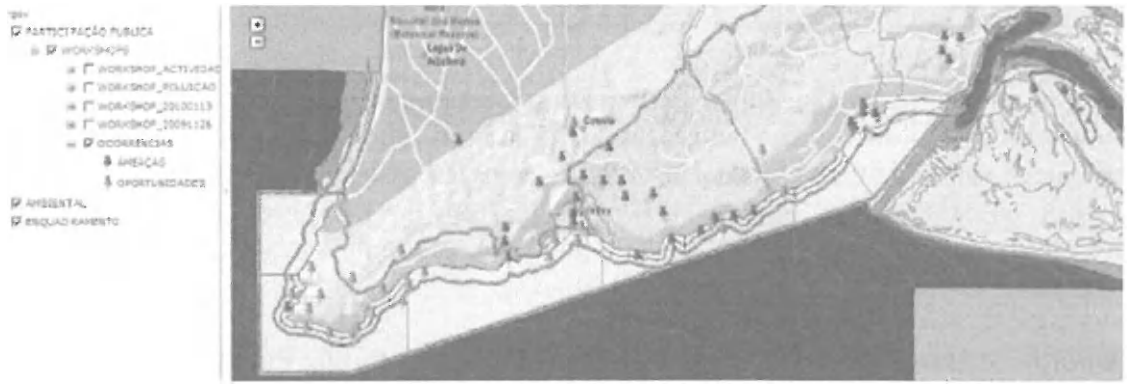

Figure 1 – Example of the interface of MARGov Public Participation GIS. On this example there are some of the contributes and remarks given by the stakeholders regarding the opportunities and threats to the Marine Park (http://margov.isegi.unl.pt)

The Marine Park Professor Luiz Saldanha, a Marine Area Protected (MPA), was the selected area as a case-study for the MARGov Project. The Marine Park, which is located 50 Km south of Lisbon (Portugal), is integrated in the Arrábida Natural Park, occupying an area of 53 Km^2, it holds about 38 Km of rocky coast between Figueirinha beach on the way out of the estuary, and Foz beach, north of Espichel Cape. It is an area with high biodiversity, classified in the national Natura 2000 sites, the Arrábida-Espichel site.

The Marine Protected Areas (MPA's) are fundamental tools for biodiversity conservation, sustainable fisheries management and cultural preservation of coastal societies. The limited participation of local stakeholders in managing these areas is recognized as a barrier to environmental sustainability and socio-economic profile of coastal and marine resources. A social agreement on conservation and use of these resources and a good coordination and

communication between players with different skills, legitimacy and responsibility constitute the basis for an effective co-management.

The MARGov Project considered as direct stakeholders, local communities and, in particular, the users of the Marine Park Professor Luiz Saldanha. Specifically these are the fishermen, the scuba diving, recreational fishing and nautical tourism practitioners, tour operators and local associations. Other relevant entities, in this area and its surroundings, were also included in the project activities, such as the Natural Park of Arrábida (ICNB), the Municipalities of Sesimbra, Palmela and Setúbal, the Ports of Sesimbra and Setúbal, the Maritime Police, the General Directorate of Fisheries, IPIMAR, among other institutions. It is also important to refer to the inclusion of the educational community, the local population, the tourists in the area and the public in general, although as indirect stakeholders of the project.

The PPGIS architecture contains ArcGIS Server (ESRI ©) on the server component, which is responsible for creating spatial web services that will interact with the various GIS applications. As for the database component, the solution used on the PPGIS was ArcSDE, allowing the storage of spatial information.

Besides the spatial visualization function, basic navigation and spatial analysis tools, this WebGIS application also integrates spatial editing tools that allow the participation of the stakeholders and actors within the public participation sessions.

These editing tools support the spatial-dynamic registration of information, created and developed by the stakeholders throughout the project, during the several thematic public participation sessions, namely:

- **Opportunities and Threats:** the stakeholders identified and commented some opportunities and threats within the Marine Park;
- **Intensity Levels of Pollution:** the participants had to describe and point out areas in which they can identify levels and types of pollution;
- **Recreational fishing:** the actors identified and gave some remarks about the areas where they used to fish before and after the constitution of the Marine Park;
- **Nautical tourism:** the stakeholders, mostly nautical tourism practitioners, indicated and commented about their recreational activities inside the Marine Park area.

The biggest challenge of the Project, besides strengthen the interaction among the Marine Park stakeholders, was to collaboratively construct, with social and institutional actors, a Governance Model for Marine Park Professor Luiz Saldanha co-management, replicable and adaptable to other Marine Protected Areas, in order to minimize and solve conflicts in the area.

NDSKIS: A DISTRIBUTED MARINE AND COASTAL INFORMATION SYSTEM

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Keywords: *Marine and Coastal Information System, GIS, Spatial Data Infrastructure, SDI, distributed systems, social software, seabed habitats*

ABSTRACT

Marine and coastal environments have been subject to particular public scrutiny, especially over the last few years. The increasing pressure of offshore use, the impact of climate change, and changing biodiversity, are key issues in the coastal zone. In cases where initial examination has covered only areas small in scale in relation to the issues specific to the project, there is a sharp increase in the requirements imposed by new European directives, such as the Marine Strategy Framework Directive [1]. Continuous monitoring of both the state of the sea and of its highly dynamic coastal areas, together with analysis of the data collected and, ultimately, the communication of such knowledge as a basis for a plan of action, all continue to present a daunting challenge to scientists and authorities alike.

Internet portals are an essential tool for knowledge management within the modern scientific community. With the help of the internet, a great many users can gain access to data, information, knowledge, and to the insights these provide. At present, research and development projects are in operation at various levels, and they support, directly or indirectly, the creation of internet portals which aim to provide marine and coastal information. This is currently rather heterogenic, making it difficult for users to locate the relevant information.

This basis in various internet portals constitutes a specialised and often scattered infrastructure that is geared toward accessing existing data and information. Using uniform definitions of standards, INSPIRE makes an attempt at limiting this heterogeneity, at least with regard to spatial data infrastructures (SDI).

The coastal information system NdsKIS works on the concept of "social software", and its consequent usefulness as a means of organising knowledge bases [2]. Initially developed for the North Sea coast of Lower Saxony, this system can easily be transferred to other areas. Data, methods, and software are presented in a transparent way by NdSKIS, thus forming a consolidated knowledge base. Via NdsKIS, basic information can be provided that is not necessarily stored centrally, but distributed on a local level. Experts from the community can use this basic information to pose more general questions and to adapt the answers they provide to the needs of specific groups of users.

The development of NdsKIS is an iterative and evolutionary process. In the current version, the essential functions to offer and maintain marine and coastal information by registered users are implemented, as well as integrating this information into a subject-specific context.

Data and software are offered in a decentralised fashion, for example via web services, in the current version; methods can be stored by means of the centralised NdsKIS DataStore. Using profiles, the possibility is brought about for registered users to generate personalised information.

Administration of NdsKIS, as well as of user-specific content, has its basis in an extension of the content management system *CMS Made Simple* (CMSms). Guided workflows are provided, that support users to integrate information to the NdsKIS. In order to present spatial information, an OpenLayerManager for CMSms has been developed for example. Spatial information is made available in the current version as WMS, WCS, WFS, TMS or GeoTIFF. In order to create dynamic data at runtime, the NdsKIS starts processes over WPS or algorithmic resources in a defined way, so for example maps can be actualized periodically every night.

The concepts of NdsKIS are evaluated using various case studies. In this way an enhancement of the MESH approach [3] for coastal areas has been established as a method of modelling habitats called MESH+. Modelling of marine habitats will focus initially on abiotic parameters, i.e. sediment, bathymetry and current, since these have a significant influence on the Wadden Sea habitats. This basic information is available on distributed servers and is offered as a WCS in the SOA style, and also as TMS and GeoTIFF resources in the ROA style. On the basis of the MESH+ methodology outlined above, there follows dynamic processing of possible habitat types. The results are again provided as WCS, TMS, and GeoTIFF, and then integrated into the NdsKIS. Realisation of download, display and processing services is achieved using Java as a programming language, in conjunction with libraries such as GeoTools and Sextant, the GeoServer REST API, and the WPS framework from 52° North.

In the course of work on NdsKIS, both the SOA and ROA styles for distributing spatial information as described in [4,5,6] have been investigated. It was possible to implement either approach successfully in the MESH+ case study, although there are significant differences both as regards simplicity and scalability, and in the relative efficiency in relation to time and resources.

In its first version, NdsKIS provides the basic functionality of offering static and dynamic information in a simple way and of integrating it into a subject-specialist context. It is based on the concepts of social software, enabling the community to gain knowledge of and insight into marine and coastal spaces, and to adapt them for sharing with specific user groups. For the integration of further tools into NdsKIS, further continuous development is vital.

[1] EU Parliament. DIRECTIVE 2008/56/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). Official Journal of the European Union, 51(L164):pages 19-40, 2008.

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MEETING THE "BILLION URL CHALLENGE" OF THE COASTAL MANAGER

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Keywords: *Atlantic Canada, Spatial Data Infrastructure, Integrated Coastal and Ocean Management, Open Geospatial Consortium, standards, web-mapping services, KML, networks, metadata ACZISC, COINAtlantic, Canada's Ocean Act, COINAtlantic Search Utility, COINAtlantic GeoContent Generator, GeoConnections.*

ABSTRACT

The Atlantic Coastal Zone Information Steering Committee (ACZISC) fosters cooperation in Atlantic Canada with regards to integrated coastal and ocean management (ICOM) and the sharing of the spatial data and information needed for informed decisions. The paper illustrates the information challenges faced by ICOM managers by analysing the information requirements for the manager of one significant piece of Canadian legislation (Canada's *Oceans Act*). It describes the work of the ACZISC to meet these challenges including the development of the Coastal and Ocean Information Network for Atlantic Canada (COINAtlantic) and an ICOM information "hub" website. The barriers to be surmounted and the vision of the ACZISC and COINAtlantic for the future are also described.

Meeting the "billion URL challenge" of the coastal manager

The Atlantic Coastal Zone Information Steering Committee (ACZISC) was established in 1992 to foster cooperation in Atlantic Canada with regards to integrated coastal and ocean management and the sharing of the spatial data and information needed for informed decisions. An early accomplishment of the ACZISC was the publication of the Atlantic Coastal Zone Database Directory. Version 2 of the Directory, published in 1994 in WordPerfect format with included jpeg map images, contained descriptions of 612 databases from many federal and provincial agencies in Atlantic Canada. In 2005 with a grant from the GeoConnections Program of Natural Resources Canada and support of other ACZISC members, the ACZISC was able to initiate Phase 1 of the Coastal and Ocean Information Network in Atlantic Canada or COINAtlantic (http://coinatlantic.ca).

COINAtlantic does not attempt to centralize the information; it is not a data warehouse, a metadata catalog or a GIS mapping engine. COINAtlantic is a network of people sharing a common objective of more informed decisions for coastal zone management, a network of information providers contributing maps, data and publications on-line and a free search utility accessed through common Internet browsers, the COINAtlantic Search Utility (CSU). Progress leading up to the completion of Phase 1 of COINAtlantic has been described in Sherin (2007) and Sherin et al (2010). The CSU searches for geographic data and information of relevance to Integrated Coastal and Ocean Management in Atlantic Canada and visualizes it on an interactive map using Open Geospatial Consortium (OGC) standards.

The CSU developed in Phase 1 relied exclusively on the metadata catalog developed by the Government of Canada as part of the Canadian Geospatial Data Infrastructure (CGDI), the

GeoConnections Discovery Portal (GDP - http://geodiscover.cgdi.ca/web/guest/home). The limitations of this approach were soon realized as organizations developed independent metadata catalogs, e.g. Nova Scotia provincial GeoNova [1] that were not well integrated with the GDP.

Phase 2 of COINAtlantic development relies on using Internet searches, such as the Google search environment, to enhance the CSU's scope and functionality. The CSU for Phase 2 searches the entire Internet for relevant information sources including direct searches for Open Geospatial Consortium (OGC) compatible sources such as web-mapping services (WMS) and KML files. In addition, the ACZISC is encouraging and supporting organizations in Atlantic Canada to populate the internet with web searchable text files in KML format with embedded polygonal information on the geographic scope of the data, publication, project or the organization's area of interest. The ACZISC has developed a simple tool, the COINAtlantic GeoContent Generator (CGG - http://labs.gatewaygeomatics.com/cgg/) that acquires basic attribute information (i.e. metadata) for an organization, publication, project or data set, links it to a KML polygon and publishes the aggregated file in a web accessible folder so that it is easily indexed and discovered by internet search engines.

Figure 1 shows an example of the results of an Internet search for web-mapping services serving multibeam bathymetry and marine surficial geology data displayed in the CSU prototype for Phase 2 of COINAtlantic. Labels were added.

A parallel initiative of the ACZISC has been the redesign of its website. The new website is

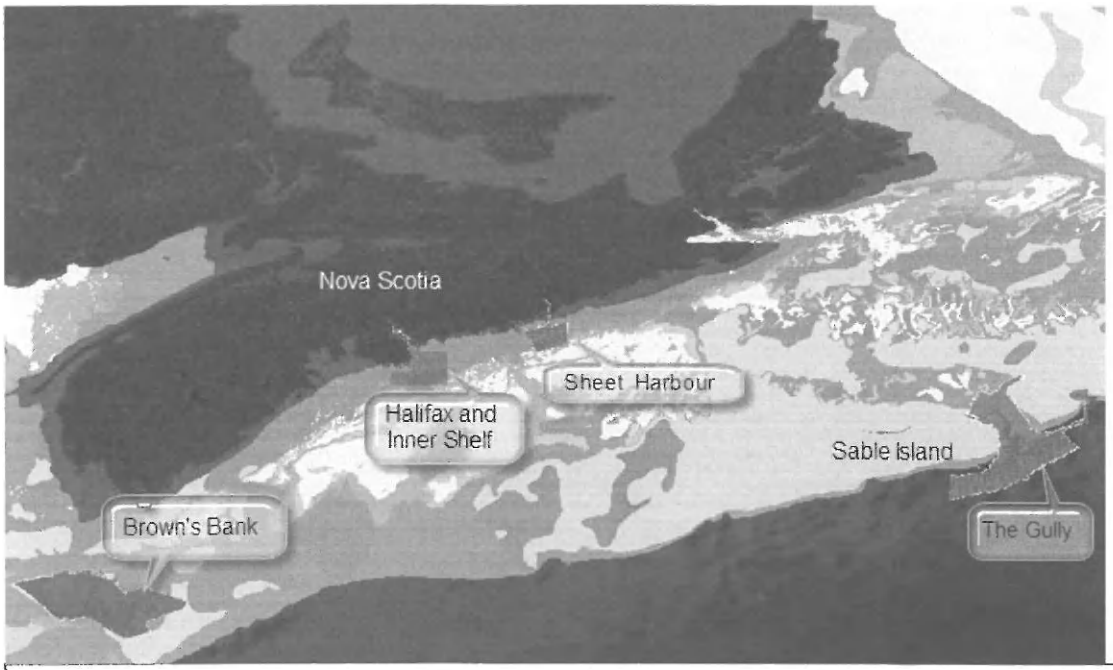

Figure 1: Four sets of multibeam bathymetry for the continental shelf and slope of Nova Scotia, Canada overlayed on a regional surficial geology map discovered by an internet search for web mapping services. Labels added.

intended to be a "hub" for information on Integrated Coastal and Ocean Management relevant to Atlantic Canadian users. The website (http://coinatlantic.ca) integrates the CSU. The website makes use of internet tools such as RSS feeds, Google Analytics and Facebook.

The paper illustrates the information challenges faced by coastal and ocean managers by analysing the information requirements for the manager of one significant piece of Canadian legislation (Canada's *Oceans Act*). It describes the work of the ACZISC to meet these challenges, the barriers to be surmounted and the vision of the ACZISC and COINAtlantic for the future.

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NT-021

AN OCEANOGRAPHIC AND METEOROLOGICAL SERVICE-ORIENTED INFRASTRUCTURE AIMED AT PUBLIC USE FOR NAUTICAL SPORTS: WWW.SURFSPOTS.ES

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Keywords: *service, infrastructure, surf, nautical sports*

ABSTRACT

The conceptualization of space and time to study dynamic systems are based on the interactions between patterns and process in geographical spaces. Coastal zones present environmental conditions that change dynamically due to interactions between sea and land process. Despite some analytical approaches of the coastal zone may be static, time is a key element of the environmental behaviour.

Real time sensors, such as meteorological stations or oceanographic buoys, provide vast amount of real time environmental information demanded by several users (scientists, managers, general public, etc.) for different purposes. Nowadays, national governments and regional administrations have established monitoring networks that allow a better understanding of the environmental patterns and provide key information for an effective management. On the other hand, private meteorological networks provide environmental information from amateur weather stations to the public sector. In addition, meteorological and oceanographic models provide predictions of the environmental conditions for a near future. Universities and meteorological-oceanographic agencies are the main providers of weather and oceanographic forecast.

Consequently, a wide range of data providers are currently in the scene, providing environmental data with diverse quality and under different interoperability protocols. This paper shows a service-oriented infrastructure that makes use of diverse oceanographic and meteorological sources to offer an integrated service that could be applied to a large number of research or applications. In this case, the infrastructure is being used by a dynamic web application that illustrates real time environmental conditions for nautical sports (surfing, kitesurfing and stand-up paddling).

The infrastructure is supported by a Service Oriented Architecture (SOA). A SOA is essentially a collection of services, and each one of them is a well-defined, self-contained piece of software that is not dependent on the state or context of other services. Adopting this pattern, several reusable services have been designed and implemented so they can be consumed by a wide range of applications, with simple and standard protocols over the network. The result is a much more manageable approach to develop IH Cantabria information systems and integrate with external agencies, such as AEMET (Ministerio de Medio Ambiente), whose meteorological and oceanographic raw data are a valuable resource not only for scientific research but for applied science and divulgation.

For the implementation of these services Windows Communication Foundation (WCF) technology has been mainly used. This is a framework, built on the top of the .NET platform, which enables the creation of services under a unified API and supersedes several previous technologies (traditional Web services, DCOM, Enterprise Services, MSMQ, among others). Firstly, the services have been developed using C# programming language in WCF library projects. Secondly, the services have been deployed at Microsoft Internet Information Server (IIS). And finally ASP .NET applications have access to them through the network to exploit their methods.

Currently, there are three main services: IH.Nowcast.MeteorologicalService, IH.Nowcast.OceanographicService and IH.Forecast.MeteorologicalService.

(1) IH.Nowcast.MeteorologicalService:

The Meteorogical Nowcast Service connects with a standard File Transfer Protocol server (FTP) offered by AEMET [1]. Although the data behind the scenes, coming from real time weather stations all over Spain, have their own nomenclature and special features, the service provides a simple and focused view of the meteorological data.

(2) IH.Nowcast.OceanographicService:

The Oceanographic Nowcast Service is an oceanographic nowcasting for a growing spatial extent (Cantabria and neighbouring regions) supported by IH Cantabria. A modelling process based on MATLAB extrapolates oceanographic real time data collected from two oceanographic buoys [2], obtaining real time oceanographic conditions of the coastal zone.

(3) IH.Forecast.MeteorologicalService:

The Meteorological Service Forecast is an accurate meteorological forecasting for the Iberian Peninsula, including variables such as temperature, precipitation, wind direction and wind speed among others. This service acts as a thin facade over a THREDDS Server [3], supported by the University of Cantabria (UC, Dept. of Applied Mathematics and Computer Science) and the National Research Council (CSIC, Instituto de Física de Cantabria IFCA).

As future lines of development a tidal service will be implemented together with an oceanographic forecast for the Spanish coasts. Several applications will be able to access the information provided by this Service-Oriented infrastructure. At this time, public users interested on surfing conditions at the Spanish coast can interact with the dynamic web application, www.surfspots.es, which integrates all the information and provides quality indexes for the practice of nautical sports, such as surfing, kitesurfing and stand up paddle. SurfSpots is a web mapping application based on OpenLayers, which implements the location and state of surfing and kiting spots. The spots location and spatially related features of interest such as buoys, tides, weather stations and webcams are managed, centralizing strategic information for the final user.

[1] FTP from AEMET - http://ftpdatos.aemet.es/
[2] Red Vigia - http://www.redvigia.es
[3] THREDDS project (Thematic Realtime Environmental Distributed Data Services) - http://www.unidata.ucar.edu/projects/THREDDS/

NT-022

THE DEVELOPMENT OF A METHOD TO DELINEATE MARINE BOUNDARIES USING A GIS

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Keywords: *spatial data, marine boundary, EEZ, GIS*

ABSTRACT

Introduction

Due to the revaluation on marine potential and progress of science and technology, today the sea is emerging as a source of unlimited resources and strategic competence. As the importance of the sea is highlighted like this, a new paradigm for marine development and utilization is being formed. According to these changes, the Northeast Asian countries such as Japan and China etc., neighboring countries of Korea as well as the major countries of the world are reorganizing National Ocean Strategies and more aggressive maritime policies. Therefore, maritime territory securing competition occurs globally, not one region and this is deepening as competition on ocean resources increases. However, in case of exclusive economic zone (EEZ) declared in International Conference on the Law of the Sea, since it can be set up to 200 nautical miles from a country, exclusive economic zones of many countries are overlapped. Though the marine boundary can be delimited through the consultation among the countries directly involved where a dispute arises, the marine boundary delimitation is in the throes because each country claims different marine boundary. To solve this problem, marine boundary is negotiated through diplomatic policies and socio-cultural analysis but comparing quantitative results through scientific analysis can be helpful in the marine boundary negotiations. Therefore, this study aimed at developing the marine boundary delimitation support methods using GIS and analyzed and studied the results.

Contents

The marine boundary is created by applying several considerations such as historical elements or geographical factors etc. and is set through negotiations with coastal states. It is almost impossible to develop the system presenting the optimal marine boundary by applying all of these considerations. Therefore, the most effective method is to present objective data to decision makers by using the marine boundary created previously and to let them choose the optimal marine boundary by using the data. In this study, the method to indicate by calculating the area of waters that can be secured when applying several virtual marine boundaries was developed.

First, necessary data were collected to calculate the area of waters and marine boundary. As a basic map, electronic navigation charts where coastlines appear were collected and data on territorial waters basic point materials needed to draw base lines and data on a virtual marine boundary were collected. In particular, a virtual marine boundary was automatically made by

applying an equal distance line law or boundary lines were made by entering the coordinates of turning points of a virtual marine boundary scenario and connecting the points.

To make marine boundaries automatically by using an equal distance line law, the following process was carried out. The straight base lines were drawn by using basic point data and EEZ was drawn by performing 200 nautical miles buffer function from normal base line and straight base line. If it is a marine boundary dispute country, drawn EEZ will be overlapped with EEZ of coastal states. At this time, a center-line of polygon consisting of the outline of overlapped part was extracted. For a center line extraction algorithm, a center line extraction technique in polygon developed previously was used.

The first thing to be done to calculate the area of waters is the definition of waters. The areas and coordinates of the seas around the world are shown in Limits of Oceans and Seas issued by IHO in 1953 and waters were set by referring to this. By calculating the area of waters automatically when applying a virtual marine boundary to set waters and showing it, a decision maker can support the marine boundary delimitation by using objective data.

Conclusion

This method can present objective data marked by numerical values by calculating the area of waters that costal states can obtain when applying a virtual marine boundary scenario. A decision maker can use these data as scientific evidence data that can draw a marine boundary favorable to one's own country when delimiting the marine boundary. Objective data can be presented by applying it to data of a distribution map of fishery resources or a distribution map of mineral resources etc. that can indicate economic profit and loss as well as the area of waters. In future research, data needs to be secured to calculate economic profit and loss by using this distribution map of marine resources. But, security will be important because these economic data are related to national security.

COASTAL SPATIAL DATA INFRASTRUCTURE IN SOUTH AFRICA: THE NEEDS OF A TRANSFORMING SOCIETY IN A DEVELOPING COUNTRY

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Keywords: *integrated coastal management, coastal spatial data infrastructure, data platform, institutional framework*

ABSTRACT

Post-apartheid South Africa is a transforming society and a developing nation with a rich natural coastal heritage. As a nation, the South African government has, faciliated through a process of extensive public participation, developed a legislative and management framework which uses integrated coastal management (ICM) as a paradigm for coastal sustainability. Considering the developmental status of South Africa and the need for defensible scientific data and information going into an uncertain climate future, what are the requirements of a coastal spatial data infrastructure (CSDI)? Such an CSDI must be sensitive to the social and economic requirements of the country, while also providing a platform for decision-making that is responsive to the need for development, balanced against the urgency of protecting the resource-base, both living and otherwise. This paper will explore the history of the movement towards and development of CSDI-like platforms in South Africa to conclude with the presentation of the shared SDI platform, a system collectively developed by the Department of Science and Technology, the CSIR, SAEON and other stakeholders. This paper will also evaluate the requirements of a South African CSDI based on the unique national challenges and legal and management drivers like the ICM Act (No. 24 of 2008). Finally, it will identify the institutional framework for the development of a functional CSDI and plot its development to the 2015 CoastGIS Conference in Durban.

While this paper will briefly review the history of CSDI in South Africa, it will focus on providing some information on the recent development of a shared data platform. This platform is evaluated for the inclusion in the emerging CSDI. The shared platform currently hosts the SAEON[2] Data Portal, The South African Risk and Vulnerability Atlas[3], the South African Earth Observation System[4] (SAEOS), the CSIR GSDI Geoportal[5], and a prototype World Data Centre for Biodiversity and Human Health in Africa (WDCBHH)[6].

The platform is based on a shared and aggregated meta-data repository, and the meta-data repository is capable of accepting and working with a range of well-established meta-data standards. These include Dublin Core, SANS 1878, the ISO 19115 family, EML, and FGDC.

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[2] South African Environmental Observation Network, mandated to monitor the environment and maintain observation data for the long term.
[3] Funded by the South African Department of Science and Technology as part of their Grand Challenge Research Plan.
[4] SAEOS is funded by DST as part of their contribution to GEOSS
[5] Previously known as 'CoGIS', funded jointly by CSIR, SAEON, and other stakeholders.
[6] Funded by NRF/ SAEON and the US Geological Survey/ NBII.

The list is likely to be extended from time to time to accommodate other standards in widespread use by a user community or new provider.
The platform and its hosted portals are designed to serve a stakeholder community as a resource for the referencing, discovery, management, and optional archiving of relevant data sets and information objects. It also allows the composite visualization of distributed data sets, provided that access to these sets is automated and standardized.

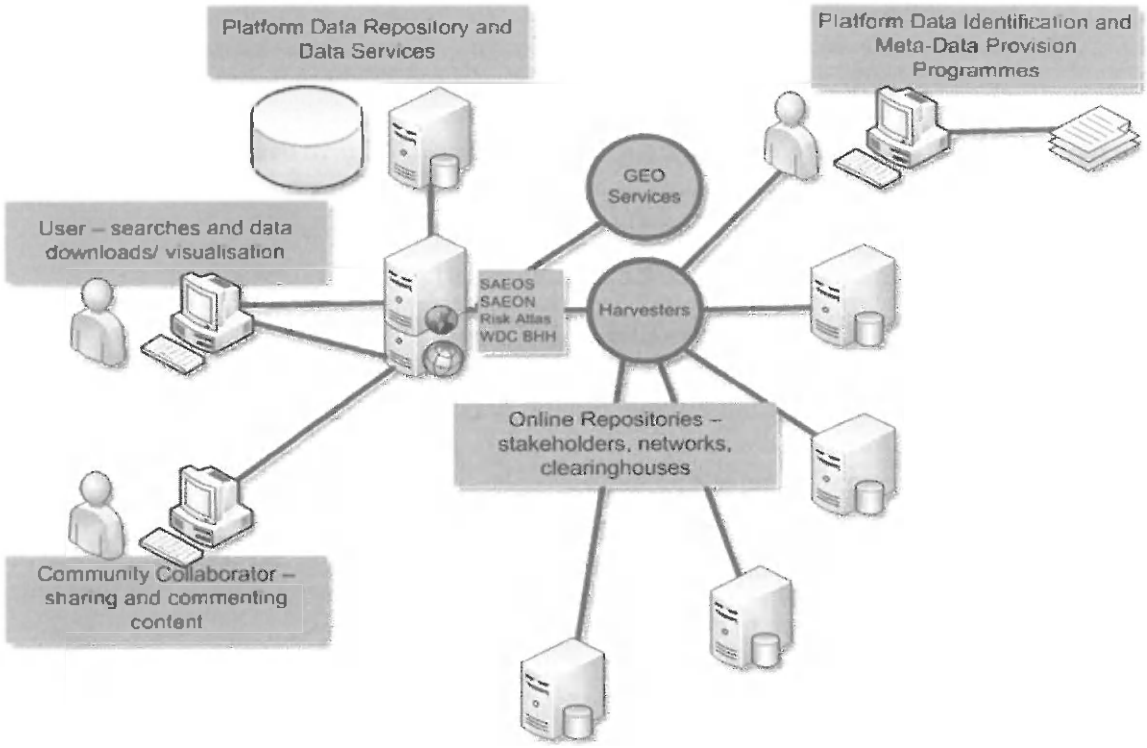

Figure 1. The architecture of the shared South African data platform

While the necessity of an appropriate technological platform for CSDI is undeniable, it can also be contended that without the institutional framework, the system will remain unfinished, unused, or inadequately supported by stakeholders. In addition to the ICM Act as a key driver of ICM, the other enabling condition for the creation of a national CSDI is the enactment of both the Promotion of Access to Information Act (No. 2 of 2000, amended No. 54 of 2002) as well as the Spatial Data Infrastructure Act (No. 54 of 2003). All of the drivers, but particularly the ICM Act, are critical for the understanding that must result in the development of a CSDI that is relevant within the context of national needs. The ICM Act, upon enactment, created a coastal management research agenda, and a need for consistent, updated and national through to local scale coastal spatial data. The complex nature of ICM is reflected in the Act and the need for scientifically defensible data is key to the implementation of statutory requirements of the ICM Act.

However, both the technological platform, the institutional framework, and the resultant CSDI must remain sensitive to the realities and requirements of coastal society in South Africa. In this instance, the transformative state of South Africa as a developing nation must guide the development of a CSDI. This is further emphasised by the pro-poor people-centred approach to managing the activities of people in the coastal zone. This paper will explore all the elements mentioned above as milestones towards the development of a functional CSDI in South Africa.

NT-024

DATA AND INFORMATION FOR AN INTEGRATED ASSESSMENT OF THE MARINE ENVIRONMENT IN EUROPE: THEORY, LEGISLATION AND PRACTICE

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Keywords: *sustainable development, integrated assessment, marine environment, EU legislation, monitoring, INSPIRE, EU marine policy*

ABSTRACT

Natural and anthropogenic pressures provide fundamental challenges for the sustainable development of the marine environment worldwide. Observational records and climate models and projections provide abundant evidence that climate change will have a significant impact on seas and oceans, both across Europe and globally. Human activities will also have a considerable impact, affecting not only marine ecosystems and biodiversity, but also key socio-economic activities across a wide range of sectors, with potential negative impacts on human health.

Traditional practices approached the management of marine natural and human systems from a sectoral perspective, developing targeted strategies for the management of specific human activities. This approach is now being considered as insufficient to solve current complex environmental and socio-economic problems and address the challenge of sustainable development. In the last years, the scientific debate and international, national and local management strategies started building and developing integrated approaches to the sustainable development of marine systems.

Such integrated policies need to be based on sound scientific knowledge of the marine environment. Data is needed, coming not only from different scientific disciplines, including marine and atmospheric chemistry, biology, physics and marine geology, but also describing the society and the economy potentially affected. These data must describe the status of the marine environment, its pressures from natural and anthropogenic stressors, as well as the impacts on natural and human systems. They must be combined and analysed, and then transformed into sound information to support decision-making. In addition to this, since such challenges strike at a global scale, cooperation is needed across borders in order to face these challenges in a more effective, coordinated way.

In Europe, accordingly, over the past three decades there has been a gradual shift from a sectoral approach towards the need to achieve a more holistic, integrated approach to the management of the European seas and oceans. This process culminated with the launch in 2008 of the Integrated Maritime Policy (IMP). This policy aims to apply to the oceans and seas of Europe a holistic, integrated approach, in order to replace compartmentalised resource management approach with an ecosystem based management view, with the objective of achieving sustainable development of EU seas and oceans. Under this umbrella, several existing, sectoral policies and initiatives have been gathered and coordinated, the most important being: the Natura2000 network of EU protected areas (under the Habitats (92/43/EC) and Birds (2009/147/EC) Directives); the Water Framework (2000/60/EC) and

the Marine Strategy (2008/56/EC) Framework Directives; the Integrated Coastal Zone Management (ICZM) (Recommendation 2002/413/EC), aiming at building a coherent and integrated approach to coastal zone planning and management; and the Common Fisheries Policy (Regulation No. 2371/2002), whose aim is to achieve sustainability of the European fishing industry.

All these policies and initiatives already require the establishment of a framework for data collection and monitoring of the marine environment. However, the present framework may not provide policy-makers with appropriate information to assess the state of marine systems and develop or adjust policies, or, to close the gap in the knowledge base for marine policies. Poor quantity of data collected on the marine environment is highlighted as an issue, and a major obstacle for achieving an integrated approach. Overlaps and gaps have been acknowledged also in data availability in national marine monitoring programmes, which are in need of harmonisation at continental scale. More in general, most data collection on the marine environment in Europe is focused on meeting the needs of a single purpose, be it a regulatory requirement, an operational or a scientific purpose.

The oral presentation will describe the programme and the first outcomes of an ongoing Ph.D. research study. The objective of the research is to analyse the current EU legal drivers for data collection and monitoring in the European marine environment, in order to evaluate the extent of integration of the marine assessments required by EU legislation. The research is being developed in four steps.

The first step is a review of current scientific approaches to an integrated assessment of the marine environment. Within sustainability science, Sustainability Assessment emerged as a new strand of studies, aiming at informing policy-makers on the objectives and methodologies to follow in order to solve complex problems and achieve sustainability in given, coupled natural and human systems. In this context, the Transition Management and the Adaptive Management emerged as promising theoretical frameworks for shaping and implementing sustainability assessment and management strategies. While coming from different theoretical backgrounds, the two approaches share the focus on complex problems, and the need to achieve and maintain sustainability through adaptive, learning-based strategies, based on sound scientific knowledge of the Social-Ecological System (SES) under analysis. Social-Ecological Systems are complex adaptive systems, involving processes and phenomena which adhere to a non-linear, unpredictable, multiple-cause, cross-scale and evolutionary behaviour logic. They explicitly consider humans and their social systems as an integral part of ecological systems (ecosystems). There is growing consensus in the academic debate for considering the complex marine natural-human systems as Social-Ecological Systems (SESs).

The second step of the research aims to assess the level of integrated assessment required by the EU legislation for supporting marine integrated management strategies. EU Regulations, Directives and Decisions disciplining the data collection and monitoring of seas and oceans will be analysed. Examples include the legislation for the protection of the marine environment, as regulated, *inter alia*, by the cited Water Framework, the Marine Strategy, the Habitats and the Birds Directives; and legislation regulating maritime activities such as fisheries (Common Fisheries Policy), energy and resources extraction, tourism and other coastal activities. Details will be recorded, regarding the collection, validation, analysis, conversion, communication and reporting of monitoring data and information required by each legal act. They will include information related to the measures required to be

monitored, such as the type of parameters (e.g. biological, physical, chemical), the frequency and location of sampling, and the methods and standards to follow. Next, an analysis of the data collected will be performed, with the objective of assessing the presence of overlaps and duplications among the details collected for each legal act. Also, possible misalignments with the reporting requirements will be identified.

These findings will be tested in the third step of the research. Their actual application will be evaluated in specific case-studies. Selected spatial areas where multiple legal regimes apply, driving multiple and sometimes overlapping requirements for monitoring specific parameters, will be identified and investigated. The purpose is to verify if the actual level of coherency in the legal requirements for data collection and monitoring is maintained at the implementation level. Case-studies selection is still ongoing.

Finally, the fourth step will summarise the findings of the research. The level of integrated assessment of EU marine Social-Ecological will be evaluated against the scientific frameworks identified in step one of the research. Possible suggestions to solve the identified problems will be drawn, and contextualised in the framework of existing initiatives for streamlining the data collection and monitoring of the marine environment (e.g. INSPIRE, GMES-MyOcean, SEIS/WISE-Marine, EMODnet).

MARINE SPATIAL DATA INFRASTRUCTURES: GIS FOR A BLUE PLANET

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Keywords: *GIS, Marine SDI, IHO, Hydrography, S-100, Data Model, INSPIRE*

ABSTRACT

Geographic information systems (GIS) have a dramatic impact on how spatial information is produced and used in different domains. Current technologies enable spatial analysis and the creation of all kinds of mapping and charting products from seamless databases, merging data from different sources, for temporal and spatial analysis. In parallel, cloud computing is becoming more popular every day and the proliferation of simple applications to be used on web browsers are flooding computers, from desktops to tablets and smart phones.

For authoritative organizations the problem comes when trying to share their geographic information either among them or with the general public. GIS is not a field exclusive to the GIS professional anymore, everyday more people require and use spatial data or products through the cloud to plan and make decisions with, to add their own data or just to go from point A to point B in a map or a chart.

But spatial data can grow exponentially and the problem of having a "messy warehouse" is very possible. Spatial Data Infrastructures (SDIs) and the efficient use of databases can be the framework to orderly organize and enable access to authoritative spatial data at different levels; many national governments around the world realize the importance not only of organizing geographic data in SDIs to optimize its usability but the need of effective ways to put it available to the user; a clear example of that is the multinational Infrastructure for Spatial Information in Europe (INSPIRE) project.

But meanwhile land based SDIs are already developing and many books discuss SDI in detail; a Marine SDI has so far a quite smaller role, not because is less important but because the Marine community is slowly understanding and turning into it. Some marine related international bodies are aware of this situation; for example, the International Hydrographic Organization (IHO) started three years ago a campaign promoting the development of a Marine SDI among its member states, encouraging them to be part of the National SDI effort contributing with their data. The recently approved new Universal Hydrographic Data Model S-100 opens up a whole new horizon of opportunities for data production and sharing beyond traditional users (that is the mariner through ECDIS and ECS).

This paper discusses considerations in building a Marine SDI, some examples of specific usages and benefits and how data can be shared and products created taking advantage of server and cloud technologies as well as the trend to the future: GIS, Marine SDI, IHO, Hydrography, S-100, Data Model, INSPIRE.

OCEAN RADAR WERA, A TOOL FOR COASTAL MANAGEMENT

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Keywords: *Coastal radar, currents, waves, predictions*

ABSTRACT

Introduction of the WERA System
The WERA system (WavE RAdar) is a shore based remote sensing system using the over the horizon radar technology to monitor ocean surface currents, waves and wind direction. This long range, high resolution monitoring system operates with radio frequencies between 5 and 50 MHz. A vertical polarized electromagnetic wave is coupled to the conductive ocean surface and follows the curvature of the earth. The rough ocean surface interacts with the radio wave and due to the Bragg effect back-scattered signals can be detected from ranges of more than 200 km [1].

The Bragg effect describes the coupling of the electromagnetic wave with the ocean wave field. To fulfil the Bragg conditions the electromagnetic wave length needs to have twice the wavelength as the ocean wave, e.g. for a 30 MHz radar signal with Lambda 10 m, the corresponding ocean wave is 5 m. Reflections from waves that fulfil this condition will generate a dominant signature in the received signal spectrum due to in-phase summation of amplitudes.

Quality of Ocean Current Maps
The ocean data that were used for this validation of the accuracy and reliability study are from an extreme dynamic ocean area off the French coast near Brest. The data are provided for the "Vigicote" project [2] with a pair of 16 channel medium range WERA systems owned by SHOM (Oceanographical and Hydrographical Service of the French Navy). The radar operates at a centre frequency of 12.38 MHz with a bandwidth of 100 kHz (range cell size of 1.5 km) at 30 Watts rf-power.

Over a period of more than 12 months a study was carried out to validate the quality of the provided data by means of a comparison with buoy data. Furthermore the reliability was qualified by comparing the users' demands for data availability with the resulting data.

The accuracy and reliability was studied by SHOM using an ADCP and a Wave Rider buoy for ground truthing [3]. Both instruments were located about 30 km off the coast. The corresponding correlation between the ADCP and WERA data shows a correlation factor of 0.947. This excellent agreement proves the accuracy of the WERA system to measure ocean surface currents.

Applications of Drift Predictions
To test this technique for SAR applications, surface drifters were launched and tracked [4]. The drift prediction for this simulated "man-over-board" situation were carried out by means of a 2D tidal model typically used for the SAR operations and by a drift prediction based on the ocean currents measured by the WERA systems.

The results clearly show that the drift prediction driven with the measured current data can keep close to the real drift trajectory much longer than the model driven prediction. This method would significantly increase the chance to find a lost person or drifting objects.

In combination with a stochastical estimation the drift of an oil accident can be predicted as well. The drift module can also be used to perform a backward computation. In case of smaller oil pollution, e.g. caused by illegal tank flushing, an observed oil slick can be "backtracked". This may enable the coast guard to identify the polluter. Another example is given by the backtracking made on request of the French authorities after a ballot of cocaine was found on a beach in France.

In-situ experiments for SAR operations

In the frame of the Norwegian-French project SAR-Drift [4], two in-situ experiments were carried out in Norway and France with drifting objects. With the help of the Navy in both cases, models of containers and a real container were left to drift in the area of coverage of HF-radar. The current-induced drifts of the objects were first predicted using forecast models, and then re-computed using currents from the radar measurements. All the results show a very good agreement between the observed trajectories and the radar-computed ones, while the predicted drifts rapidly diverge from the real trajectories. Figure 1 shows the results for the real container in the Iroise sea. This emphasizes the importance of HF radar for search and rescue operations, especially in complex areas. After an accident, a much accurate estimation of the location of an object or body can be obtained using HF radar, compared to what can be done with forecast models.

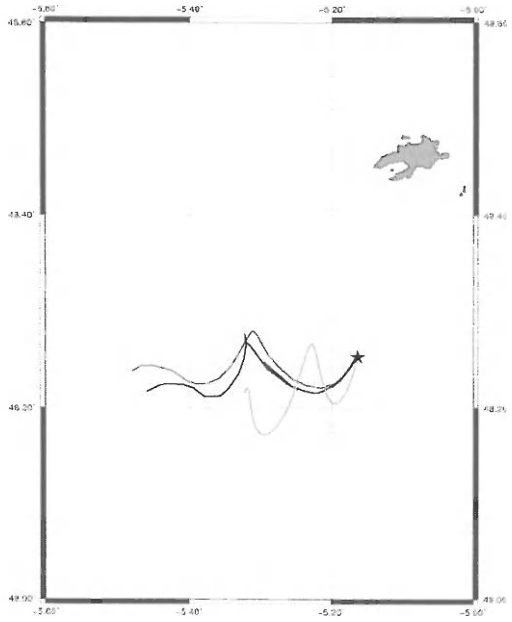

Figure 1 - Drift of a container in the Iroise Sea. The black line indicates the real trajectory, green based on a model and red based on radar data.

Conclusions

The ocean radar data provide a valuable contribution to improve the quality of numerical models that are used for current drift predictions. Results from the experiments show the significant improvement of the drift simulation, if real-time current data are used provided by the radar systems. This can be a very valuable tool for Search and Rescue applications. In addition this drift prediction can be used for the forecast of drifting oil spill or containers in case of an accident to make the management of the pollution more effective. Furthermore this tool can be used in case of the detection of smaller oil slick for backtracking this slick to identify the origin and time of this pollution. This can help to identify the polluter.

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A MARINE BIOLOGICAL GIS FOR EUROPE, BASED ON OGC STANDARDS

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Keywords: *marine biology, data integration, GIS, data portal, Europe*

ABSTRACT

In December 2007 the European Parliament and Council adopted a common text for the Marine Strategy Framework Directive which aims to achieve environmentally healthy marine waters by 2020. This Directive includes a requirement for an overarching European Marine Observation and Data Network (EMODNET). The "proof of concept" of EMODNET is being tested through preparatory actions. Portals for a number of maritime basins are being set up for biological, physical, hydrographic, geological, and chemical data as well as functional habitat maps. These portals will provide access to marine data of a standard format and known quality and identify gaps in coverage.

The biological data portal, launched in February 2011 aims to visualize and redistribute fragmented marine biological data for complete maritime basins. The architecture of the system, partly based on the European Ocean Biogeographic Information System (EurOBIS), is developed to meet the final objective of EMODnet - that is to become an integrated and inter-operable network of systems of European marine observations and data communications. The biological data portal is fully OGC compliant, allowing compatibility with OGC compliant data servers (like Geoserver). This allows integrating and visualizing species observations served from different data providers and databases, and OGC compliant geographic maps. Through OGC compliancy, the marine biological data portal can visualize also data products developed in the other thematic projects of EMODnet. The main functionalities of the portal include viewing a catalogue of the data available, data querying, data visualization and data downloading. In order to integrate marine biological observation data, taxonomic standardization is a key element. The taxonomic standardization allows to detect and filter out spelling mistakes of species names occurring in the contributing datasets, solve issues or ambiguities related to the nomenclature of a species and to search and browse data for aggregated groups. Therefore all species names are matched with the World Register of Marine Species (WoRMS) and its European component, the European Register of Marine Species (ERMS).

The biological data portal of EMODNET can be consulted at http://bio.emodnet.eu/portal.

TC-003

GIS AS A TOOL TO STUDY AND PRESERVE SAND DUNES (BULGARIAN COAST)

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Keywords: *GIS modelling, spatial data infrastructure, sand dune inventory, coastal geodiversity.*

ABSTRACT

Since coastal dunes are complex and changeable landforms and therefore difficult to be studied, a Geographic Information System (GIS) has been proved as the most relevant tool for integration of all types of coastal information, and for spatial geo-statistical analyses and modelling. GIS methodology also has been recognised as an essential approach used for development of any coastal zone management strategy and in particular for studying dynamic coastal processes, such as shoreline evolution and beach/dune changes. The most important advantage of GIS in this relation is the ability to combine historical datasets with modern high resolution data so they can be presented in a geographically correct space and the observed changes in various time scales can be precisely evaluated.

Large sand dune formations were widely distributed along the Bulgarian Black Sea coast. However, due to expanded coastal zone urbanization the total dune landscape has been constantly diminishing. Dunes presently comprise only 10% of the entire 412 km long coastline, embracing a total length of 38.57 km and a total area of 8.78 km^2. Although most sand dunes in Bulgaria are protected areas and national reserves, they have been exposed to huge anthropogenic pressure over recent years. There is an increased demand of proper management measures for dune use and preservation of their geodiversity. Such activities first require an understanding of dune behaviour/changes, mapping dune areas most sensitive to risk of destruction, and assessment of natural/human-induced factors that affect dune persistence.

Dunes along the Bulgarian coast have not been well documented and explored. Therefore to start research and monitoring sand dunes the first task was to perform an inventory of existing dune locations on the Bulgarian Black Sea coast. For this purpose, a preliminary indicative GIS-based map has been produced using data from 1:25,000 scale topographic maps and field observations/surveys. Thus, an initial GIS database for sand dune areas has been established and this could be further easily updated with new coastal data and spatial information. About 20 locations of different sand dune fields were identified around the Bulgarian coast, mostly at its northern part, partially at the middle one, as the numerous dune complexes exist along the southern coastline.

Important tasks in dune protection are identification of dune landscape changes for a certain period of time and accurate delineation of sand dune areas. The paper discusses the

advantages of a GIS approach by using geospatial information to detect and assess changes of sand dunes along the Bulgarian Black Sea coast over a 27 year period (1983-2010). This period includes also the time of the expanded tourist boom and overbuilding of the coastal zone, and respectively presents the largest dune changes and reductions. Various natural and human factors for dune area degradation are also identified and analysed on the base of the landscape change analyst in a GIS environment.

The present study is based on different types of data for sand dunes: topographic maps in 1:5,000 scale from 1983; aerial orthophotographs from 2006-2010; and statistical information for population and tourist infrastructure. In addition, for more detailed description and visualization of main dune types, a number of digital photos have been made at certain parts of the Bulgarian coast. All raster maps were scanned, geo-referenced and digitized with help of ESRI ArcInfo 9.2. The developed GIS methodology of area change analysis is based on the lines and polygons intersection and polygon-to-polygon overlays in order to trace the changes of sand dune areas. An assessment of identified dune alterations due to beach/dunes systems advance/retreat or increased tourist/coastal infrastructure is performed and dune areas with high priority to risk of destruction are identified.

Under this research new very high resolution data for sand dunes at Bulgarian coast were obtained. The presented methodology for use of GIS within the context of sand dune study will promote establishment of wide database processing with various types of data. Subsequent processing and interpretation of data available from different times revealed the increased occupation and progressive destruction of large dune areas along the coast. Analysis and visualisations of dune area changes using the GIS will contribute to define the magnitude and timing of these changes as well as to assess dune systems evolution in response to natural and anthropogenic factors in coastal zone. Thus, the GIS comprise a key part of dune management plans, updating data and modelling sand dune landforms in support to their proper use and preservation.

CCM2 HYDROLOGICAL CODE AS EXAMPLE FOR A COASTAL CODING SYSTEM

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Keywords: *Hydrology, interoperability, coastal coding, islands, coastline*

ABSTRACT

The Limit of Oceans and Seas is a standard to define the names and limitations of the waters of the Earth using light houses and other visible or measurable features. The limits were defined at the beginning of the 20th century and finalized in the fifties. Recently (in the year 2000) a decision to delimit a Southern Ocean was agreed by the International Hydrographic Organisation.

These shared delineations and names are of great help for sailors and other people working on the oceans in other to describe events unambiguously by whilst using different languages and names for topographic features.

With the implementation of the Water Framework Directive in Europe, a similar need was felt for the definition, delineation, naming and coding of hydrographic features such as rivers and lakes.

It proved that many of these features are defined differently and that even for legal purposes a predictable definition is desired.

With the creation of CCM (Catchment Characterisation and Modelling) we took the opportunity to define a coding system for the features that were generated with CCM. It is a coding system that is applied to the continental coastline, islands, watersheds, lakes and riverbranches. The coding system developed was based on the advice of the Water Frame Directive Committee. A system inspired on the so-called Pfafstetter coding was exploited.

CCM is a model generated vector database, its topological consistency allowed us to define coding rules, and generate, subsequently, the coding in an automated manner.

In order to uniquely code a river branch, it was useful, to take into account the sea, freshwater ultimately flows into. Therefore we also had to expand the Pfafsttetter coding to the coding of seas, the coastline delineating it and the islands lying nearby the continent or far away in the sea.

CCM was a project limited to the Oceans and Seas surrounding Europe. We therefore limited ourselves to define a coding system for the European Seas and Oceans. In our methodology we used the IHO limitations of Oceans and Seas.

We will present this experience in the paper and give insight in the effort to be expected to make a coding system for oceans, seas, coasts, islands and freshwater bodies for the world.

Furthermore we will present some of the benefits of a comprehensive coding system as implemented for Europe through CCM.

High Quality map of the Coding of the European Coastline can be generated using this link: http://desert.jrc.ec.europa.eu/action/php/index.php?action=view&id=114.

THE USE OF AERIAL SURVEYS TO MEET THE ECOLOGICAL SPATIAL DATA REQUIREMENTS OF THE MARINE RENEWABLES INDUSTRY

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Keywords: *offshore renewable energy, marine mammal, aerial survey, ornithology, remote sensing*

ABSTRACT

Offshore wind, wave and tidal energy development has increased rapidly in European coastal waters in recent years, resulting in a huge demand on resources at each stage of the planning, consenting and construction process. As part of this, developers are required to undertake an environmental impact assessment for each new renewable energy site, which invariably involves the collection and analysis of spatial environmental data. One of the key potential impacts investigated as part of a wind farm development is that of avian and marine mammal ecology. As such, the collection of spatially accurate avian and marine mammal population data is one of the chief data requirements of the development process.

Ornithological surveys have traditionally been carried out using boat based observation with visual spotters to record sightings. This technique is often extremely costly, restricted by weather and open to questions regarding data reliability as a result of view angle. As such, new survey techniques have been developed. High resolution aerial photography surveys have provided a viable alternative and are now taking hold in the industry as the preferred method of avian data collection.

Aerial surveys can cover huge areas in a single day and collect large datasets quickly and efficiently. While this has clear advantages it has also presented the industry with a need to develop and implement innovative tools to handle and analyse the data. Developers often require a quick turnaround between survey and data delivery and therefore maximising automation in the data handling process is key to meeting industry requirements.

APEM Ltd has developed a bespoke object recognition software package that is designed and implemented with the specific purpose of bird and mammal surveys in mind. The software can automatically sort through thousands of images and identify the location of each bird that is then subsequently presented to an ornithologist for identification. The software incorporates a range of tools to assist with the identification of similar species, as well as functions for body length, flight height and wingspan measurement. Integration of this software with 2cm resolution imagery provides an extremely powerful tool for avian survey analysis.

The workflow produces spatially corrected GIS datasets relating to birds observed over a wind energy development zone with associated avian attribute data. The GIS outputs have associated metadata that conform to industry standards and are typically added to national ocean databases.

The survey approach is also conducive to spatial statistical analysis which developers and regulators find increasingly reliable for bird population assessment. The scientifically robust nature of the survey design and the significant cost savings compared to other techniques has led to a huge increase in the demand for aerial photographic surveys. As such, it is anticipated that this survey technique, automated image analysis and statistically based spatial modelling will quickly become standard tools for the offshore renewable energy industry.

INFORMATION SYSTEMS FOR COASTS AND SEAS: A HOLISTIC APPROACH TO SYSTEM DEVELOPMENT

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Keywords: *Information Systems, Information Science, Management Tools for ICZM and Marine Planning.*

ABSTRACT

Development of information systems for coastal and marine management is often seen as technical undertaking, yet the impact of it these systems can make a major contribution to capacity building and knowledge management. This paper proposes a holistic framework for information system development. The paper reports results from the Corepoint EU INTEREG 3C Programme which explored the development of coastal information systems in six coastal regions around Europe. This research considered key factors, including: the measurement of information needs and requirements; the development of collaborative networks; solving technical obstacles; deploying multiple technologies (including GIS); supporting implementation and training; and justifying investments. The findings highlight the benefits of drawing on ideas from the disciplines of information and information science, and the special considerations in applying these to coasts and seas. The paper will of relevance to a range of ICT specialists and policymakers who are interested in applying such methodologies.

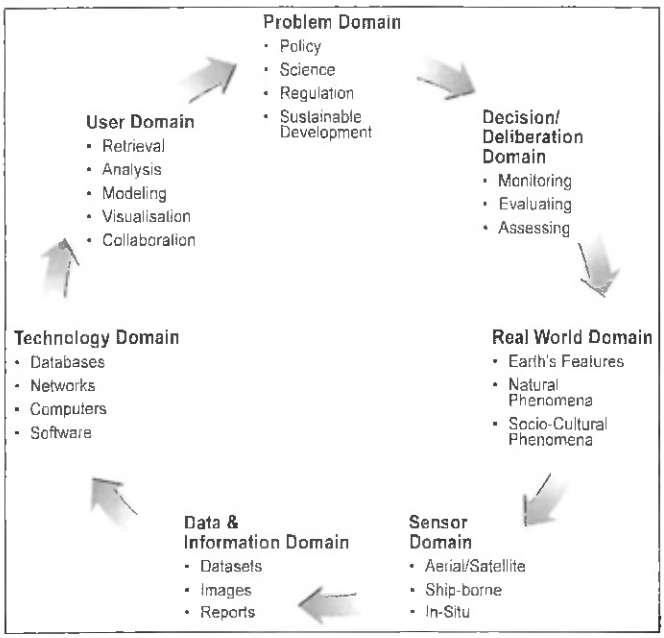

Figure source: Stojanovic, T., D. R. Green, et al. (2010). "Approaches to knowledge sharing and capacity building: The role of local information systems in marine and coastal management." Ocean & Coastal Management 53(12): 805-815.

USING RAPIDEYE DATA FOR DETECTING VEGETATION CHANGES CAUSED BY EXTREME HYDROLOGICAL EVENTS IN THE ELBE ESTUARY

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Keywords: *Remote sensing, RapidEye, multi-temporal, multi-seasonal, environmental monitoring*

ABSTRACT

The German satellite system RapidEye that has been operating since 2009 promises highly effective data for developing and realizing long-term environmental monitoring, especially for monitoring areas that cannot be reached easily. Moreover, the high temporal resolution of the five sensors of five bands from 440 nm to 850 nm provides a good coverage of season-internal changes of phenology. Compared to other satellite systems, the RedEdge channel of RapidEye (690 nm to 730 nm) offers a new means for monitoring vegetation. The geometrical resolution of each channel is 6.5 m per pixel (ortho-rectified 5 m per pixel).

The banks and flood plains of the estuary of the Elbe river are subject to constant quantitative and qualitative changes caused by the growing frequency of extreme hydrological events. Therefore, safety measures for banks and dykes as well as adaption strategies in regard to maintenance measures are necessary to a greater extent. In order to introduce appropriate measures for protecting the banks and flood plains, it is of essential importance to know the extension and the development of vegetation structures and species in the areas along the waterways, especially the reed stock which is important for protecting the flood plains. It is necessary to examine extensively the system of relevant vegetation structures, above all in less developed areas, so called disruptive spots, i.e. areas of reed which are devastated or considerably impaired. Therefore, the Federal German Institute of Hydrology (BFG) initiated a research project with the aim of developing a robust monitoring concept supported by satellite images of the vegetation in the flood plains of the estuary of the lower Tideelbe, Northwest Germany. The potential of the high temporal and geometric resolution of the RapidEye sensors will be utilized for this purpose.

Study Area and Datasets

Along the lower Tideelbe three areas have been chosen for developing a concept of remote sensing that could be transferred and used for monitoring the whole area. In April, August and October 2010 vegetation surveys were taken randomly in areas with a minimum size of 9 m^2. This information of the field mapping of the vegetation coverage is used for working out rules for the classification of the reed. Data are transmitted in a sensor-radiometrically corrected form (Level 3A data). Additionally, corrections of the atmosphere are carried out by the software ATCOR. In the years 2009 and 2010 satellite images of the vegetation periods were used for multi-temporal and multi-seasonal evaluations. Data from ATKIS (Official German Topographic & Cartographic Information System) and a habitat map from 2006 were included as well.

Methods and Results

The acquired RapidEye images have been utilized for discovering changes in the reed stock as well as for differentiating different reed types from other vegetation. The main method of classification is a combination of knowledge-based and object-based approaches for detecting

biotypes, dominant species and disruptive spots. The classification hierarchy includes the following steps: 1. land cover classes, 2. biotope types and 3. dominant species.

The identification of land cover classes using the knowledge-based approach requires universal and transferable rulesets that do not relate to direct gray values of the satellite images. So, derived values like indices (e.g. NDVI, NDWI) and ratios are calculated, especially ratios produced by the RedEdge-channel. Also textures and existing a-priori information, such as ATKIS are integrated to refine the analysis area. For the analysis of biotope types and dominant species, the training data from the field mapping are separated into test (30%) and training (70%) areas. For each pixel different indices and ratios are calculated. The training data are used as input into a regression tree classifier (spatial data mining tool 'See5'). To improve the classification, process results of an object-based approach are used. Pixels from homogenous groups are summarized into segments. As initial imagery segmentation a multiresolution segmentation is chosen followed by a spectral difference segmentation. Afterwards indices and ratios (used above) are calculated for each object. For the land cover classification the training dataset is used to create a decision tree, whereas fuzzy classification is used for the determination of biotope types and dominant species. A multi-seasonal comparison of spectral data increases the definition and determination of dominant species. For detecting disruptive spots a multi-temporal analysis gives additional information.

As result a potential habitat type and dominant species map will be created including also disruptive spots. All classification methods are fully automated and allow a consistent long-term monitoring.

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A GEOPORTAL FOR THE SCHELDT ESTUARY

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Keywords: *Geoportal, data, metadata, standards, open source*

ABSTRACT

Over the years, a lot of data has been collected with regard to shapefiles, raster images, salinity, temperature, species observations, and many more. This data is however usually stored in proprietary formats and often only accessible to the collector of the data. In this paper we present the Scheldt GeoPortal. This tool allows easy access to the raw data, as well as a simple way of representing this data visually. The goal of the GeoPortal is to provide users and scientist with a straightforward centralised method to obtain specific data. By following the standards of the Open Geospatial Consortium and using open source programs, our portal is easy extensible and data can easily be added.

Overview of the approach

The purpose of the Scheldt Data Portal was to offer the user data about this area of research. Previously, datasets were described using an information system. To have access to the data, the person responsible for the dataset usually had to be contacted. In rare occasions the data could be downloaded. Another drawback of that approach is that every dataset was described in a separate way. This means that the user has to search through the entire information system in order to find the relevant information on a particular topic. We mitigated this issue, by grouping all data and allowing the user to visualise this data on the data portal. Moreover, it is possible to download in one step this data if the license allows it.

During the implementation of the GeoPortal, interoperability and compatibility were very important. Next to showing the data we received or own, it was also important to be able to display images from other servers, through Web Mapping Services (WMS), and Web Feature Services (WFS). This was greatly facilitated by the fact that the system obeys the Open Geospatial Consortium Standards (OGCS).

GeoServer is the tool used to display the shapefiles and raster images we have at our disposal. Moreover, it is also possible to plot data, linked to geographic coordinates, from an integrated database.

So far we have only discussed how data is being displayed. With regard to easy access and interoperability, an adequate description of the data is also required. To achieve this goal, GeoNetwork was used. This open-source application allows for intensive descriptions of metadata.

The structure of the entire system is displayed in Figure 1.

The combination of the external data, provided by web services, the internal data from the integrated database, the shapefiles and raster images from PostGIS/GeoServer and the metadata descriptions from GeoNetwork are all managed in a central database. In this database it is also possible to add a flag, indicating the permissions that exist on the data. i.e. can the data be downloaded or is it proprietary.

The layout of the GeoPortal uses the Central Code Library, together with OpenLayers and the Yahoo! User Interface Library (YUI). OpenLayers is an open-source JavaScript library for displaying map data in web browsers.

YUI is also an open-source JavaScript library for building richly interactive web applications using techniques such as Ajax, DHTML and DOM scripting.

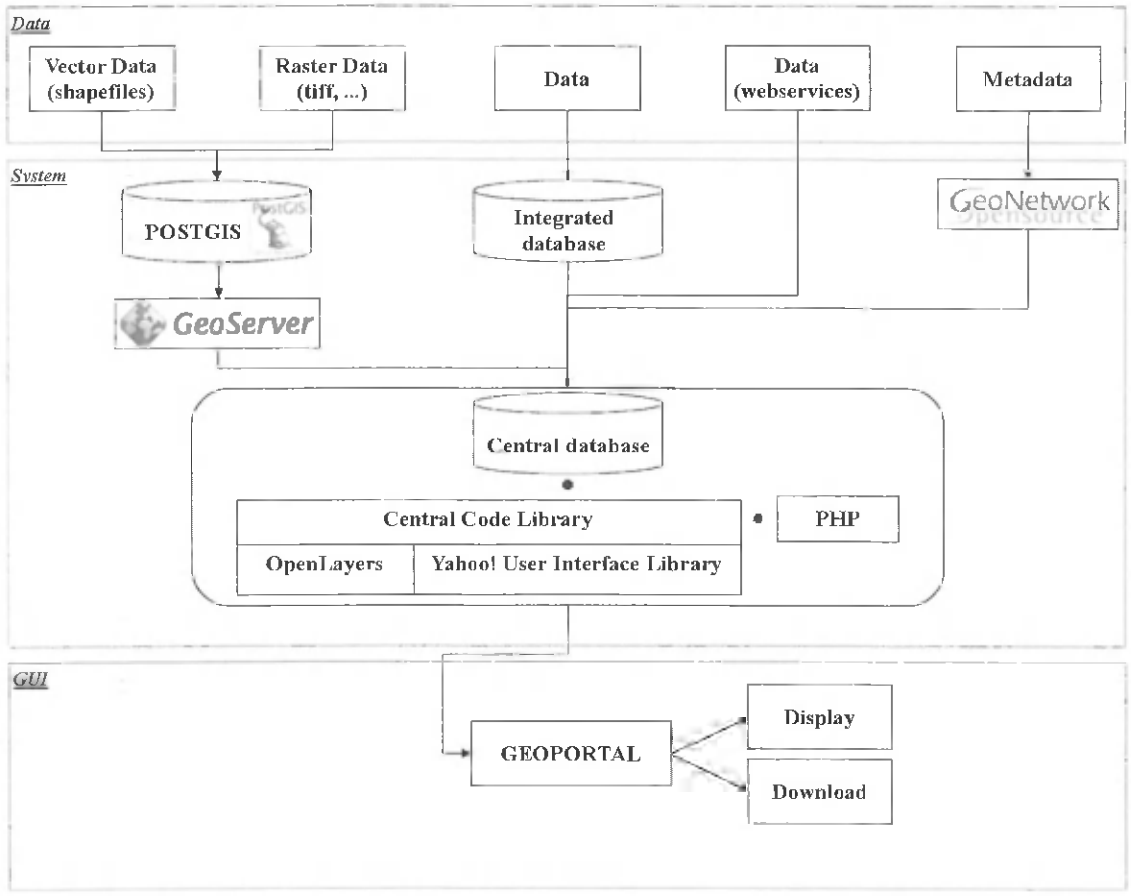

Fig. 1: Schematic representation of the Geoportal system

In closing, we would like to encourage everyone to visit the Geoportal via the web on http://www.scheldemonitor.be/dataportal/ and contribute new data to expand the range of applicability of the portal.

COASTAL SENSIBILITY AND RISK EVALUATION TO SEA LEVEL RISE: A STUDY CASE IN SANTA CATARINA ISLAND, BRAZIL

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Keywords: *climate change, sensitivity index, risk assessment, Geographic Information System, GIS, Hyogo Framework for Action.*

ABSTRACT

Climate change, as a result of global warming, intensifies the pressure on the coastal zone, endangering ecosystems associated with estuaries and oceans, as well as socioeconomic activities and coastal infrastructures, with a direct impact on the security, public health and economy of these regions. The lack of information about hazards and risks associated with climate change difficult the urban management and natural resources protection. Identifying and mapping of costal hazards and risks are important steps towards coastal protection, as well as in reducing the possibility of disasters on these areas. Furthermore, they are in consonance with Hyogo Framework for Action goals, which aim to reduce up to 2015 disaster losses in lives and in the social, economic and environmental assets of communities and countries.

The risk assessment stands for the probability of occurrence of a specific event (hazard) combined with some evaluation of its consequences. For coastal areas it means setting the threatening elements and the sensibility of the area, so as to define how easily an environment could be affected. This study understands the sensibility as a composition between the susceptibility (internal characteristics of the system and its resilience) and the vulnerability (external condition of the systems, such as social, physic, economic/environmental facts, all able to increase the susceptibility of a community to a hazard).

In order to identify coastal sensibility and the population at risk to sea level rise, this study has evaluated and adapted an index to map the coastal sensibility to erosion and flooding by using available data for Santa Catarina coast. The *Smartline Methodology*, a segmentation mapping approach developed in Australia, was chosen due to its easy applicability. The Santa Catarina Island was chosen as testing ground for two reasons: (a) the existence of a full set of data related to the Oil Spill Sensitivity Index mapping from NOAA (b) and its diversity of environments, making it possible to cover most of environments of the state's coast.

Despite the fact that some data required by the *Smartline Methodology* were not available, the research has found data from potential parameters observed in other methodologies, allowing the addition/substitution of new criteria to the index calculation. As a result, the *Smartline Methodology* got a new set of parameters.

Data integration and analysis were performed by using a Geographic Information System. Unlike the original methodology, which starts from a query attributes resulting in a qualitative assessment, this adaptation produces a numerical index obtained from weighted average overlay of the criteria (Figure 1). The quantitative criteria included in the analysis

were associated with concepts of stability of each segment and ecological function of each environment. The inclusion of weights in the criteria simplifies the understanding of sensibility, and allows the change of weights from each criterion depending on regional characteristics, the objective of the study, or even the researcher's standpoint. Furthermore, new criteria can be easily added to the sensibility index, as well as other targets to evaluate the risks.

This study case resulted in thematic maps for coastal sensibility and socioeconomic risk to coastal erosion and flooding due to sea level rise in a scale of 1:50.000, proving the possibility of expanding this adapted methodology to the entire Santa Catarina coast.

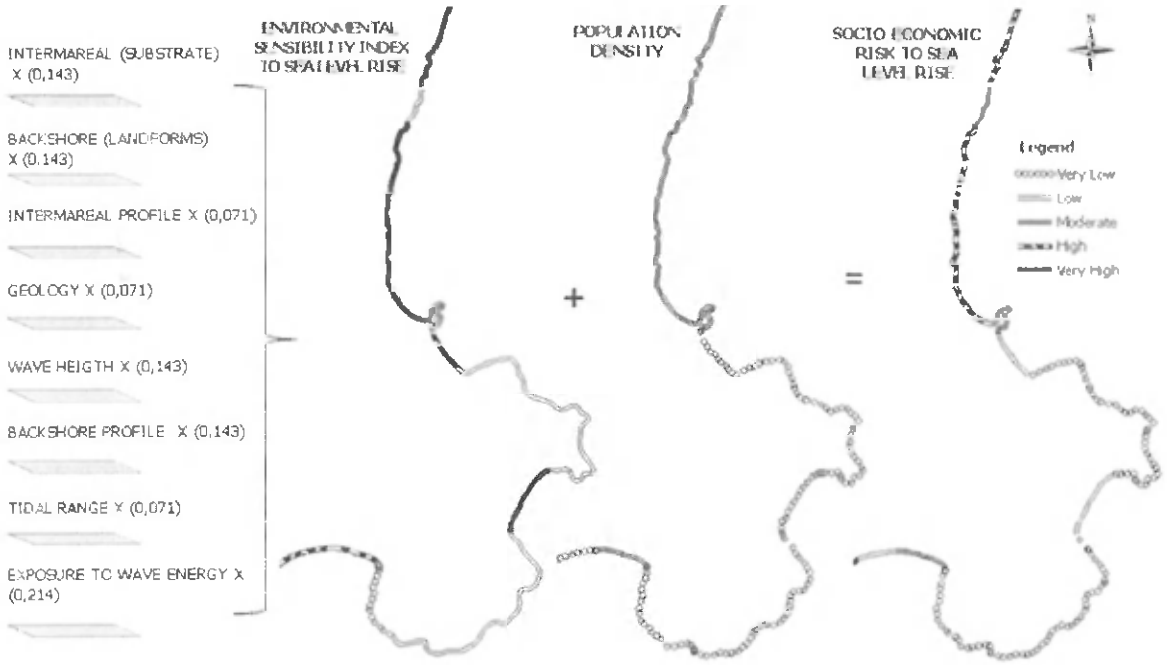

Fig. 1. Criteria and weight used to evaluate coastal sensibility and the population at risk to sea level rise.

COASTAL EROSION AND ARTIFICIALIZATION, ROLE OF GIS AND VISUAL IMAGE ANALYSIS

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Keywords: *coastal areas, GIS, visual image analysis, land use map (COS), Portugal, Espinho, Costa de Caparica, Ilha de Faro*

ABSTRACT

Coastal areas always had a leading role in the location and evolution of the population. These areas are also characterized by being the target of constant pressure over the years due to natural dynamics that make them up, where coastal erosion has been increasing sharply due to human action, with consequences that have been reported as a factor of tension between man and nature.

The need to build an integrated coastal zone management (ICZM) regime has been voiced by several disciplines from many different scientific areas in relation to measures for analysis of the land in all its components, management and support for the political decision to regulate the conflicts that take place in these coastal areas.

It is in this aspect of need to build an integrated coastal zone management approach that Geographic Information Systems (GIS) have shown many uses starting to develop a set of methodologies that have been applied in the diagnosis of areas with potentially more risk factors, serving as an aid in essential policy making.

In Portugal, it is assumed that coastal areas have been artificially transformed, much more than the countryside, causing an increasing impact, resulting in an exponential increase in population and the resulting pressure on the infrastructures that have been built there. Some effects have been noted in communities living in areas of potential risk, as the three areas concerned in the study that is the focus of this paper - Espinho in the North, Costa de Caparica, and Ilha de Faro (Faro Island).

Therefore, assuming that maps of land use play a leading role in analysis of the territory that enhances the temporal comparison of the effects of environmental and socioeconomic factors, this study aims to use one of the methodologies supported by GIS analysis of the territory. The Land Use Map (COS) examines the evolution of the artificiality of coastal areas, using as supporting data COS'90 (1990 data) as well as COS'2007 (as the name indicates, data of 2007).

The methodology explained and applied in the paper, to demonstrate the role of GIS in area analysis, that is much discussed in current times, from a methodology to compare the data according to the time difference that both of them represent.

In addition to these data, the study is based on the Base of Geographic Information Referral (BGRI), which provides demographic information at the level of statistical subsection, which allows carrying out a comparison of this result with the results obtained with COS. The information on BGRI corresponds to the census year 2001.

The three study areas were selected in advance according to an analysis of various natural and socioeconomic factors, culminating in three areas of extreme risk, the above mentioned areas of Espinho, Costa de Caparica and Faro Island.

The project consequently aims to demonstrate how GIS can be used to develop an analysis and a methodology that makes the connection being the artificiality of the Portuguese coastal areas with erosion of the cases that have been taking, compromising the people who live there. GIS can even serve as a preventive agent.

AUTOMATIC SHORE LINE DETECTION AND ANALYZING SEDIMENT TRANSPORT: CASE STUDY ISTANBUL-TERKOS/TURKEY

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Keywords: *pixel-based classification, shoreline detection, remote sensing, shoreline change, sediment transport*

ABSTRACT

The coastal zone is a physically dynamic and ecologically sensitive environment which is subject to a variety of anthropogenic pressures (urban growth, industrial development, tourism) and natural (climatic induced) events resulting in significant coastal erosion. It is often densely populated and is a region of commercial, industrial, and recreational activity. It is an important environment to be monitored and managed effectively for sustainable use. Shoreline mapping and shoreline change detection are critical for safe navigation, coastal resource management, coastal environmental protection, and sustainable coastal development and planning.

Coastal engineers frequently encounter the problem of changing shorelines and chronic erosion and unexpected deposition due to the sediment transport. Therefore, to understand the level and reasons of sediment transport is an important factor in shoreline change. One of the ways detecting the shoreline change and levels of the sediment transport is remote sensing.

In this study, the problem in shoreline change of Terkos Lake Basin, which is one of the most important drinking water sources in Istanbul, is demonstrated. This basin has great importance among the coastal zones that suffers from erosion in our country. The erosion existing at Terkos Lake coastal zone has been determined by applying remote sensing method. The geomorphology of Terkos Lake Basin is introduced. The long-term analysis of wave and wind characteristics in the region was performed. The wind and wave data are used for the determination of longshore sediment transport in the region and tendency of the shoreline change.

In this study, Landsat images (1986, 2001, 2009) have been used to determine shoreline and land use changes. Four different land use classes have been used which are urban areas, vegetation, non-urban areas and water bodies. Besides, the shorelines have been extracted automatically by using an algorithm and software which have been developed by (Bayram, et all, 2008) [1]. The algorithm is based on a hybrid technique. The most prominent aspect of this algorithm, which establishes its superiority over other similar algorithms, is its ability to discriminate between the sea zone and the earth zone at complex regions; these are difficult to differentiate even for human eye, especially in regions such as bays and the woodlands.

With this algorithm, a time-consuming digitization (numeration) process is eliminated. In most cases, it demands no editing or only minor corrections to be sufficient to achieve the result for the required coastline extraction. Therefore, it allows getting the coastline curves expeditiously and correctly. This yields the necessary data for determining the current coastal structure and establishes the fundamental layer for detection of any future coastline changes. In practice, coastline extraction is very difficult to interpret even for the human eye and classical methods because of the effects of bays, woodlands along the coast, low-resolution images, *etc.* It is observed that a method of using a developed algorithm with various images that have different radiometric and geometric resolutions extracts the zones on the images successfully. The developed algorithm performs independently from the contrast of the image. The results have been verified with manually digitized shoreline results.

[1] Bulent Bayram, Ugur Acar, Dursun Seker, and Anil Ari, "A Novel Algorithm for Coast Line Fitting Through A Case Study Over Bosphorus", *Journal of Coastal Research*, 24(4), 983–991, 2008.

TRANSFERABILITY OF A REMOTE SENSING APPROACH FOR COASTAL LAND COVER CLASSIFICATION

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Keywords: *remote sensing land cover classification, integrated coastal monitoring, Landsat, SPOT, RapidEye.*

ABSTRACT

Accurately determining key characteristics and the tracking of temporal changes of spatially defined components within the coastal is a much needed Integrated Coastal Management capability. A remote sensing based approach for the semi-automated extraction of the water line, bare soil (beach and open dunes), coastal vegetation and the surf zone from multispectral imagery is presented. The method being originally intended for Landsat TM/ETM data, will be transferred temporally using reflectance images of the same site from various acquisition dates. It will also be transferred spatially, applying the approach to other test sites. Furthermore it will be applied to SPOT 5 and RapidEye data in order to assess the transferability to sensors with higher spatial resolution. The results are presented and discussed.

Background and methods

Coastal management frequently relies on spatial information of some selected land cover features as basis for the assessment and monitoring of the coast. Recently remote sensing imagery has proven useful in the once-off as well as the standardised repetitive assessment of coastal landscapes. Probably the most important feature is the shore line, frequently synonymised with the water line (Boak & Turner, 2005). However, the position of the water line being subject to tidal, seasonal and meteorological conditions usually is a somewhat vague feature, even if the extraction from remote sensing imagery technically is relatively easy. Therefore, the much less dynamic seaward edge of the coastal vegetation line can be used as proxy for the coast line and coastal changes, instead of the water line. With the extraction of the vegetation line and the water line from remote sensing imagery and the beach width as area given in between the two lines, useful aspects of coastal dynamics can be assessed for large areas. This information can be used as basis for various coastal management applications, such as the assessment of the intactness of dune vegetation (where bare soil indicates disturbed areas in the vegetated dunes), to monitor the effect of coastal management measures (beach erosion protection measures, dune stabilisation), or the impact of climate change on coastal vegetation and sediment transports along shore (changes in beach width and surf zone) and impact of extreme weather events.

Alesheikh et al. (2007) suggested a semi-automated remote sensing approach to extract the waterline from Landsat 4/5 TM and Landsat 7 ETM+ imagery for the Lake Urmia in Iran. The accuracy of their approach was 1.3 pixels. With a pixel size of 30 x 30 meters, this means a potential position error of 40 meters – provided the geometric inaccuracy of the satellite imagery is insignificant. However, for practical coastal management questions, the

resolution of the Landsat imagery and the potential error of 40 meters are too coarse considering the beach width or tidal range frequently being in the range or lower than 40 meters. In other words: the maximum detail the medium resolution scale of Landsat can provide is not sufficient for many coastal monitoring applications.

In this paper we present a remote sensing approach which takes a modified Alesheikh's et al. approach as a starting point for the development of a semi-automated classification system for coastal vegetation, bare soil areas (i.t.o. beach and open dune areas) and water in three different test regions. The sites in Maputo (Mozambique), and Richards Bay and the Cape Agulhas – Arniston region in South Africa are examples for different coastal morphologies in Southern Africa. Additionally we suggest a method for the extraction of the surf zone, which is the nearshore area where the waves break. The width of the surf zone can be used as indicator for the nearshore slope, and changes in the width of the surf zone can indicate changes in the bathymetry. The temporal and spatial transferability of the approach will be tested using Landsat TM/ETM imagery for the different sites of multiple acquisition dates.

Furthermore, in order to overcome the restrictions of the relatively low spatial resolution of Landsat, it will be tested whether the approach can be transferred to other satellite sensor data with a smaller pixel size. Therefore we test the applicability on multispectral SPOT 5 and RapidEye imagery with 20 – 5 meter and 5 meter resolution, respectively.

In order to assess the impact of tidal effects on both, the Landsat time series and the high resolution imagery, the results for the water line extraction will be correlated with lunar tidal data as modelled by the WXTide tool.

The results of the currently pixel-based approach will reveal whether the further development of the approach towards an even more automated object-based feature extraction approach is possible and advisable in order to aid national integrated coastal management actions.

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SPATIAL PLANNING OF THE LAND-BASED MARINE RADAR SENSORS BY USING 3D CARTHOGRAPHIC MODEL OF THE PORT AND URBANIZED AREAS

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Keywords: *spatial planning, 3D port model, radar sensors, viewshed analysis, navigation*

ABSTRACT

Spatial planning is widely used in many fields of human activity. It is also very helpful during planning of various sensors location where performance depends on spatial factors. Good examples of such sensors are land-based marine radars, which are an important part of marine and inland Vessel Traffic Systems. On waterways they create a specific sensor network which should ensure the proper monitoring of vessel movements and provide ongoing assessment of the navigational situation.

Unfortunately, spatial objects in the vicinity of waterways are natural barriers for microwaves produced by radars. Behind these are created the radar shadows, which decrease the range of the radar observation. For maximizing overall radar system performance, radar shadows should be minimized. This goal in urbanized and port areas is often difficult to realize due to the complex spatial geometry, limited number of existing platforms for planned sensors and places for the new radar stations to be located. Additional difficulties are caused by moving and variable objects, which by changing their position or size can reduce the range of radar observation. All types of objects are often situated along the natural shoreline and berths within port limits and urbanized areas. All of these should be considered while choosing the optimal location of radar sensors and assessing future overall system performance.

Earlier studies, conducted by the authors, presented the usefulness of GIS techniques during the spatial planning of sensor location. The research presented in this paper was focused on application of a more detailed, but still simplified, 3D cartographic model of the port and the urban area. Detailing the model in these areas was dictated by their importance in vessel surveillance and requirements of more complex and accurate spatial planning. Based on the land and waterborne reconnaissance, the objects used for 3D model creation were grouped into two basic feature sets: permanent and variable. Permanent features do not change their placement and size over a long time. This set consists mainly of buildings, bridges, groups of trees, single trees, chimneys, tanks, masts, power lines and other port objects. Such objects clearly designate the shadows and the possible range of radar observation. Variable features can change their size and/or position. This group consists mainly of objects which are the products of human labour, various cargos gathered in port storage areas, ships, cranes, floating docks, gantries or other wheeled vehicles. These objects, in turn, alter the spatial geometry of land cover, which results in variation of the range of radar observations and radar shadows. This division has enabled the development of a dedicated 3D model and the adaptation of a GIS application for sensors planning.

The cartographic model was elaborated in an ArcGIS 10 environment with 3D Analyst extension by using the ArcScene 10 application. It contained all the significant objects from

both features sets. The GIS application allowed for proper data preparation, data management and performing the analyses. An example of the part of elaborated model for urbanized area is illustrated in Figure 1.

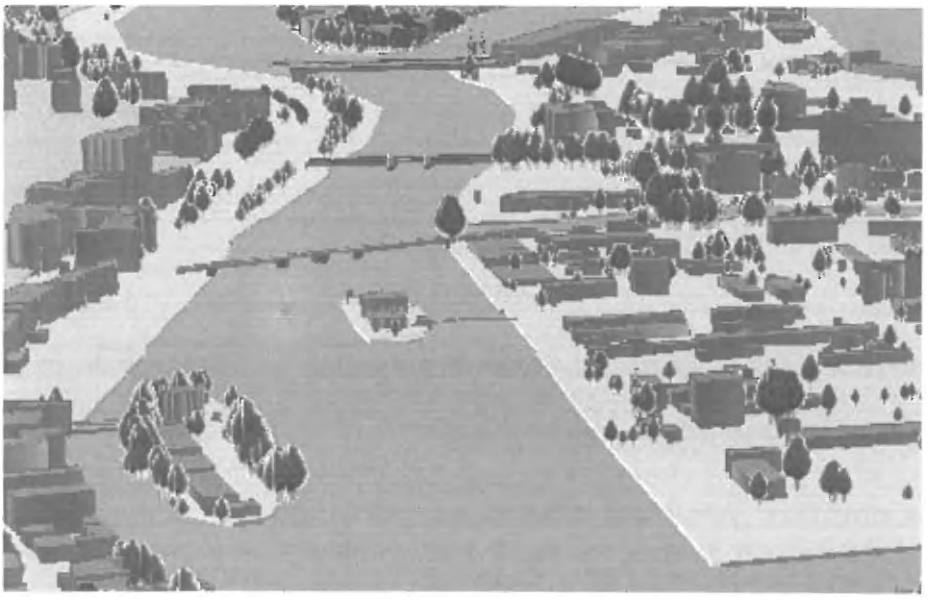

Fig. 1. Elaborated 3D model of urbanized area.

The studies show that spatial planning with a simplified 3D model can be an effective aid in determining the optimum location of the radar station and even designing the radar sensor network. The 3D model consists of basic objects useful for analysis. It refers to permanent and variable spatial features. They can be easily identified as potential barriers for microwave propagation and also as a potential sensor platform. Analyses based on the more detailed 3D cartographic model were also compared with similar ones conducted with a raster model. This comparison enables more precise determination of advantages and disadvantages of both methods. An example of sensor planning has been performed for the marine port and the urbanized areas of the city of Szczecin.

LOCATION, LOCATION, LOCATION: LOCATING, MAPPING, AND SOURCING BEACH LITTER AT THE COAST

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Keywords: *Mobile, GIS, GPS, barcode, beach litter, mapping*

ABSTRACT

Litter on our beaches has become a major problem worldwide. Although the presence of litter on beaches is often just considered unsightly, it also poses many risks and hazards to both humans and wildlife at the coast and in the sea.

Beach litter originates from many different sources on the land, at sea and from harbours. Over time the amount of litter on our beaches has gradually increased as a direct result of the amount of packaging now used on supermarket goods, and from social attitudes towards effective disposal. This is despite attempts by the Marine Conservation Society (MCS) and the Blue Flag (BF), amongst many others, to raise awareness and educate people about the problems associated with beach litter, the growing number of voluntary beach clean-up activities, and attempts to encourage people at the beach to prevent further littering through the use of bins, recycling, and bag-it-in/bag-it-out approaches.

Whilst the situation has improved in some parts of the World through these approaches, there is still a need to try to address this problem at source, to find new ways to reduce the amount of packaging used on goods, and to raise awareness and educate people further about more effective ways to prevent litter reaching the beach in the first instance. Locating and tracing the sources of litter found at the beach may eventually help to reduce the volume of litter likely to reach our beaches aided by fines and new legislation.

This paper describes the outcome of two recent research projects using a mobile GIS- and GPS-based approach to the monitoring, mapping and sourcing of beach litter on a number of beaches along the northeast coast of Scotland, UK. Mapping the location of different types of beach litter was used as the basis to develop a conceptual model accounting for the spatial distribution of litter on the beach. Explanatory variables included knowledge of the local wind and wave direction as well as descriptions of the physical geography of the beaches and their surrounds.

Thales Mobile Mapper hardware running PocketGIS software, ESRI's ArcView/ArcGIS, and Global Mapper software were used to collect and map the data respectively. A database was created of the litter recorded and the information placed on a web-based information system using TimeMap software. Data collection was carried out on several beaches along the NE coastline of Scotland. GPS locations along with digital photographs and field observations were recorded. The field data collected was uploaded to ESRI's ArcGIS for mapping, analysis and visualisation.

This work was subsequently extended by examining temporal changes in the location of different categories of beach litter with the aid of a mobile Psion Barcode/GPS mapping system running PocketGIS. Barcode tagging of litter provided a means to track litter deposited at a particular location and to explore how different types of litter with different physical characteristics respond to wind and wave energy both in the water and on the beach. Spatio-temporal locations of beach litter were collected using a Psion Barcode/GPS mapping system running PocketGIS. The combined GPS and barcode system facilitated recording of the litter location and its characteristics. It also provided the means to identify the origin of any litter which had an intact barcode label

There is also future potential to provide insight into coastal processes operating at a beach using litter. Monitoring beach litter combined with data on coastal currents and wave climate using the DHI MIKE21 modelling software and the SWAN wave model can provide some additional insight into the origin and pathways of sediment movement along the coast.

THE LNS WEB-GIS: A FISH MIGRATION DATA AND INFORMATION RESOURCE

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Keywords: *North Sea, fish, migration, resource, WebGIS*

ABSTRACT

The Living North Sea (LNS) project (www.livingnorthsea.eu) seeks to identify key issues and solutions for fish migration. The team consists of fifteen partners working on re-connecting the rivers and deltas around the North Sea region. The project is funded by the European INTERREG North Sea Program. The partnership focuses on:

- addressing knowledge gaps about fish populations that depend on free movement between the North Sea and freshwater systems,
- innovative fish migration measures,
- collaborating with local water management authorities and policy makers, and
- creating greater public awareness about the Living North Sea and its aims and future achievements.

The project aims to promote free fish migration from sea to source and addresses three essential aspects about the management of migratory fish:

- migration routes,
- threats such as man-made barriers and fish migration measures, and
- influencing future policy at a regional, national and international level and informing the general public.

Data and information resources are very important to people and organisations ranging from the general public to the environmental manager. Provision and ease of access to such resources is also important. Internet technology has provided rapid and easy access to multiple and a disparate source of information in many different formats including text, images, video, and sound. Much of this information often has a spatial component such as location and can be presented in the form of maps.

Access to spatial information has been widely demonstrated in recent years by Google Maps, Google Earth and Google Ocean. Tools to allow users to add their own information to a Google map or image background have resulted in many valuable sources of information becoming available via the Internet. With the aid of user-friendly interfaces, Web-GIS provides the opportunity to make spatial information widely available to the public, government, education and commercial organisations. Web-based Geographical Information Systems (GIS) also provide a powerful means to access spatial information with the added functionality to pan, zoom, and query the information.

Through a web-portal a Web-GIS can provide a single interface providing end-users with a simple, intuitive and familiar window onto both scientific data and information presented in the form of an interactive map. Simple GIS functionality such as pan, zoom, and measure allows the end-user to interact with the map information, whilst a query tool can be used for information retrieval. An overlay capability also offers the possibility to establish relationships between different layers of data and information. Pre-preparation of datasets using desktop-GIS can also be used to generate the results of an analysis using buffering or Kriging that can then be made available via the web-portal.

Much of the data and information associated with the Living North Sea (LNS) project has a spatial dimension. Access to this information is important for a number of reasons: to provide scientists and researchers with a data and information store and resource; to provide educators in schools, colleges and universities with a source of data and information for teaching and research; and to provide the public with access to map-based information for planning and decision-making.

The LNS Web-GIS is an ongoing element of the LNS project which will provide a data and information resource for fish migration data from sea to source. Datasets provided by the many partners of the LNS project are being prepared to input to the Web-GIS. The web-based spatial information is currently being developed in a number of different formats using different software: TimeMap, Mapserver, and Google Earth. Figure 1 shows a screenshot from the TimeMap Web-GIS.

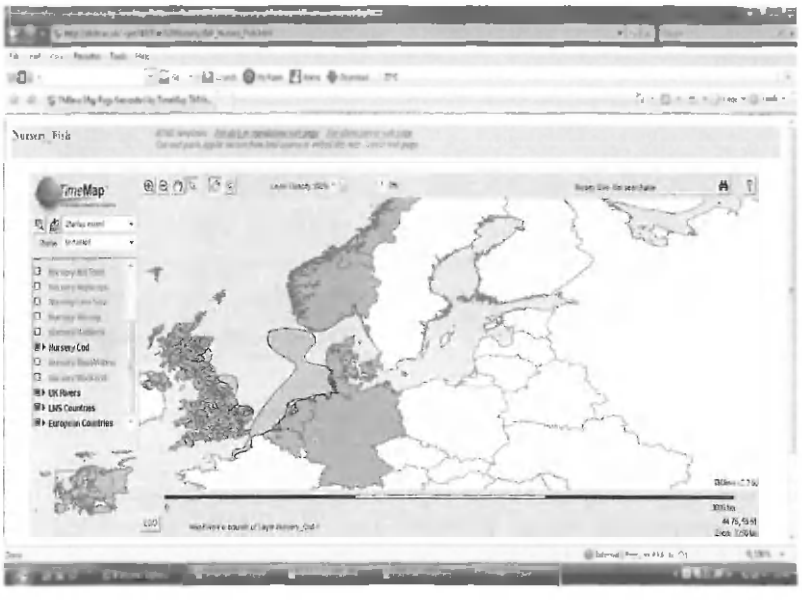

Figure 1 – LNS WebGIS in TimeMap

The Web-GIS will eventually be publicly accessible through the Living North Sea web portal [1]. A GIS portal highlights the mapping capability of fish migration in the LNS website. It has been developed to help users quickly and easily access GIS maps, their associated data, and other GIS related information. It is also a one-stop solution for GIS users to access maps related to fish species distribution, migration, river barriers, and migratory patterns in the North Sea region. A key consideration in the development of the Web-GIS will be inclusion of the INSPIRE data directive (http://inspire.jrc.ec.europa.eu/) as a guideline for metadata and the data model to ensure compatibility of the multiple sources of geospatial datasets. This paper presents an overview of the LNS project with a special focus on the development of a web-based GIS.

[1] www.livingnorthsea.eu

IMPLEMENTATION OF KOREA OPERATIONAL OCEANOGRAPHIC INFORMATION SYSTEM USING WEB-GIS

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Keywords: *Operational Oceanographic System, Korea, Web-GIS, scientific visualization, spatial analysis, KOOS*

ABSTRACT

The Korea Operational Oceanographic System (KOOS) can produce and provide nowcast and forecast information of ocean/coastal environmental changes required for different maritime operations and support solutions of pending problems in ocean related governmental agencies, industrial circles and the public in Korea. It provides data/information of the high-resolution sea surface winds/waves, storm-surges, tides, tidal currents and 3D regional/local circulation, temperature, salinity, suspended sediment, etc. required for more rapid detection and timely prediction of ocean and coastal state changes for better management decisions, different industrial activities and a solution of pending problems such as storm-surge, tsunami, oil spill, search and rescue, maritime port prediction systems, sediment transport and so on.

Fig. 1. Conceptualization of Korea Operation Oceanographic System

To support the various kinds of multi-dimensional data collection, processing, visualization, analysis and service distribution generated from KOOS, the Web-GIS based coastal information system is developed and applied to the Korea operational oceanographic system (KOOS) project. Ocean/coastal environmental data comprise vast amounts of geo-referenced spatio-temporal data, so we implement this system based on Web-GIS.

The Web-GIS based KOOS information system consists of four parts: HW/SW system, data analysis/processing/visualization, DB and service, and Web design and user interface. In the HW/SW system, there are DB and Web server for data pre-/post-processing and storing and data map service via yjr internet and workstation for data geo-processing. In the data analysis/processing/visualization, we gather the real-time observation data from buoys and towers from KORDI, KMA and KHOA and numerical model data for ocean prediction from FVCOM, ROMS, MOHID, KOSY, WRF, etc. The serviced information is like that: wind direction/speed, pressure, temperature, salinity, tide, tidal current, wave and water qualities.

In DB and service, we make the database and service through internet using visualization method such as vector, raster and contour. Lastly, in web design and user interface, we use OpenStreetMap for default service map using map mash-up technique and provide various kinds of user interface for data service and querying.

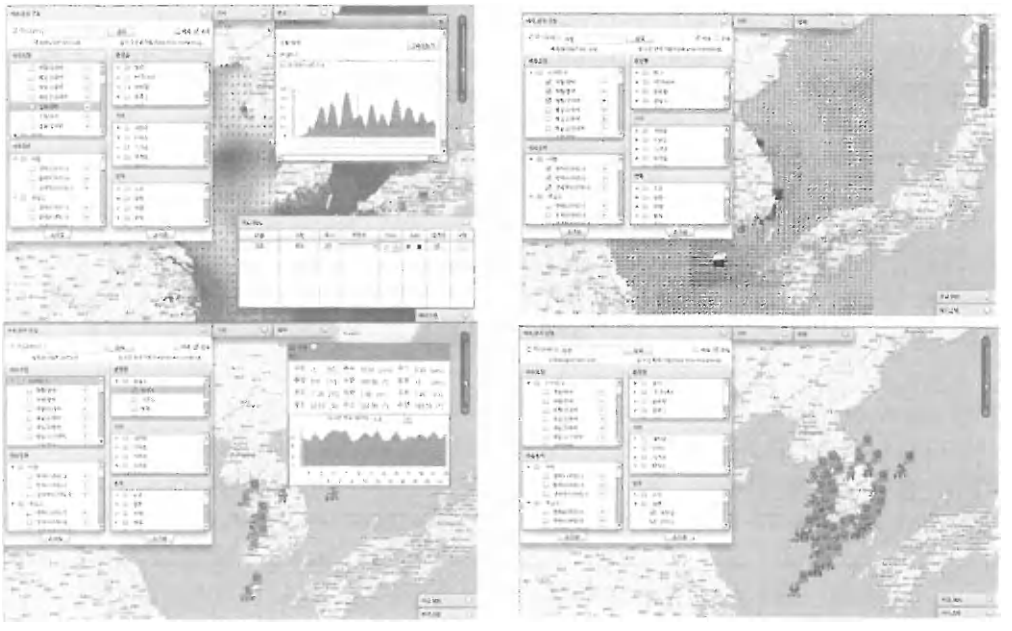

Fig. 2. Examples of Web-GIS KOOS services (visualization, data proving) of current, wind and real-time observation

In this way, the Web-GIS based Korea operational oceanographic information system is a very useful tool proving a comprehensive and innovative understanding for coastal information service. Development of more intuitive visualization of coastal data and GIS-based spatial and statistics/probability analysis methods (data mining technique), will improve the usability of various extensive information. The diagnosis of specific matters following coastal development, based on cross-over analysis results with scientific data using this system, will also support and contribute to political decision making for knowledge discovery and coastal management.

MORPHOLOGICAL GEOGRAPHIC INFORMATION SYSTEM FOR THE PORTUGUESE COASTAL ZONE (AVEIRO REGION)

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Keywords: *GIS, coastal zone, morphodynamics, open source, INSPIRE*

ABSTRACT

The coastal zone is an interface area between land and sea, establishing a boundary with continuous morphodynamics changes. This area is shaped by terrestrial and marine processes to short till long term time scales, due to natural and anthropogenic factors.
The knowledge of coastal zone, regarding the interaction of several physical processes, especially in the breaking and swash zones is reduced when compared with the emerged ones. In this context a project was developed to provide an interdisciplinary perspective between coastal geomorphology and hydrodynamics and Geographic Information Technologies (GIT).

The methodology proposed by Pais-Barbosa, 2007 and Pais-Barbosa et al., 2007, based on aerial photography interpretation in a GIS environment, identified and typified several morphological and hydrodynamic patterns and forms. Besides, an analysis of the temporal evolution of those patterns and shapes was also performed (Pais-Barbosa, 2007).

All the data was stored (vector and raster datasets, as well as alphanumeric information and data resulting from the visual analysis performed on GIS environment) in a Geographical Information System (GIS) database, named COastal MOrphoDYnamic (COMODY). The main reasons to developed a GIS geodatabase were: (i) makes possible to carry out spatial analyses such as the vegetation line retreat, the urban settlement evolution, the coastal features measurement and evolution, the identification of hydrodynamic and morphodynamic patterns and their location through time; (ii) data overlapping and comparison; (iii) easily to introduce new datasets. However the COMODY geodatabase reveal some structure problems. In this context a new structure definition and/or updated and implementation was required. The main objective of this work was to optimize this geographic database, in order to make the process of storing, querying and updating of data easier and more effective. The new structure takes in to account the implementation of open source technologies, applied to the information storage and their access (local and Web environment through a geographic web site), following the recommendations published in the INSPIRE directive.

The work was divided into two stages: in the first was carried out a restructuring of geographic information and migrating it to an open source technology; and in the second all the data access aspects were addressed, both locally and Web, also by using open source tools.

It was concluded that the open source technologies make possible obtained good results in the implementation of a GIS, for the coastal area considered. This GIS open source implementation will also allow for a more easy integration of new information in the future.

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SACRED COWS BUTTING HEADS: INTEGRATING OPERATIONAL MARINE DATA PRODUCTS INTO ALTERNATE VISUALIZATION APPROACHES (ESRI AND GOOGLE)

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Keywords: *IDVsoftware, KML/KMZ format, NetCDF format, OPeNDAP protocol, shapefiles*

ABSTRACT

This paper attempts to describe the current state of affairs regarding the use of "operational" marine data (near-real-time, rapidly disseminated, incorporated into models) in the separate visualization approaches of ESRI products and Google (Google Earth and KML/KMZ). The discussion is timely, due to the proliferation of NetCDF operational products, third party extensions to the ArcToolbox functionality to convert oceanographic data to ArcGIS formats, and the growing popularity of Integrated Data Viewer (IDV), a program that makes access to and synthesis of NetCDF products from a broad spectrum of operational sources quite easy. IDV produces Google-compatible (but not ESRI-compatible) products.

One reason that ESRI does not appear to be the manifest leader in these evolutions is due to their traditional focus on land-based applications. The Arc Marine Data Model has been developed for the marine GIS community, but has achieved limited success due to its complexity and requirement for a full ArcInfo licence, which is often too costly for developing countries. Functionality, such as the representing the x and y components of ocean currents, has often been developed by marine researchers and GIS analysts who have specific marine application requirements. The IOC/IODE marine data training program for non-commercial GIS software (i.e. Saga), has solved this problem (similar to the method of GMT, a non-GIS mapping program.). In IDV, both U and V grids, or speed and direction grids, can be displayed immediately and directly as vector arrows. It seems, based on the scope of IDV and various companion programs in the US OPeNDAP family of services, that direct access to multiple simultaneous sources, without intermediate re-reformatting, is the paradigm of choice today. So older GIS approaches often fall short of the modern mark for rapid operational product access.

The Google Earth display system combines the user's own products (e.g. analyses from IDV or ESRI) with a broad host of global and regional products that can be used as backgrounds or for purposes of comparison. Originally viewed as a novelty by GIS "purists", its ease of use and spectacular display capabilities have moved it into an enviable position as the platform expected by many program managers. Increasingly today, we are finding that students in IODE classes simply expect Google visualization of their work.

Remaining problems in the operational arena, as they regard IDV, include relatively simplistic graphics (compared to the excellent cartographic capabilities of ESRI applications), and relatively primitive OGC-compliant data interfaces. These items are already mentioned in the IDV literature as "to do" priorities. Finally, we must mention cost, always a factor in developing countries, even in view of ESRI's generous support of international organizations.

FLOOD MONITORING AND DAMAGE ASSESSMENT BASED ON HIGH RESOLUTION SPACEBORNE SYNTHETIC APERTURE RADAR (SAR) SYSTEMS

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Keywords: *flood monitoring, damage assessment, high resolution spaceborne synthetic aperture radar (SAR) systems, cadastral data integration*

ABSTRACT

Coastal areas are particularly vulnerable to storm surge flood events, a fact that will even be exacerbated due to sea-level rise and large-scale land subsidence. As these events present a critical danger to human life and property, a fast determination of the flood extent and the area affected is essentially important for local authorities and decision makers - not only for disaster management but also for damage assessment. Due to the improving agility, recent earth observation systems and especially weather independent spaceborne synthetic aperture radar (SAR) systems are particularly suitable for flood mapping purposes. Further including additional data sources, such as land use and cadastral information enables risk modeling and a first estimation of the expected damages.

This paper outlines the technical base for data processing regarding a robust and operational service for a wide area, semi-automated mapping of the flood extent based on COSMO-SkyMed SAR-data together with a fully automated spatial evaluation of affected objects. The findings presented are based on study areas located at the German coast of the Baltic Sea.

COSMO-SkyMed (Constellation of Small Satellites for Mediterranean Basin Observation) is the largest Italian investment in Space Systems for Earth Observation commissioned and funded by the Italian Space Agency (ASI) and the Italian Ministry of Defence (MoD). The system consists of a constellation of four mid-sized satellites, in Low Earth Orbit, each carrying a multi-mode high resolution Synthetic Aperture Radar (SAR) instrument, and a dual Ground Segment aimed at providing services for resource management, environmental security (risk prevention, damage assessment) and strategic surveillance to both Civilian and Defence use. Due to the availability of 4 satellites it is possible to monitor a wide area of interest with a high spatial and temporal resolution - this means coastal regions in central Europe can be covered and mapped at least twice a day. Taking advantage of the system's complete flexibility and agility, specific locations can be observed even more often.

After semi-automatically mapping the flood extent on COSMO-SkyMed data, a first spatial evaluation of the occurred damages is done by comparing the mapping results with Euro-Maps Land Cover (LC) data. Euro-Maps LC is a homogeneous thematic land cover dataset in raster data format derived from IRS-P6 Resourcesat-1 satellite data which consists of 22 distinguished classes for whole Germany. This allows, with only low processing expenditure, determining whether critical areas, e.g. very dense built up areas, are affected by the flooding.

A more in-depth analysis of the damages is achieved integrating official data provided by national land-registry and land-surveying offices which are available for the entire Federal

Republic of Germany. In this case, the Digital Cadastral Map (ALK), which is a fundamental part of the official large-scale information system and spatial data infrastructure that is used in Germany. This dataset contains all relevant objects in a high level of detail, such as industrial buildings or various types of transport infrastructure. Another dataset based on the Digital Cadastral Map provides official house coordinates and thus allows relating all mapped objects affected by the flooding to real entities. Our case study shows that both single and area objects are mapped with a high degree of confidence. So, an area based index providing the ratio of flooded area to real area can be provided for all area objects.

GAF AG's analysis and modeling approach is based on GIS techniques which allow a high degree of automatization. Herein topography and optionally water depth/gauge are used as boundary conditions. As spatial analysis is operationally available and can be scaled according to the observed area's extent, the whole process is capable to differentiate the observation area in respect of specific spatial levels (geographically, administratively, hydrologically, etc.) - according to the user's requirement. Due to this setup the workflow can be parallelized for a variable number of defined sub-regions – this is essential for rapid mapping and especially wide area monitoring.

The presented method itself is capable and intended to be individually adapted to precise user requirements. With respect to the needs of e.g. insurance companies, economic data can be integrated and spatially related to real objects. Thus, besides e.g. geoscientific risk analysis, fiscal modeling could also be performed.

SPATIAL INFORMATION MANAGEMENT APPLICATION: SEMANTIC SENSOR WEBS FOR COASTAL FLOODING

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Keywords: *Real-time, sensor data, open source GIS, coastal flood risk*

ABSTRACT

Sensing devices are increasingly being deployed to monitor the physical world around us. One class of application for which sensor data is pertinent is environmental decision support systems, e.g. emergency flood response. For these applications, the sensor readings need to be contextualised by integration with other local environmental data sources, including data models. Traditional systems for predicting and detecting flooding typically rely on labour intensive methods. In this paper we describe a semantic sensor web architecture that enables the integration of multiple heterogeneous datasets, including live and historic sensor data, databases, and map layers. The architecture provides mechanisms for discovering datasets and integrating them for visualisation and interaction. Our approach makes extensive use of semantic technologies to discover and integrate datasets. We demonstrate the use of our semantic sensor web architecture in the context of a coastal flood response web application on the south coast of England, integrating multiple datasets including real-time sea state sensor networks.

The application discussed herein is the result of a project entitled "Semantic Sensor Grids for Rapid Application Development for Environmental Management" (SemsorGrid4Env) - a joint project of seven European partners co-funded by the European Commission's Seventh Framework Programme.

The increased use of deployed environmental sensor networks is coupled with advancements in real-time data and a need to increase data availability. Over time, a fuller picture of the environment can be built up by analysing the historic values sensed with these devices. Integrating this with the dynamically changing real-time values enables a greater understanding of both current and evolving conditions. For example, consider the benefits of being able to forecast the severity of tidal surges, and hence reduce the potential devastating effects flooding has to businesses and lives. To effectively predict a tidal surge and its potential impact on the coastal environment relies on data harvesting from a wide variety of sources published by independent providers. These might be derived from networks that monitor and/or forecast met-ocean data based upon models and sensor networks. Examples include; the Channel Coastal Observatory (CCO) on the south coast of the UK, which provides real-time sea state datasets, national meteorological offices who provide weather forecasts, and government organisations providing physical coastal defence data.

The SemsorGrid4Env application uses these data as inputs to environmental models which predict the future sea-state, and the probabilities that sea defences will be breached or over-topped. Moreover, planning the response to a potential flooding event requires a large

number of additional data sources (e.g. shipping, emergency planning, and man-made assets). This application integrates multiple datasets to be utilised along with the results of the forecasted and current sea state conditions.

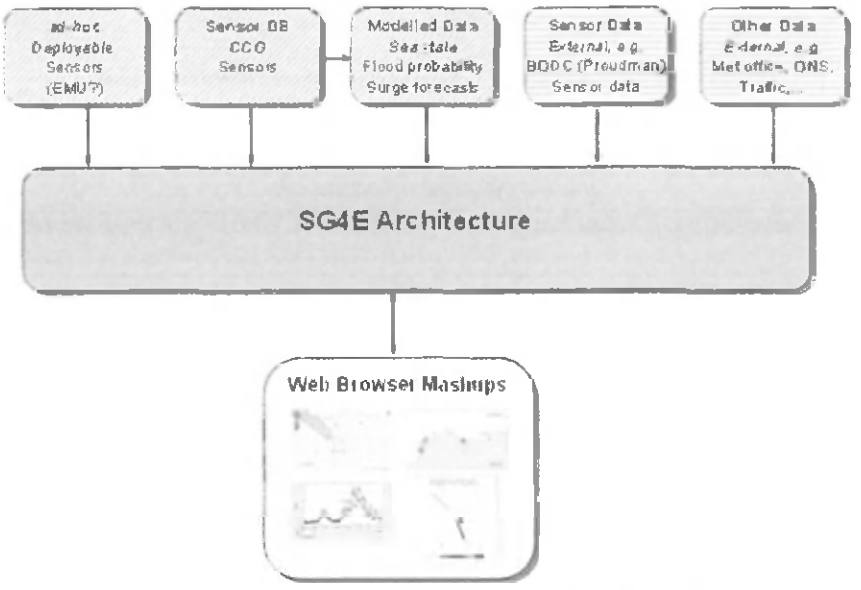

Figure: SG4E web application data flows

The Solent region is the area surrounding the Isle of Wight off the south coast of England. This region has a complex tidal regime and wave pattern which generates a high demand for sea-state forecasts. This site represents a high volume of coastal users and a number of coastal defence issues. Seawards of the coastline it is a busy shipping area servicing the ports of Southampton and Portsmouth, while landwards of the coastline it is a densely populated area and home to a number of protected sites, including special areas of conservation. As a consequence, the data made available by the semantic sensor web is of interest to a wide variety of users; commercial, academic and recreational. One of the aims of the project has been to provide an on-going relationship between the development of the technology and the needs and expectations of the user groups. A broad base of stakeholder research has provided substantial evidence for the value of the information management system, in particular the operational response to coastal flooding. The project outputs have attracted some commercial interest in recent months.

Throughout the project an emphasis has been placed on testing the architecture with a dynamic range of data sets including baseline data (Ordnance Survey, National Flood and Coastal Defence Database), real-time data sets (CCO, meteorological, sea-state, traffic (road and sea)) and model outputs (sea-state forecast). To augment the research components of the study, substantial work has been undertaken in the generation of a real-time coast flood forecasting methodology based upon the met-ocean conditions in the Solent region. This modelling process relies upon the real-time assimilation of CCO data into standard met-ocean parameter models (MIKE21, SWAN) and the development of ensemble based Kalman filtering forecasting methods. The project has also undertaken to deploy additional sensors to enhance model validation in the form of real-time wave and tide meters. The development of rapidly deployable coastal overtopping sensors is on-going, and would be an integratable dataset to the SemsorGrid4Env application providing localised real-time data at coastal defences.

A THREE DIMENSIONAL NAVIGATION INFORMATION SYSTEM

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Keywords: *Google Earth, 3D, situational awareness, navigation information*

ABSTRACT

Hypothetical scenario: In the near future, a US Navy submarine is operating in shallow littoral water near a country involved in a deadly civil war. The US Navy is attempting to help the United Nations mission in an effort to restore peace and assist with an orderly transition from the existing tyrannical rule. This submarine is providing intelligence and reconnaissance to help monitor the growing human crisis on the ground. There are concerns that chemical weapons will be used on the native population, and there are concerns with proliferation of WMD and related technology that the country possesses in modest amounts. Up ahead in the water, a dangerous seamount lurks that is not clearly obvious to the crew by their traditional 2D situational awareness display. The data exists in several different electronic chart products in a 2D format, but the operator really requires the data to be visualized in 3D to aid in the safe operation of the submarine. A collision with the seamount occurs, and the submarine must retreat and surface to evacuate the wounded and return to port for extensive repairs. Now return to the same scenario, but the operators have at their disposal a 3D situational awareness display that incorporates all available 2D hydrographic and bathymetric sources for display in a well recognized Google Earth format. The danger from the sea mount is clear to the operator, a course change is enacted and the potential grounding was averted, as the submarine continues its vital mission. Intelligence reveals that the WMD are secured and that no chemical weapons were used on the population.

We have developed the Google Earth Navigation Information System (GENIS) that can provide a 3D situational awareness display to help reduce the risk of undersea groundings and collisions as in the scenario in the opening paragraph. We used the Google Earth Pro software as a foundation to develop a 3D tactical and navigation information system to display and operate with many existing 2D hydrographic and bathymetric databases from the National Geospatial-Intelligence Agency (NGA), including:

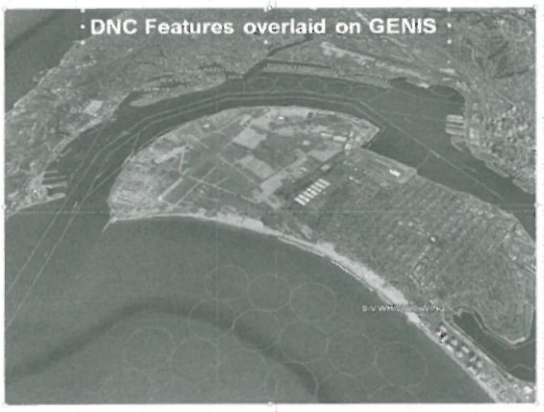
- Digital Nautical Chart (DNC)
- Tactical Ocean Data (TOD)
- High Resolution Bathymetric Data (DBDB)

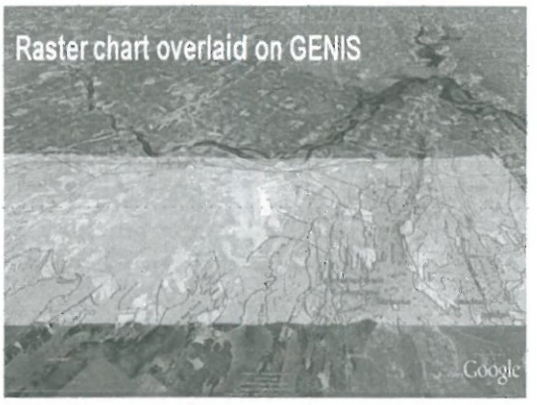
We modified and integrated existing Navy navigation and electronic charting software to provide the following information for display on GENIS:

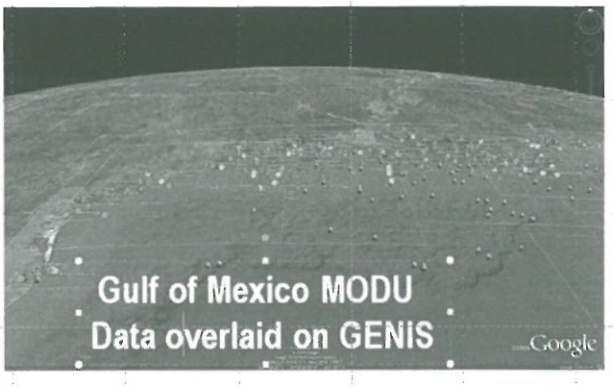
- Ownship position inputs
- Radar ARPA contacts
- Automated Identification System (AIS) contacts
- Simulated sonar contacts

The GENIS software has advanced the state of the art by building the basis for a 3D tactical command and control system. The operator would have the ability to have a navigation quality situational awareness display that would show ownship position/track, as well as contacts from radar, AIS or sonar in 3D. By having this 3D display that operates with high resolution geospatial data from NGA, the operator could see the bathymetric profile of the ocean and confidently use this information to push the mission envelope. This has implications for the improved ability to conduct littoral warfare, anti-submarine warfare (ASW), mission planning and for the safety of navigation (grounding avoidance/collision avoidance). GENIS could help prevent another incident like the "San Francisco" submarine grounding.

This paper will describe the design process and decisions made in the development of the GENIS software. Several engineering trade-offs were evaluated and decided in order to meet development risks and schedule. We will present the architecture of the GENIS software and explain how we decomposed 2D data in a variety of relational database formats for conversion into Keyhole Markup Language (KML) format for display in Google Earth. Our paper will also present numerous examples of results of the integration of the 2D hydrographic and bathymetric data into a Google Earth based 3D display. This work was sponsored by an Innovation Grant from the Space and Naval Warfare Systems Center Atlantic.







FUGRO LADS MK 3 AIRBORNE LIDAR BATHYMETRY TECHNOLOGY DEVELOPMENT

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Keywords: *Airborne Lidar Bathymetry, Coastal Zone Management, hydrography, LADS, hydrographic survey*

ABSTRACT

Fugro has unveiled a new cycle of bathymetric lidar system development with the commissioning an all new Fugro LADS Mk 3 Airborne Lidar Bathymetry system. Developed from the operationally proven Laser Airborne Depth Sounder (LADS) technologies, the system is now smaller, lighter and more efficient to operate while maintaining or improving upon the robust performance features of its well known predecessor systems. Set to work trials of the new system were conducted in May 2011 and its first survey for a Coastal Zone Management project to support tsunami modelling, climate change and storm surge assessment on the Australian East Coast is to be conducted in June 2011.

From its origins in nautical charting, Airborne Lidar Bathymetry is now widely accepted as a highly competent and efficient technology to support Coastal Zone Management and Habitat Mapping applications; and as such, Fugro has developed and integrated tools such as digital imagery, seabed reflectivity and hyperspectral data capture capabilities within the Fugro LADS Mk 3 ALB system. Fugro is also employing an ongoing development and improvement strategy for their ALB systems and is using Fugro's in-house hardware, software, electronics, mechanical and optics engineers to provide continuous system improvements.

The Fugro LADS Mk 3 system offers a high laser power, large aperture receiver and automatic gain controls enabling superior system performance. Maximum depth performance has been extended to 80 metres subject to environmental conditions. Using the Fugro LADS Mk 3 Airborne Lidar Bathymetry system, data is collected IHO Order 1a or 1b specifications, and the faster laser rate provides wider and more efficient swath widths up to 430 metres. Leading edge improvements in shallow water performance, seabed reflectivity, target detection, operating altitudes and hyperspectral imagery have also been implemented.

The continued development of the Fugro LADS Mk 3 system will also enable Fugro's technology to be acquired by or be accessible to government agencies and hydrographic offices, as it can be operated from a wide range of aircraft and be deployed for nautical charting, environmental projects such as climate change and Coastal Zone Management applications. The architecture of the system will also protect these customers against redundancy, as it is designed with a future upgrade path to incorporate emerging developments on which Fugro's team of specialist engineers and hydrographers are currently engaged. This system is ideal for operations in a wide range of marine environments and will

continue to meet the increasing needs of the marine and coastal spatial planners involved in Coastal Zone Management.

The paper covers the system development and how the Fugro LADS Mk 3 facilitates the coastal zone to be surveyed faster and more cost effectively, by enabling high quality data to be collected across a wide range of environmental conditions. The results of the coastal zone management survey to be conducted on the East coast of Australia in June 2011 are discussed. Also discussed is the range of ALB survey products from the Fugro LADS Mk 3 system available to marine and coastal spatial planner such as digital elevation models, point data, seafloor classification, habitat mapping and hyperspectral images in the marine and coastal environment.

WHAT LIES BENEATH: EXPLORATIONS IN SEASCAPE VISUALIZATION

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Keywords: *seascape, visualisation, virtual reality, marine protected area*

ABSTRACT

More often than not, geographic representation of the marine environment belies the richness of habitat and biodiversity. Mapping the marine environment in Geographic Information Systems (GIS) results in marine features represented as a 2D plane on the sea surface or as bare bathymetry. These are geographically accurate, but not visually pleasing nor comprehensive in representing marine ecosystems. In contrast, gaming and virtual reality programs produce attractive visuals but are not geographically referenced. This paper explores the application of landscape visualization principles and software (Visual Nature Studio) to develop geographically accurate and visually attractive models of the marine environment.

Sgaan Kinghlas/Bowie Seamount, an offshore marine protected area in Canada, is used as a case study. Bowie Seamount is located approximately 180 km offshore from Haida Gwaii, an island off the north coast of British Columbia. Bowie Seamount rises from 3000 m to within 25 m of the sea surface. It is a productive and diverse ecosystem containing both coastal and offshore species and is used as a staging post for migratory birds and marine mammals. Despite its designation as an MPA, due to its remoteness it is not very accessible and little is known about its ecosystem. Thus, it is an important candidate for seascape visualization to provide a more comprehensive model of the ecosystem for both science and public outreach.

Three steps were involved in producing the seascape visualization: (1) acquiring georeferenced source data; (2) creating and applying visual elements including a species and habitat library, ground texture, and water column effects; and (3) creating a 'dive through' animation. Data sources included multibeam bathymetry, video footage, photographs, species lists and survey observations from scientific expeditions. A digital elevation model of the top 200 m of the seamount was created from the multibeam data. Images of species and seamount surface habitats were acquired from videos, reports and photographs. These images were processed to establish an image library in VNS. Based on survey observations, a ground effect was applied to more accurately represent the colour and rugosity of the seamount surface. A texture was applied to represent ground cover, again based on scientists' observations from field studies. Images of observed benthic species were added to the scene to reflect the density of species acquired from observations. Landscape visualization effects such as fog, haze and light were applied to represent a 'murkier' visibility in the marine environment. Finally, an animation was produced to follow a 'dive through' path around and over the seamount.

This study is a 'proof of concept' of seascape visualization. While there were limitations in data processing and data availability, the study does demonstrate the promise of generating geographically accurate and visually pleasing seascape models to support scientific understanding and public outreach.

MODELLING AND VISUALISING VULNERABILITY OF COASTAL SYSTEMS TO ENVIRONMENTAL CHANGE

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Keywords: *coastal vulnerability; fuzzy cognitive mapping; geovisualisation*

ABSTRACT

Understanding the vulnerability of people and coastal areas to global environmental change is critical for local governments to successfully adapt to such threats. However, acquiring and communicating to multiple audiences, including scientists, decision makers and the wider community, the level of knowledge needed to capture the complexity of coastal systems can be a challenging and time consuming task. In particular, coastal systems are dynamic, nuanced, and subject to multiple interpretations and perspectives. These challenges are compounded by the difficulties of making explicit how such systems function, and what the ecological and socio-economic implications and comparative merits of alternative management interventions might be.

Fuzzy Cognitive Mapping (FCM) is an approach to systems analysis. It facilitates the identification of system components, the relationship between these components and the degree of influence exerted by one component on another. These characteristics of FCM allow for the generation of different scenarios to be tested and has therefore been used to increase the understanding of a system's dynamics and for environmental decision-making. Currently, however, FCM does not have an inherent spatial component, which limits its utility for spatial environmental planning. A spatial component is important for local governments, who are responsible for instituting adaptive responses, to both understand where vulnerabilities are highest, and then to subsequently evaluate what place-specific adaptive responses are appropriate.

That spatial component can be communicated in a variety of forms, e.g., traditional paper maps, 2D thematic maps, 3D models, interactive GIS, map animation and virtual reality. Choosing the most appropriate form of geovisualisation is dependent on the thematic content, the intended message and the audience. However, little research appears to have been done on the appropriateness of different forms of geovisualisations. There has been an increasing concern regarding whether or not the geovisualisation products are actually usable and useful for knowledge discovery and decision making. Having been applied widely for coastal vulnerability studies, geovisualization has demonstrated its great capacity, but the challenge comes when users keep trying to make the best use of technology.

In this paper, we present a new framework for adaptive coastal management, decision-making and communication. This framework is based on two inter-linked components: firstly, a spatial analytical approach to FCM to generate place-based vulnerability scenarios and secondly, a usability focused geovisualisation (UFG) schema to design and evaluate map-based representation of these scenarios. The primary spatial analytical approach is weighted raster analysis, whereby each FCM system component is defined as a spatial layer and the influence exerted by one element is the weight applied to a given layer when it coincides in space with the component upon which it has an influence. The output from the spatial analysis of FCM can be represented in different forms. The ensure the most useable and useful form, the UFG schema is focused on enhancing usability throughout the whole design process, via a fully communicative and coordinated workflow among users, developers and stakeholders.

A FRENCH ATLAS FOR POTENTIAL SOURCES OF MICROBIOLOGICAL POLLUTION OF HUMAN OR ANIMAL ORIGIN BASED ON CARTOGRAPHIC INFORMATION

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Keywords: *microbial source tracking, pollution sources, sanitary survey, atlas, GIS*

ABSTRACT

France produces about 200 000 tonnes of shellfish a year from 458 shellfish production areas, representing the second-largest producer of the European Union. Most of these coastal production areas may be impacted by pollution originating from river basins, resulting in microbiological or chemical contamination of shellfish. The European regulation n° 854/2004 requires that shellfish production areas be classified A, B or C, based on microbiological and chemical quality. A sanitary survey has to be undertaken before an area is classified. For such sanitary surveys the competent authority must make an inventory of the potential sources of pollution of human or animal origin for production areas. It is also required to examine the quantities of organic pollutants released during different periods of the year, to determine the characteristics of the circulation of pollutants, and to establish a sampling program of bivalve molluscs in the production area. In France, the microbiological contamination of production areas is controlled by a sanitary monitoring network (REMI = *Réseau de contrôle microbiologique des zones de production de coquillages*) composed of 371 monitoring points. In order to respond to the European regulation and to assist the competent authority in organising sanitary surveys, this study was aimed at the identification of potential sources of microbiological pollution of human and animal origin present on the French coast.

Existing national data were identified, collected, harmonized and compiled to make a national interactive atlas of potential sources of microbiological contamination. Various government services at a national and local level of the coastal administrative region were sought to participate and supply existing data. The study investigated in depth the three following categories of data: (i) basic cartographic data establishing maps (French National Geographic Institute), (ii) cartographic or non cartographic data at a national level : delineation of classified areas, typical ecological statutory zones (Natura 2000), land use (Corine Land Cover), demographic data (INSEE), data on the quality of recreational waters (ARS), and meteorological data (Meteo France), (iii) cartographic or non cartographic data at local and departmental level : shellfish production areas, location of industries, farms, wastewater treatment and sewage plants, sewer network, pumping stations, delimitation of slurry spreading of urban, industrial or farm origin, location of harbours, marinas and mooring areas, location of camping sites, riding schools etc. Geographical information was then compiled, harmonized and organized in various themes : population, tourism, wildlife, land use, and others. The cartographic atlas (Geographical Information System) was organized by river basin. Interactive maps were defined at different scales, depending on the theme in order to get the best representation of the information. This atlas has been distributed to more than 200 French organisations implicated in sanitary protection to give them some elements to

protect population and coastal waters by reducing the sources of contamination. This study was financially supported by the French Directorate General for Food and carried out by Ifremer (French institute for the exploration of the sea) from May 2009 to November 2010.

LAND USE CHANGE IN THREE PORTUGUESE REGIONS SUBJECT TO COASTAL EROSION

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Keywords: *land use change, coastal erosion, Portugal, Espinho, Costa da Caparica, Ilha de Faro*

ABSTRACT

The Millennium Ecosystem Assessment (MEA) concluded that two thirds of the world's ecosystems from wetlands to coastal regions, forests and soils are either degraded or have been managed unsustainably. The processes of degradation of coastal areas, which became a problem with which governments seek to deal, stem from their attractiveness to society. These regions are rich in biodiversity but they also provide food, transportation and recreation, so they are attractive to people and economic activities and are becoming densely populated areas.

The increase and diversity of activities that are located in coastal areas or which directly or indirectly depend on them have led to increasing pressures with damaging consequences for ecosystems and is accelerating the process of coastal erosion. Some of those pressures result from natural processes but others, that include fishing and aquaculture, maritime transportation and related infrastructures, and changing land use, primarily to agriculture or pasture, later on due to the accelerated urbanization process, industrialization and massive growth of tourism, are directly related to the development of societies.

The combined result of these pressures, which have changed in intensity and importance over time, are leading to a process of degradation and over-utilization of coastal areas. But those damages are also reflecting increasingly in society as besides the loss of biodiversity the process of coastal erosion is threatening tourism infrastructures, beach facilities, private residences and the interests of the economic activities here located in Espinho, North of Portugal, Costa de Caparica, center and Ilha de Faro (Faro's Island) in the South.

In Europe, several publications point to pressure situations and erosion processes more or less severe across the coastline (Dobris, 1995, EEA, 1999, EEA, 2006, UNEP Blue Plan, 2008, SOER, 2010).

In a EEA report (2006) which assesses changes observed in European coastal areas during a decade (1990-2000), Portugal is mentioned several times as one of the European countries where the growth of urban areas were faster (34%), together with Ireland and Spain, were the growth of population living along the shoreline was higher, where most agricultural area along the coast was lost to other uses (317Km2), where there was a further expansion of urban sprawl, higher impact of tourism development (housing, hotels, golf courses, secondary housing, ...) and loss of dunes due to construction or exploitation.

The concentration of population and economic activities is a result of the historical process of development that has favored coastal areas. Rural areas in the interior are progressively loosing population and economic activities to the coastal ones more developed and offering a wider range of opportunities. The internal migration, which reached its maximum intensity between 1960 and 1973, towards the coastal towns strengthened the growth of metropolitan areas and lead to a high imbalance between the densely populated coastal areas and the depopulated municipalities of the interior, bordering Spain. Also tourism boom added increasing pressures.

Tourism emerged as a significant economic activity in Portugal in the 60's, when foreign tour operators discovered the Algarve and made it a privileged destination for the European middle class. Pressure intensified when Portuguese families' income rose and the domestic tourism represented a major share of demand. Tourism represents a significant economic activity, both in contribution to GDP and as a generator of revenue and employment, but its environmental and social impact are often forgotten. Mass tourism has disruptive effects (sometimes irreversible) on ecosystems either by changing the land use, by increasing pollution, water consumption, etc., but also the abandonment of traditional activities, by their seasonality (with implications for wages low and high job insecurity) and the sometimes brutal landscape change with the transformation of small fishing villages in densely built areas, that in summer often exceeds the carrying capacity.

So although the mainland Portuguese coastline extends for 950 km, a large majority is heavily artificial due to urban, tourist, industrial and port infrastructures and in consequence is becoming more and more vulnerable.

From the coastline, three case studies were previously chosen accordingly to several physical and demographic variables (the referred Espinho, Costa de Caparica and Ilha de Faro).

The aim of this paper is analyze land cover change using a data set of the Land Use Map (COS) census in 1990 and in 2007 that will provide information on how these coastal areas have been evolving, according to the population occupation, and how these connections can make the conflicts between both human and nature getting bigger and with even more drastic consequences, according to population growth and infrastructure here located.

MARINE FORECASTS: TECHNICAL APPLICATION, TOOLS AND COMMUNICATION

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Keywords: *coastal vulnerability, fluctuation, sustainable development, coastal hazards, marine forecast*

ABSTRACT

Hazards and atmospheric phenomena within coastal areas are caused by marine variable conditions which are due to sea-air temperature, prevailing wind direction and speed, wave direction and height, wave dynamics and wave tide fluctuation. These coastal phenomena remain a serious danger for marine activities in socio-economic development and maritime navigation. The vulnerability of coastal regions due to these hazards and the inability to respond in real time to mitigate disasters were serious problems. Coastal marine forecast is the response to alleviate havoc for sustainable development. Coastal marine observations and their urgent transmission plus archiving for met marine studies become a necessity for safety in maritime navigation along the coastal zone.

Marine meteorology and oceanographic responses are attributable to interactions between the ocean and the atmosphere. Natural hazards and many types of weather patterns along coastal areas can be influenced by such conditions as changes in ocean temperatures and fluctuations in ocean currents. Monitoring natural hazards due to oceanographic events along the coast needs to improve technical application and understand touls for marine forecast.

The ability to anticipate and respond promptly to natural hazards depends on understanding how weather systems develop through the interactions between Atmosphere - Land - Ocean. Despite the importance of the coastal zone in the Gulf of Guinea, marine meteorology service is quasi inexistent or in infancy in West African coastal countries

A "Technical workshop on forecasting for maritime security in the Gulf of Guinea", held in Lagos, Nigeria 14 - 23 September 2010 allowed us to learn and understand applications and techniques for maritime forecasting and management of hazards in coastal areas based on tools, models and real-time data collecting and processing. A regional network in the Gulf of Guinea has been set up for data and met marine forecast exchange in real time.

After that workshop a technical application enabled us to undertake marine forecasting on the Togolese coast. We issued, since January 2011, marine forecast bulletins for users along the Togolese coast, such as Port authority and Maritime gendarmerie, Fishing practitioners and Phosphate port users, who have our product in real time three times per week by email.

Observations analysis, models analysis, analysis verification and analysis elaboration are the various stages undertaken for forecasts. In this process we use the models, weather forecast sites and satellites data from EUMETSAT and other sources:

- http://www.eumetsat.int

- http://oiswww.eumetsat.org/IPPS/html/MSG/imagery
- https://www.fnmoc.navy.mil/public/
- http://www.nrlmry.navy.mil/aerosol
- jeff.hawkins@nrlmry.navy.mil..

Result of the latest bulletin issued: Marine Forecast for Coastal Navigation and Shipping for Togolese Coast on the date of April 28th to 30th 2011.

WARNING: NIL
SYNOPSIS ANALYSIS: OF APRIL 28, 2011 AT 0000UTC:
Pressure 1009.7 hpa,
Wind 11 knots,
Fairly cloudy,
Good horizontal visibility

FORECASTS FOR NEXT 24 HOURS ON COASTAL AREA UNTIL APRIL 29, 2011 AT 0000 UTC:
WIND: Moderate breeze (11 knots),
WAVE HEIGHT: 0.5 - 1 m in the south-west direction,
SEA STATE: Large wavelets and crests begin to break. Possible scattered white horses,
WEATHER: Rain,
VISIBILITY: Good (10 km)

OUTLOOK FOR NEXT 48 HOURS UNTIL APRIL 30, 2011 AT 0000 UTC:
WIND: Gentle breeze (9 knots),
WAVE HEIGHT: 0.5 - 1 m in the south-south-west direction,
SEA STATE: Large wavelets and crests begin to break. Possible scattered white horses,
WEATHER: Cloudy,
VISIBILITY: Good (10 km).

Fulfilling the need for marine met equipment to monitor various parameters will allow us access to real time data for marine Forecasts. The equipment which is given by NOOA through NIOMR of Nigeria, once operational, will fill this gap. A working group should be set up to coordinate data processing. Also, a better understanding and efficient marine forecast is important. A regional approach is needed to ensure efficient coast and marine management policies to better estimate sea state parameters in the Gulf of Guinea.

THE URBANFLOOD EARLY WARNING SYSTEM: SENSORS AND COASTAL FLOOD SAFETY

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Keywords: *Flood Early Warning, ICT and climate change, sensor networks, dike failure prediction, flood management information*

ABSTRACT

In this paper we present the UrbanFlood flood early warning system (EWS). This is an Internet based system designed to monitor data from extremely large sensor networks in flood defences such as embankments, dikes, levees, and dams.

The EWS uses real-time sensor information to calculate the probability of dike failure and the possible scenarios of dike breaching, hydrographs and flood spreading in near-real-time. This computed information is presented via the internet on interactive decision support systems that assist dike managers and public authorities during flood events. In particular, the UrbanFlood multi-touch table is optimized to assist the decision making process of collaborating, multidisciplinary, medium-sized emergency teams. One of the features of this interactive user interface is to allow intuitive map-based access to libraries of pre-calculated detailed flood scenarios and to initiate multiple computer simulations as part of "what-if" scenario analysis. Furthermore, web-based interactions and smart phone apps using intuitive map-based user interfaces are also supported.

The Artificial Intelligence (AI) component of the EWS detects abnormalities in the behaviour of monitored objects by the application of novel machine learning methods to the sensor measurements. The AI component continuously calculates the confidence values for actual dike conditions and detects possible deviations from the known – safe – reference state, indicating the development of abnormal situations at an early stage. It flags exceptions and alerts flood experts, who then decide if the exception indicates a potentially dangerous situation. In this way the EWS 'learns' which sensor values are consistent with the reference state.

To demonstrate the usefulness of a EWS based on sensor networks, the UrbanFlood project has supported the installation of suitable sensor systems in flood defences in the Netherlands, the United Kingdom and the Russian Federation, measuring parameters such as water pressure, temperature and motion. Data from these and other networks are now available for online monitoring from remote locations.

In non-emergency situations, the UrbanFlood EWS can be used for flood management policy development and is able to support dike managers in routine dike condition assessment and management. This way it becomes an integral part of the professional toolkit providing information on the actual conditions of the embankments and fact-based computations of their strength, which ensures that staff members will have the necessary routine and practice to use the EWS effectively and with confidence when a flood emergency occurs. Flood emergency drills are still needed but cannot ensure the same level of familiarity that the daily or very regular use of a system will bring about.

The UrbanFlood EWS is built on a generic Internet based EWS, and able to use virtually all types of digital (sensor) information. It is able to run computationally demanding applications such as near-real-time (flood) modelling in Internet attached Cloud-based data centres that allocate computational resources according to priority and requirements. For dependable use during flood emergencies, several EWS can run in parallel in different geographic locations, possibly operating different computational models. This enhances the reliability of the system and offers a second opinion for assessment of the current emergency situation. In addition, local mirroring, alternative communication means and even the ability to use a minimum set of functionality locally should be considered.

In addition to the UrbanFlood EWS the Virtual Dike computational module has been developed. This module can be used for advanced research into dike stability and failure mechanisms. As it is able to compute the same observables that sensors are registering, it can explain which physical mechanism may cause the observed behaviour, possibly even during an actual flood event. The module is also used to train the AI component to detect anomalous combinations of sensor measurements.

Our paper describes the UrbanFlood EWS design and functionality, the main stakeholder requirements, the workflow, the individual modules, their integration and the first results of EWS monitoring and performance benchmarks. It also describes the pilot sensor networks installed in the Netherlands and in the UK with special emphasis on coastal and tidal areas, and provides a brief overview of the main sensor types deployed in these networks.

UrbanFlood is a project supported by the European Community's Seventh Framework Programme, Theme ICT-2009.6.4a, ICT for Environmental Services and Climate Change Adaption, grant agreement no. 248767. It started in December 2009 and will be completed by the end of 2012; the project website is www.urbanflood.eu.

QUALITATIVE SURVEY IN THE DELINEATION OF CUSTOMARY MARINE TENURE BOUNDARY IN THE STUDY OF EMPOWERING INDIGENOUS COASTAL COMMUNITY IN MALUKU ISLAND, INDONESIA

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Keywords: *survey mapping, customary marine tenure, Maluku Island*

ABSTRACT

Poverty experienced by mostly coastal community in Maluku Islands, Indonesia occurred due to low education level and abundance of conflicts of interest within the use of coastal areas. The conflict of interests in the utilization of marine space can contribute to the increasing of poverty because coastal communities are not able to get access to the collateral of marine space management as a basis for the exploitation of marine resources. No exception is applied as well to the indigenous coastal community.

In the context of cadastre, marine cadastre system has an important role in marine spatial managing. Accordingly, it will contribute greatly to the development and implementation of sustainable marine management systems. Cadastre system should not only cover the concept of ownership, assessment and utilization of land objects, but also accommodate the concept of three-dimensional spatial use of land, sea, and air.

A methodology could be proposed in this paper is an engineering research method. The engineering research methods employed are spatial analysis by implementing the concept of 3D marine cadastre survey and mapping. This paper presents the engineering research methods by using spatial analysis. First, a site investigation is proposed to conduct qualitative survey in the delineation of customary marine tenure boundary of indigenous coastal community in Maluku Island, Indonesia. Then, it is shown the importance of problem identification in access to marine space for poverty reduction and reviews the concept of boundary determination by indigenous coastal community in Maluku Islands.

By applying the above concept, cadastre system can be used as a tool to support the objective of the performance of coastal community's empowerment strategy, which is to achieve the economic growth and improve people's welfare, as well as to preserve the environment and socio-cultural values.

Then, we present a case study of qualitative survey in the delineation of customary marine tenure boundary in areas of Maluku in general and particularly in Haruku (Haruku Island) and Latuhalat Village (Ambon Island) (See fig. 1). Because of the concept of ownership in the study areas have been there both on land and at sea. The delineation of customary marine tenure could be identified by *coverage of the area*, *social right holding unit* and *legality and its enforcement*. This means that in order to build a customary marine tenure models in the community at areas study, it is important to find indications of the above concepts. One of the

qualitative survey methods could be done by interviewing the indigenous community using the existing maps and revised them after the interviews.

The case study shows that the qualitative survey method is fairly effective in the delineation of customary marine tenure boundary in relation to the study on empowerment of indigenous coastal community through provision of assurance of access to marine space for poverty reduction.

Figure 1. Study area of customary marine tenure in Maluku islands

DIFFERENTIAL DYNAMIC RANGE OF TWO STATES OF BEACH: AN EXAMPLE OF THE COAST OF TOGO IN WEST AFRICA

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Keywords: *Landform, accumulation, reflexive, hydrosedimentary, littoral drift, diachronic study, coastal erosion, coastline, morphosedimentary, spatiotemporal dynamics*

ABSTRACT

The West African coast is marked by significant morphological, very dynamic, in the Gulf of Benin. The study examines the pace of evolution of the coast of Togo, characterized by two states on the beach. One, in accumulation at the west of the port of Lomé on 10 km, the other reflexive at the east of the main pier of the port.

Located on the two cells and separated by port work, the coastline has always been subject to monitoring and measurement in both segments of accumulation and of erosion (5-7 m back / year), for economic reasons and scientific importance (Blivi, 2010). This work, very regular, showed the pace of the evolution of the coastline.

Marine structures disrupt the hydrosedimentary mechanism under the impulsion of a strong littoral drift and exacerbate the disparity between the two states of beach. This characterization of morphodynamic beach, and during long-term response, is a significant variation of the sediment budget, whose consequences are very important because of the use of the coastal zone for varied urban industrial activities and strong concentration of population.

The shore accumulating sector spans nearly 10 km at the west of the main pier of the port of Lome to the border with Ghana. This accumulation is favored on one hand, by the sole direction of littoral drift and the sustainable supply of adequate and fairly sandy material, and secondly, by the consistency of hydrological parameters (Blivi, 1993). The hydrosedimentary mechanism is due to the supply of sediments by the Volta, constituting a punctual source, set on a sandstone catchment of 400,000 square kilometers and carrying a volume of sand about 1 Mm^3/year representing 40t/km^2 / year (EEC, 1989). Volta provides the essential of sediment that enters to the process of the formation of the strand and beaches.

The eroded coast on the eastern of the port is directly issued from the blocking of the coastal drift's sediment flux by the main pier, which creates a disruption of the morphosedimentary balance. Downstream the port work, the drift attacks severely the beach, recovers sand, causing in fact the decline of the coastline that reaches 10 meters/ year. The process evolved gradually eastward from 1970, moving by tips of erosion to Togo and Benin border in 1985 (Rossi, 1989). The extension of the phenomenon results in heavy losses of land and destruction of housing and transport infrastructures (towns and entire villages, coastal road). The coastal road has been already severed in many places. Sequence surveys of the coastline are organized by the center CGILE. In 2010, the existing coastal road in the town of Afiadégnigban (PK 22) is located within 100 m of coastline.

The present study focuses on several methods through the spatiotemporal dynamics of the coastline from 1955 to 2010 and makes projections of the phenomenon. The methods are fundamentally based on geomatics. Aerial photographs from 1955, 1985 and 2010 were analyzed using a diachronic approach. The results of this analysis have been reinforced by the positioning of the coastline between 2003 and 2011 with GPS FX 312, HI 9828 with GPS and GPS eTrex Legend HCx. Everything was calibrated regularly monitored by surveying the study area located between the frontier of Ghana and the town of Afiadégnigba, 25 km of coastline. The information on the dynamics was treated with the extension Digital Shoreline Analysis System (DSAS) of ArcView to display the results. This extension allows you to calculate changes in position of the coastline between two dates from their intersections. These results are presented using a method developed by Faye and Giraudet (2010) that combines mapping and locating showing the evolution of the coastline, a graph measuring the evolution of the statistical variations in the position of the coastline.

The Togolese coast, like the coast of the Gulf of Benin countries, deserves serious surveillance that will result in the implementation program of regular monitoring of the shoreline to supplement the data and facilitate the development of a study of protection, vulnerability and adaptation. Model results are significant only in broad given the complexity of changing the parameters to be included in a system quite fixed. However, in the context of foresight, models are the means of evaluation and optimization of results.

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TEAMSURV: CROWD SOURCING IN HYDROGRAPHIC SURVEYING

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ABSTRACT

Current multi-beam Hydrographic survey techniques have unprecedented levels of coverage and accuracy, but there are not the resources to re-survey all coastal waters, and keep the surveys up to date. Crowd sourcing has proven to be an effective method of knowledge and data acquisition, as shown by open source projects such as Wikipedia and OpenStreetMap, and its commercial use by organisations such as TomTom and Navionics to update their maps and charts.

TeamSurv is a project that brings surveying and crowd sourcing together, using vessels of opportunity to log depth and position data, which is then uploaded to the web for processing. This paper first examines the hardware and software framework for data acquisition and processing created in TeamSurv. This consists of both hardware and software based non-intrusive data loggers, the web server for data upload and presentation of results, and the bak end databases and associated code.

It then presents the techniques used in processing the data. This covers filtering bad data out of the logged tracks, through tidal, speed of sound and other corrections to produce a set of reliable soundings reduced to a common datum. Tidal data uses a combination of tidal predictions and tide gauge data; speed of sound corrections use either temperature and salinity sensors or, where not available, seasonal data. It then proceeds to the synthesis of the track data, and the further work carried out at this stage to further enhance the data and form a surface which can then be used as the basis of output data sets.

Finally, it examines the errors and levels of accuracy that can be achieved by using this approach. This covers the accuracy of the GPS and depth sounders used by most of the data loggers, and also error sources from the motion of the vessel in a seaway. The output of computational fluid dynamic models of vessel motions in a seaway is used to assess the effect of waves on the data accuracy. These various data errors are then pulled together to give an overall level of accuracy for the individual tracks. The error analysis is then taken to the next stage, where the tracks are combined to produce a surface, and the effect of bringing forward these errors combined with different data densities is considered. Also, the spread of depths is shown, to indicate the consistency of the logged data.

The ultimate test of this approach to surveying is in comparing data from TeamSurv with other surveys of the same area, and examples of this are presented showing differences in surveyed depths. Having examined the methodology and results of TeamSurv, we conclude by considering areas of application where a crowd sourcing approach could be used to complement existing survey methods. These include surveying in areas where there are not the resources for multi-beam or other professional surveys, and also as a tool for monitoring for changes in the sea bed, which can then be used to trigger a re-survey when required.

LAND USE CHANGE IMPACT ON COASTAL VULNERABILITY: SUBSIDIES FOR RISK MANAGEMENT AND COASTAL ADAPTATION

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Keywords: *land use change, land cover change, coastal zone, environmental vulnerability, GIS*

ABSTRACT

The pace, magnitude and spatial reach of human activities make the society increasingly dependent on technical solutions, in order to minimize its vulnerability to natural disasters and extreme events. Land use and cover changes are among the most drastic human-induced alterations of the ecological systems. The medium littoral of the Rio Grande do Sul coastal plain have experienced substantial land changes due to urbanization and deforestation, which in turn may contribute to flood and landslide hazards. The goal of the present study is to assess how land use changes have affected the flood and landslide vulnerability of the Rio Grande do Sul Medium Littoral and define priority areas for risk management, based on GIS and Remote Sensing. The GIS-based models incorporate a digital elevation model, rainfall and soil infiltration potential data to calculate flow direction and accumulation. Other criteria are derived from land use and soil data. The resulting images spatially show the relative flood and landslide risk, giving us a hint about what areas should be the focus of concern in the case of extreme rainfall events. It also can be used as a scenario generation tool, prospecting the effect of land use and climate changes on hydrological vulnerability. The results are intended to support environmental management and development planning of the costal municipalities surrounding the Patos Lagoon, some of them already suffering the socio-economic consequences of hydro-meteorological disasters.

Introduction

The pace, magnitude and spatial reach of human alterations of the Earth's land surface are unprecedented. Land changes coupled with extreme meteorological events increase the environmental vulnerability related to flood and landslide hazards. The Medium Littoral of the Rio Grande do Sul coastal plain is of special concern regarding to flood and landslide incidents. It comprises about 2.5 million inhabitants living in 17 municipalities along the Patos Lagoon coast. Depending on the meteorological conditions, water is driven toward the Patos Lagoon coastline. If it is combined with an intense rainfall through the drainage basin, a flood takes place. At least two major hydro-meteorological disasters were recorded in the west coast of Patos Lagoon in the last couple of years, leaving thousands of homeless and some deaths. In spite of the number of efforts in understanding the Patos Lagoon and surrounding environments, land change analysis are very recent and scarce. There is a lack of a decision support framework, integrating multi-source spatial data, providing visual tools for

stakeholders to better understand flood and landslide hazards and how the environment respond to land use and cover changes. In this context, Geographic Information Systems (GIS) has excelled in the development of spatial modeling. Beyond the conventional models, GIS is capable of generating vulnerability and suitability indexes, based on map algebra and context operators, pointing areas at high-risk. Whereas Remote Sensing is an unique data source, GIS spatial modeling allows to establish multiple analytical approaches to assess local vulnerability to environmental changes. Thus, the goal of the present work is to assess how land use changes have affected the flood and landslide vulnerability of the Rio Grande do Sul Medium Littoral and define priority areas for risk management, based on GIS and Remote Sensing.

Methodology

The GIS hydrologic model (Idrisi Taiga) used to define areas at flood risk was based on elevation data and water infiltration rates to calculate flow direction and accumulation. Hydrologic soil groups, or HSGs, along with land use, management practices, and hydrologic conditions, determine a soil's runoff curve number. The average infiltration rates of each HSG were used to build the flood risk model, in combination to the soil data from the Mapa de Solos do Brasil (IBGE, 2001). The initial absortion values were defined based on the land use and cover maps for 1987 and 2000 (Silva, 2008) and the runoff curve numbers (adapted from Tucci, 2007). The resulting flow accumulation images were reclassified by equal intervals in five classes (very low to very high flow accumulation). Weigths from 5 to 1 were assigned to the distance images from the flow accumulation classes proportionally to the amount of water accumulated. The weight 2 was assigned to both initial absorption and infiltration rate (derived from the HSG data). No compensation between factors was applied. The landslide risk was also assessed through a multi-criteria evaluation. Equal weights were assigned to the following criteria: initial absorption capacity, slope, land use and soil. Initial absorption was inversely related to landslide risk based on a linear function, while the slope was directly related to it, based on a J-shaped function. The HSG map was used to represent soil erodibility. Land use was also considered a crucial factor, where the soil stability is supposed to increase in the following order: agriculture, silviculture, forests, and urban areas. Wetlands and aquatic land covers were not consired in the analysis (masked out).

Results

The land changes detected between 1987 and 2000 with potential impact on flood and landslide susceptibility are due to deforestation (707 km^2) and urbanization (178 km^2). These changes led to an average decrease in the initial absorption capacity of around 26 mm in the affected areas. The flood risk is a continuous index, varying from 0 to 1. However, the flood risk images were classified in low, moderate and high risk for a better understanding of the results. The high flood risk class increased in area about 1,300 km^2 between 1987 and 2000. All urban areas showed an increase in the flood risk level, going from low or intermediate to high or very high, according to the model. In a general sense, the northern part of the study area was more affected in terms of flood risk increase. The landslide risk, in the other hand, increased in about 600 km^2 of the study area. This increase was spatially concentrated in some municipalities, namely Porto Alegre and the upper lands of Pelotas, Turuçu, and São Lourenço do Sul. Porto Alegre is of great concern, once it comprises 1.5 million inhabitants. The east coast of Patos Lagoon showed virtually no landslide risk, since the slopes are very gentle.

Conclusion

The flood and landslide control and predictoin are one of our biggest challenges given the current scenario of global changes. Once the medium littoral of the Rio Grande do Sul coastal plain is increasingly urbanized and deforestated, the runoff components are altered and flood and landslide hazards worsen. The GIS-based models spatially shows the hazards, giving us a hint about what areas should be the focus of concern in the case of extreme rainfall events. The results are intended to support environmental management and development planning of the costal municipalities surrounding the Patos Lagoon, some of them already suffering the socio-economic consequences of hydro-meteorological disasters.

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SPATIAL CHANGES IN THE WETLANDS OF LAGOS/LEKKI LAGOONS OF LAGOS, NIGERIA: INTERIM RESULTS

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Key Words: l*agoons, wetlands, spatial changes, remote sensing, GIS*

ABSTRACT

Lagos metropolis, the current economic capital of Nigeria is a low-lying coastal city endowed with a number of lagoons and wetland ecological assets. Lagos/Lekki Lagoons being the largest with a combined size of 646km^2 are fringed on many sides by wetlands. Many of these wetlands have undergone severe spatial changes from rapid urbanization in the past three decades. But like in many coastal cities of the world, the precise nature of these changes is largely unknown and unreported. As the area is experiencing intense development pressure, this on-going study is therefore examining the spatial changes in the wetlands fringing these lagoons using the integrated approach of remote sensing data and GIS with topographic maps providing baseline data. The objective is to quantify and establish the precise location and magnitude of these changes over the years from 1985 to 2006. Two types of wetlands have been established to be prevalent in the Lagos area namely: the freshwater and mangrove swamps.

The hardcopy 1/25,000 topographic maps were scanned to convert them to softcopy format. These maps were georeferenced and digitized on AutoDesk Raster Design. The digitized maps were then edge-matched to produce a seamless mosaic. This vectorised mosaic was thoroughly cross-checked for errors and then inputted on ArcGIS for extensive editing (trimming and clipping) and area calculations. In addition, three scenes of Landsat TM (Thematic Mapper) and ETM+ (Enhanced thematic Mapper) were processed in order to extract the wetlands, mangroves and water bodies across the area of study. One of the scenes is a Landsat TM dated 18th December 1984 while the remaining two scenes are both Landsat ETM+ dated 28th December 2002 and 7th December 2006 respectively. Only three bands were used for the analysis and band sequence 5, 4 and 3 was used for the composite in order to identify the wetlands, mangroves and water bodies distinctly.

The image processing technique used was the supervised classification. The supervised classification method was chosen over the unsupervised classification method because of the ease at which the former identifies the wetlands and/or water bodies and also because this simplifies the editing stage. In supervised classification, pixels are clustered in a dataset into classes corresponding to user-defined training classes. The parallelepiped classification technique which uses a simple decision rule to classify multispectral data was employed. The decision boundaries form an n-dimensional parallelepiped classification in the image data space. The dimensions of the parallelepiped classification are defined based upon a standard deviation threshold from the mean of each selected class. Areas that do not fall within any of the parallelepiped classes are designated as unclassified. Using the ENVI (Environment for Visualizing Images) software the LANDSAT band based imageries were combined together

to get a multispectral view. The wetlands were identified as having a greenish colour, while the mangroves had the dark green colour as its trademark. These wetlands were then uniquely assigned as regions of interest (Training class). A parallelepiped supervised classification technique was then carried out on the trained class to extract the wetlands from the entire multispectral imagery.

After the classification exercise, the output shows only the wetlands and a few other features picked as a result of similar spectral reflectances. A post classification method is done in which auto vectorization of the classified features is carried out to extract the wetlands. After the extraction process is ended, the vectorized wetlands are then exported as shapefiles. On Arcmap, these shapefiles are edited to delete all the other features that were captured due to similar spectral reflectances. Areas were then calculated.

Interim results show that the mangrove wetlands decreased from 148km^2 in 1984 to 133km^2 in 2002 while the other wetlands decreased from 200km^2 in 1984 to 85km^2 in 2002. Results further showed that the wetlands occur only in six of the Local Government Areas out of the twenty Local Government Areas in Lagos State. These decreases in the wetlands could be attributed to human pressure in the environment.

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FLOOD RISK MAPS IN COASTAL AREAS

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Keywords: *dune erosion, coastal mapping, flood risks*

ABSTRACT

This paper describes a method for the production of flood risk maps in coastal areas. It starts with the objective of flood risk maps in Coastal Zone Management (CZM). Then, a general procedure is described to compute the flood and erosion risks in coastal areas. Finally, this procedure is illustrated for a flood risk map for Vlieland, a Dutch Wadden Island.

Objective of flood risk maps

It is the responsibility of CZM to protect natural and human values in coastal areas, to develop new opportunities and to inform stakeholders about the risks of being near the sea. Therefore, in CZM the probabilities of dune erosion and related flooding events need to be known.

In the Netherlands 13 coastal towns have been identified with an increased risk of flooding in populated areas. Therefore a national safety assessment method has been developed in order to quantify the risks of dune erosion and flooding, and to publish the results in flood risk maps. This national method is translated to a general method for the production of flood risk maps in coastal areas with dunes. An example where this method can be applied is the framework of the European Flood Directive 2007/60/EG.

General procedure to compute flood and erosion risks

The paper describes the general procedure for the computation of flood risks, which is composed of the following steps:

1. Collection of statistical information about the hydraulics loads on the dune defense, namely the storm surge level, storm duration and the wave conditions.
2. Collection of statistical information about the dune strength, namely the grain size, the cross – shore profiles of the coast, and the topography of the hinterland.
3. Choice for a dune erosion model, that calculates dune erosion in cross – shore profiles.
4. Application of a probabilistic model to compute exceedance frequencies of dune erosion retreat positions, with the statistical information and the dune erosion model.
5. Development of a semi-probabilistic model that provides similar results as the fully probabilistic model.
6. For a selected number of exceedance frequencies, dune erosion retreat positions are calculated for all cross-shore profiles, with the semi-probabilistic model.
7. The dune erosion retreat positions of all cross – shore profiles are connected into dune erosion retreat lines for the selected exceedance frequencies, which, after GIS – processing, can be published in a map.
8. Evaluation which of the dune erosion retreat lines passes the rear of the dune, which

indicates failure of a dune and flooding of the hinterland for the related exceedance frequency.

9. Computation of the area which will be flooded, where the storm surge level has an exceedance frequency equal to the probability of failure of the dune. After GIS processing, the flooded area can be published in a map.

Illustration of a flood risk map at Vlieland

Figure 1 shows a part of the flood risk map of the Dutch Wadden Island of Vlieland. In this example, the dune retreat positions are calculated with the semi – probabilistic model DUROS+, which is the standard dune erosion model for The Netherlands. The figure shows the dune erosion retreat positions and the connecting dune erosion retreat lines. It appears that failure of the dune can be expected for an exceedance frequency larger than 1 / 500 p.a., but smaller than 1/100 p.a. This frequency corresponds with a storm surge level of 3.5 m + NAP (Dutch Ordnance Level, that is about Mean Sea Level). The flooded area is represented with a white colour.

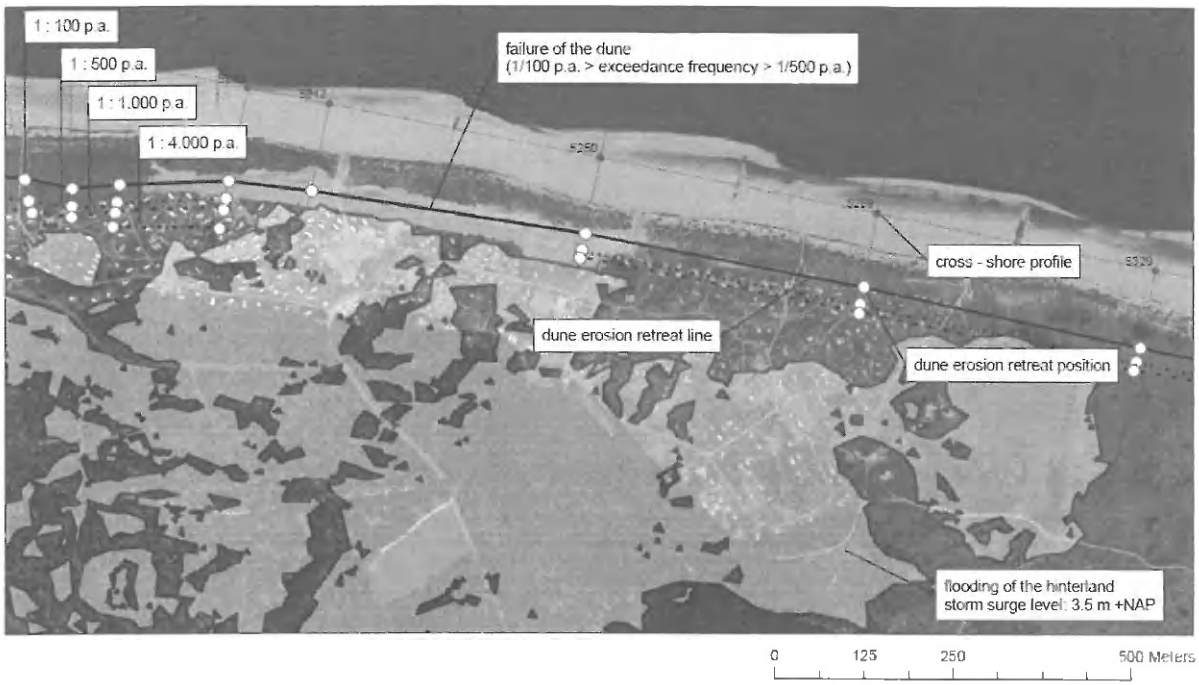

Fig. 1. Flood risk map of Vlieland

THE WASHINGTON STATE COASTAL ATLAS: TARGETING USER NEEDS AND INFORMING MARINE AND COASTAL ZONE MANAGEMENT

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ABSTRACT

The Washington Coastal Atlas (http://www.ecy.wa.gov/programs/sea/sma/atlas_home.html) provides geographic information to support informed management of Puget Sound and the outer coast of Washington State. Over the years the atlas has developed a broad user community beyond its targeted coastal management audience. Recent redevelopments have focused on improving usability, upgrading technology, and adding and enhancing tools that target specific user groups and needs. These tools include information on public beach access locations, an improved shore photo viewer, federal flood maps, and beach closure and water quality information. The development of each tool involved creating user profiles to represent the diverse audience, designing each tool page to meet user needs, and user testing by a sampling of users who represent different groups. Early awareness of atlas user needs improve the overall usability of this online resource.

The atlas is coordinating with other coastal atlas-type applications on the west coast of North America (http://ican.science.oregonstate.edu/westcoast/), as well as participating in the International Coastal Atlas Network (ICAN) to collaborate on data interoperability, tools and resources for improved coastal zone management.

Designing for the User

The Washington Coastal Atlas's primary purpose is to serve as a resource for coastal managers and planners across the state to efficiently find information needed for their work. As a publicly available web-based resource, the atlas is used by a broad range of users beyond its intended audience, including local and Tribal governments, state and federal planners and resource managers, researchers, consultants, and interested citizens. Information available in the atlas includes habitat features, physical features, regulated features, shoreline modifications and jurisdictional delineations, among others.

Previous versions of the atlas focused on a map-dominant web page, with a legend and layer list and an array of tools across the top of the map – including both standard ArcIMS and custom-built tools, such as the Shoreline Photo Viewer and Land Use Change tools. The design made it difficult for some of the less technical users to find the tool or information to meet their needs.

Recently redeveloped to meet additional user needs, the atlas features an improved user interface designed to be easily accessible to a diverse audience. The new design integrates

maps, thematic tools and textual information. Improvements include the addition of important new data sets and associated tools such as (1) public beach access locations in Washington State, where much of this land is privately owned, (2) new digital Federal Emergency Management Agency (FEMA) flood maps, and (3) beach closure and water quality information. The Shoreline Photo Viewer, the most popular tool in the previous version of the atlas, is also redesigned. This viewer includes decades of oblique aerial photos for the entire shoreline of the state. It can be used to view current and historic shoreline features, such as level of development and presence of any shoreline modifications.

Usability of the atlas has been central throughout the atlas redesign process. A web designer with extensive web usability experience provided input from the beginning of the current project, which was invaluable for meeting redesign goals. User profiles were developed to define backgrounds, skills and needs for the array of atlas users. User testing was conducted at various stages in the process to gauge the actual usability of individual tools and integration of the atlas components as a whole, such as linking from a public beach page to the corresponding image in the Shore Photo Viewer. User testing groups included a sampling from the broad range of users, from coastal planners and managers to homeschool moms. As a result, visitors to the Washington Coastal Atlas will be able to quickly find the information they are looking for, no matter what their technical skill level.

The redevelopment is moving forward in a phased approach. Phase 1 is designing and developing the tools and implementing the ArcGIS JavaScript API for thematic maps in the tools. Future phases include the redevelopment of the central map and its integration with all atlas components and upgrading to the ArcGIS JavaScript API, redeveloping the land cover change tool which enables the user to see land cover change over time by county, and additional tools as determined by the agency.

TH-022

USE OF GIS FOR FLOOD ZONING IN URBAN WATERSHED AREA CASE STUDY: IRAN, NORTH OF TEHRAN

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Keywords: *flood zoning, Geographic Information System, GIS, mathematics model, flood plain and urban watershed area*

ABSTRACT

Urban Irregular development has created a lot of problem in urban areas of the world. This problems include natural hazards such as flood, earthquake and in some cases drought, percentage of occurrence of flood is more than other natural hazards. Rivers are the most essential resources for providing water for human and other creatures and sometimes this resource of life has caused destruction and uncompensated damages. Forecasting hydraulic behavior of river against probable flood for decreasing damages entered into urban areas, installations under construction, fields and other usages around the river has special importance. City of Tehran as the most important urban center of country every year exposed to natural potential hazards including flood. This urban area is located on flood plain of rivers such as north of Tehran, Kan, Golabdareh and Darband, each of them can generate terrible floods.

Determining flood plain in urban area could be enumerated as one of the most basic information in non-structural control of flood water. In this research, we paid to determining flood plain areas in a part of urban watershed area of Tehran (Tehran north river). Used mathematical model in research is HEC-RAS which has very high capability in simulation of river hydraulic behavior, analyzing lasting and non-lasting flows, calculation of profile of water level and relation with geographic information system. Geographic information system also is considered as an applicable science in systematic attitude and inspection interaction of various factors as supporter of making decision which in this research, its relation with mathematic model of HEC-RAS was evaluated. With regard to results of research, this relation was accepted well and map of flood plains was provided against return periods of 25, 50, 100 and 200 years.

TH-023

COASTAL HERITAGE VIEWER FOR IRELAND – A PILOT PROJECT

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Keywords: *coastal heritage, Ireland coast, Coastal Viewer*

ABSTRACT

A coastal heritage viewer has been developed for non-GIS specialists through an innovative partnership between the Heritage Council of Ireland, 8 coastal local authorities, and Compass Informatics. Started in 2010, the purpose is to develop an evidence-based tool to inform policy development at national and local authority level. Importantly the viewer allows users to view data across a number of boundaries: administrative ones, as well as the land-sea boundary, and through the range of data sets included, it facilitates users to see beyond their own special interest boundaries.

In Ireland, as elsewhere,e pressure is increasing on the coast - through land-based developments, increased tourism numbers, renewable energies - on and off shore, increased coastal erosion and flood risk, extensions to ports. The need for coastal heritage viewer became apparent from the frustrations felt by heritage professionals as to how to bring the myriad complexities of heritage together to ensure they can be taken into consideration from outset of any project or policy process by colleagues in other sectors.

While the main focus of this project is centred on coastal heritage of the Irish coast, (land and sea, built, cultural and natural) it also includes many other data sets, relating to tourism, coastal flood risk and erosion risk, geology, fishing activities, energy and coastal infrastructure. At present access to the viewer is limited to personnel in the participating local authorities, the Heritage Council and other data providers. However it is intended to provide a level of public access in the future.

The Coastal Heritage Viewer is designed to support OGC web services as far as possible to ensure data is current and to minimise on-going data management overhead. The Viewer also builds on work conducted by Compass Informatics Ltd (Dublin, Ireland) for the National Biodiversity Data Centre, Ireland, and other organisations in developing a viewer based on Esri ArcGIS Server with the Silverlight API and a custom mapping framework. Importantly the Viewer integrates the rich biodiversity records resource at the National Biodiversity Data Centre and many of the associated data management and visualisation tools including multi projection support.

In 2010, the project was focused on data collation, completing a metadata catalogue, and developing the viewer itself. This year we are testing its relevance and application – in what contexts can the viewer be used? How does it help? What simple analytic tools could be developed? In particular we are focusing on the potential to assist in considering heritage issues in relation to Strategic Environmental Assessment, and appropriate assessment under Article 6 of the EU Habitats Directive, in particular in generating alternative scenarios, and assessing cumulative effects. The potential impacts of wind strategies (on and offshore) on heritage, and its value in planning sustainable heritage tourism products will also be examined. The presentation will also outline other issues arising in the project around data resolution, and metadata.

P-001

SPATIAL ASSESSMENT AND IMPACT OF ARTISANAL FISHERIES' ACTIVITY IN CAP DE CREUS

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Keywords: *métier, GIS, fishing spatial activity, MPA, fisheries management*

ABSTRACT

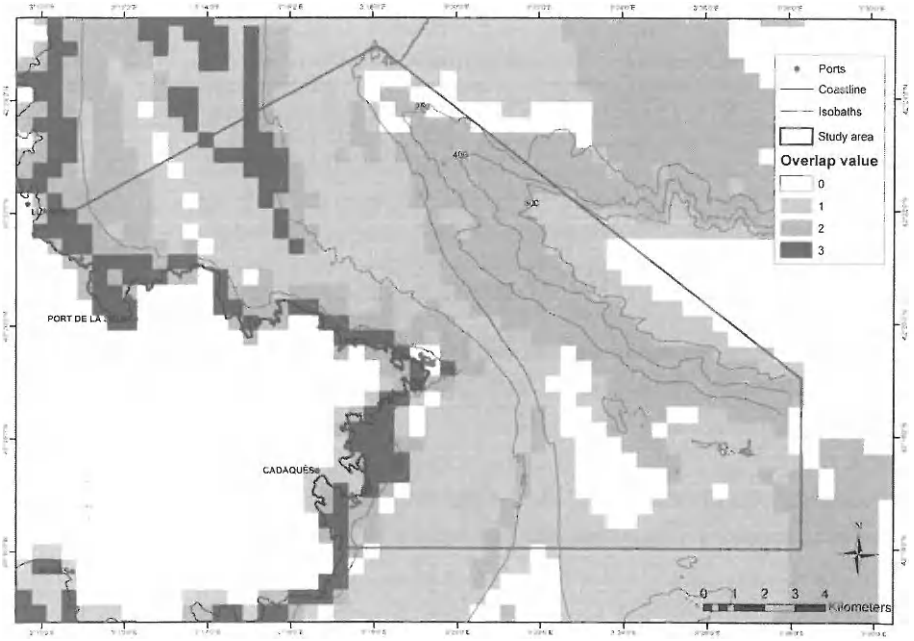
European directives are strongly encouraging to increase the number of marine protected areas in each European nation. MPAs have been envisaged not only as a potential tool for conservation but also as safeguard against most fishing practices, either commercial or recreational. Northwestern Mediterranean is characterized to present high fishing activity and consequently the awareness to preserve and protect high ecological important areas has been recently on the scope. The region of Cap de Creus has been subjected of study in order to evaluate its value in the frame of the Habitat Directive and Natura 2000 Network, as the LIFE+Indemares Project (LIFE07/NAT/E/000732) and to become its first declared MPA offshore. The aim of this study is to combine the provided information of artisanal fisheries' components by *métiers* from the FAO-COPEMED Project together with other data gathered in the region referring to substrate and benthic communities.

When studying marine areas for conservation purposes, one of the main objections is to localize the anthropogenic pressure exercised in the area. Fishing tradition has distinguished the area of Cape Creus since the old times; however, during the last decades fishing pressure is an evident fact. Commercial fishing is mainly represented by artisanal fisheries, which due to the physical and environmental conditions prevail over semi-industrial and industrial fisheries; nevertheless, the big battle of professional anglers is the coexistence with uncontrolled recreational fishing. Due to the unavailability of data from the later, the focus of this study is the spatial role of artisanal fisheries. By taking advantage of the stocktaking of the main fishery components associated with artisanal fisheries, a compilation with other existent regional information from the area is intended. In order to obtain the most complete conception of the spatial fishing activity in Cap de Creus and to assess the incidence of gears on an unprotected ecosystem, GIS tools have been employed.

Aiming to classify the degree of impact of certain areas according to the coexistence of one or more fishing gears will serve to evaluate the existent community types. Integrating important features such as substrate and benthic types together with the existing information will allow localizing throughout a spatial distribution the vulnerability of the system, as a result, a relationship between outstanding communities and less exploited areas will be tested. Just like in other fishing regions in Europe, the Mediterranean faces the problem of reconciling the economic activity with sustainable fish stocks and habitat conservation; thus, achieving a well understanding of key communities and fisheries' distribution is a first step for an integrated management including fishermen as one of the main stakeholders.

An overlap value has been set to define the coincidence in space of two or more fishing gears and to detect the degree of impact over the system (see Figure below). Only those gears acting in a broader scale over the study area for protection have been considered by excluding thus, minor gears. The assigned values can then be ranged from 0 to 4. A value of 4 has not

been obtained meaning that in any area the confluence of all gears has been recorded. The resulting map reflects the limitations in the coexistence of particular fishing types, i.e. trammel nets and longlines hardly coincide; due to their fishing techniques, their coincidence in space would result inconvenient for both of them.



In this study one can see how the seabed experiences different levels of fishing activity; areas subjected to a greater presence correspond to areas relatively undisturbed by natural perturbations (i.e. muddy areas) unlike areas suffering of high environmental influence with unconsolidated sediment being predominant. It is important knowing the benthic characteristics to ensure that fishing closures in no-take or partially protected areas do not cause a displacement to other vulnerable areas. An opportunity for protection of particular areas where ecologically important species have been recorded is by taking into consideration the spatial distribution when managing.

The partition of fishing activities is an effective approach for habitat conservation. Both, areas used exclusively by unique fishing gears (i.e. parceling) or areas shared seasonally by two or more participants (i.e. considering target species' behavior) have seen to work and to avoid conflict among the several sectors. Thus, this is an excellent management strategy in areas where ecologically important species have been recorded, to ensure their protection and to promote an efficient sustainability in the ecosystem and minimizing the impact onto benthic communities. Notwithstanding, to fully protect mobile species and their habitats it is urgent to identify the so-called Essential Fish Habitats, which not only encompass areas for nursery and spawning, but areas as relevant to keep up other stages of their life cycles such as food or predator avoidance sites.

Conservation needs to be seen from a more integrated and proactive perspective, assuming the relation of protected spaces with the surrounding territories and human uses. Involving local communities in taking the most profit of the economic potential of MPAs needs to be highlighted when planning with stakeholders. Looking for coherent ways of territorial ordination through Marine Spatial Planning will keep the functions and natural services.

BASELINE HABITAT MAPPING AND ASSESSMENT OF THE PULAU BANYAK ARCHIPELAGO, SUMATRA- TOWARDS COASTAL SPATIAL PLANNING OF A TOURISM-CONSERVATION AREA

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Keywords: *Pulau Banyak, coastal planning, island ecotourism, coral reef mapping, Aceh*

ABSTRACT

Pulau Banyak is an archipelago off the west coast of Aceh, Sumatra. It has important extents of coastal habitats such as coral reefs, mangroves, rainforests, etc. Despite a population of only 7000, extraction rates of marine and forest resources are far from sustainable. The objective of this work was to produce the first habitat map for the region, as well as an assessment of these habitats (emphasizing on marine ones) and a zonification recommendation for the development of ecotourism. Landsat 5 TM images were classified using over 1000 sample points (divided into training and validation data sets). Furthermore, fishing zones maps were produced by means of a participatory GIS exercise. The resulting habitat map consisted of 10 different classes, 5 underwater and 5 terrestrial habitats. The underwater habitat map had 70% accuracy, while the terrestrial habitat map had 82% accuracy.The habitat and the fishing zones maps were coupled with the habitat assessment and ocean currents data to produce a zonification map. This work was done in coordination with the local authorities (the governor and regent of Aceh, the forestry and fisheries department, and the local headman of Pulau Banyak), and constituted the baseline information for the management plan of the area, focused on eco-tourism management and conservation activities.

Introduction

Pulau Banyak is an archipelago off the west coast of Sumatra, Regency of Singkil, in the south of the province of Aceh. It has an important range of habitats: e.g. coral reefs, sea grass meadows, algae patches, freshwater swamps, mangrove forests and lowland rainforests. A low population density (only 7000 inhabitants), traditional laws, and a relative long distance to the mainland, have up to a certain extent served for the preservation of the resources in the area. However, the current extraction (by locals and outsiders) rates of plants and animals are far from sustainable. If maintained, it could lead to extinction of many species of biological and economical importance in the near future.

Threats to these ecosystems include: pollution, destructive fishing practices, extraction of living coral for construction, land use change. Furthermore, natural disasters such as the 2004 earthquake and tsunami, which lifted areas as much as 1.2m, damaging and destroying extensive areas of both coral reef and mangrove forests.

Therefore there is an urgent need to work towards obtaining tangible benefits, both for the conservation of the natural resources of the area, and for the local communities relying on

them. For this reason, the objective of this work is to generate baseline information of what habitats are found there, where exactly they are and in which state.

Methodology

In order to produce the habitat map, Landsat 5 TM images were classified. Applied preprocessing included: radiometric, atmospheric, and water column corrections and sun glint removal. These images were preclassified to established a fieldwork sampling scheme. A two month field campaing was overtaken, were sample sites were visited, and later divided into training and validation data sets for the final calssification.

Furthermore, during the field campaign, a rapid assessment of the visited habitats was performed, and a participatory GIS was carried out in order to create a map of land and ocean use by the locals.

The habitat map, and land and ocean use map were coupled with the habitat assessment and ocean currents to desing a recommended zoning with the main purpose of planning ecotourism activities that do not undermine the regeneration of the marine and terrestrial resources. The main criteria for zonation were: state of the resources, potential for regeneration, ocean currents, economic activities and existing protected areas.

Results

An underwater habitat map (70% accuracy) and a terrestrial habitat map (82% accuracy) were overlaid to produce the final habitat map. Ten classes were identified: coral reef, patchy coral reef, sea grass, algae dominated patches, sand, lowland rainforest, mangrove forest, dead mangrove, altered vegetation, bare land/villages. The number of identified islands was 71.

The field campaign yielded the most accurate assessment to date of the condition of the habitats, including photographic evidence in over 1100 sample points. It was very clear from the surveys that most reefs with less than 25% live coral cover were either closer to the villages (extraction for construction), were considered good fishing spots or closer to areas visited by trawlers. Coral in better state was found in the shallower central area (apt for tourism).

Seagrass patches are found mainly in 2 islands to the north of the archipelago. Massive patches of dead mangroves are evident (it occured after the 2004 earthquake), as is its recuperation. Cocunut plantations have replaced native forest in many of the smaller islands, while in the bigger ones it is intact except in the inmediate sorrounding areas to the villages.
The zonification map included nuclear, recovery, tourism and fishing areas, taking into account the above information.

Discussion

Scarce information is available for Pulau Banyak. The use of freely available satellite imagery combined with intensive fieldworked and GIS analysis produced a satisfactory habitat map that could serve for sustainable management of the area.Derived information could serve as baseline to undertake many other actions, e.g habitat monitoring, social-ecological studies, fisheries evaluation, habitat restoration, marine planning, etc.

The maps have already been used to delimit no-take zones in a payment for environmental services scheme. Moreover, the zonification and the habitat maps were presented to the local authorities, who decided to use them as the base for the management plan for the region.
After the assesstment it is evident that bomb, cyanide fishing and trawling have destroyed big patches of coral reef; these practices should be banned. Nonetheless, the area has great resilience potential with important areas of live coral cover and diversity. Although these areas should be totally protected, buffer areas around them could hold low-impact and well managed ecotourism (plans already exist for island hopping, kayaking tours and boungalows in 2 of the island).

P-003

ASSESSMENT OF SEA LEVEL RISE USING GEOGRAPHICAL INFORMATION SYSTEMS AND DEM DATA FOR CUKUROVA DELTA COASTAL ZONE

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Keywords: *sea level rise, GIS, DEM, Cukurova Delta, Turkey, coastal zone*

ABSTRACT

In this research sea-level rise was simulated based on a series of land elevations (0-1, 1-2 and 2-3 m). The study area of the Cukurova coastal zone is located in the south of Adana on the south-eastern Turkish Mediterranean coast and it represents an internationally important coastal strip ecosystem, 110 km long (Figure 1). The coastal zone of Cukurova is one of the most important agricultural and industrial centres of Turkey as it makes important contributions to total agricultural crop production of the country and provides land for industries. Proximity to major transportation networks attracted industrial establishments such as fertiliser factories, steel mills and oil refineries. The most important cash crops grown in the delta are cotton, cereal and citrus fruits. Most of the 150 km wide land strip along the coast is less than 2 m above sea-level, and is protected from flooding by a 1 to 10 km wide coastal sand belt only. Research area is also a breeding and nesting area for three globally threatened sea turtles; *Caretta caretta, Chelonia mydas*, and *Trionix triunguis*. This coastal zone is important not only for sea organisms, but also for some endemic vegetation. A type of Aleppo pine, not common in Turkey, can be seen in this area, and it is surrounded by sand dunes and lagoons with wetlands with a high floristic diversity. There are also some endemic halophytic plants in the area.

In this research, two different kinds of elevation data were used. One of them, 1:25.000 scale digital elevation contour maps (DECM), was produced by General Command of Mapping and the other, Shuttle Radar Topography Mission (SRTM), was produced by NASA.

In order to create digital elevation model, spatially joined twenty eight contour line sheets were transformed from line to elevation point. These map sheets border was also interpolation boundary. Elevation points were interpolated by using natural neighbour algorithm. Natural neighbour interpolation algorithm was used for creating digital elevation model from elevation points. This algorithm is a geometric assessment technique that uses natural neighbour regions generated around each point in the data and it is particularly effective for dealing with a variety of spatial data subjects presenting assembled or highly linear distributions (Vertical Mapper User Guide 2001). As a result of interpolation, DEM with 25m cell size was created. Grid form of DEM was re-classed as 0-1, 1-2 and 2-3 m elevation zone and was transformed to vector layer. Land use, settlements and various maps were clipped with these vector layers so as to determine features and areas in the 0-3 m land elevation.

As a result of the analysis of DEM data, approximately 101.399 hectare of land area lies below 3 m contour line in Cukurova Delta, and is hence highly vulnerable to sea-level rise. It

is estimated that a 0-1 m rise would cause flooding in approximately 52.447 ha land area. This land consists of wetlands, sand dune, salt marshes-swamp and pasture, wetlands covering the biggest area. Especially the coastal wetlands and beaches of Akyatan and Yumurtalik Ramsar Area function as a globally significant resting, feeding and reproduction stopover for millions of shorebirds migration route. These same wetlands also provide essential spawning and nursery area for commercial fish species.

Considering population and infrastructures, 3313 person lives in 7 settlements under 1 m contour line in Cukurova Delta coastal zone. Considering population and infrastructures, 3313 person lives in 7 settlements under 1 m contour line in Cukurova Delta coastal zone. These people are using as infrastructure 15 transformers, 23 bridges, 6 schools and 1 oil-station (Table 1). According to the census between 1996 and 2004 annual population increase rate is 13.8‰ for this region, which means that this population will be around 13200 until the next century.

The area under 2 m and 3 m contour line with rich alluvial soil, which gets enriched annually, and irrigation network of canals and tube wells support multiple cropping pattern providing relatively high crop yields. Agricultural land (with or without irrigation) covers area of 26.736 ha, sand dune 2.080 ha, salt marshes 1.392 ha, pasture 9.177 ha and settlements 255 ha. On the other hand there are 3.313 people who live in 7 settlements under 2 m and 3 m contour line in Cukurova Delta coastal zone. These people are using as infrastructure 31 transformers, 1 water source, 159 bridges, 2 health offices and 13 schools (Table 1).

At the end of the analyses it was estimated that as a important wetland and agricultural areas of Turkey Cukurova Delta costal zone would be vulnerable to sea level rise and flooding. At these levels, major portions of Cukurova Delta coastal zone would be permanently inundated over the next century. Model results showed that there are major portions of the coastal zone in Adana region, settlements and population that would be affected by inundation in case of the sea level rise due to the climate change. Various factors make the Cukurova Delta coastal zone highly vulnerable to inundation. These are characterized by flat coastal plain, softly sloping shoreline, sandy beaches, wetlands and salt marshes, which produce extensive shoreline displacement with relatively small rises in sea level.

Turkey, being a coastal country, recognized the increasing number of problems in coastal zones and many safety measures are being taken by several governmental institutions and agencies. For example, most of the areas declared as protection zone by the Turkish government are located in the Aegean and Mediterranean coast. In the short term, for the struggle of negative impact of sea level rise, The Ministry of Environment should declare new areas as protection zones and develop special national level environmental programs.

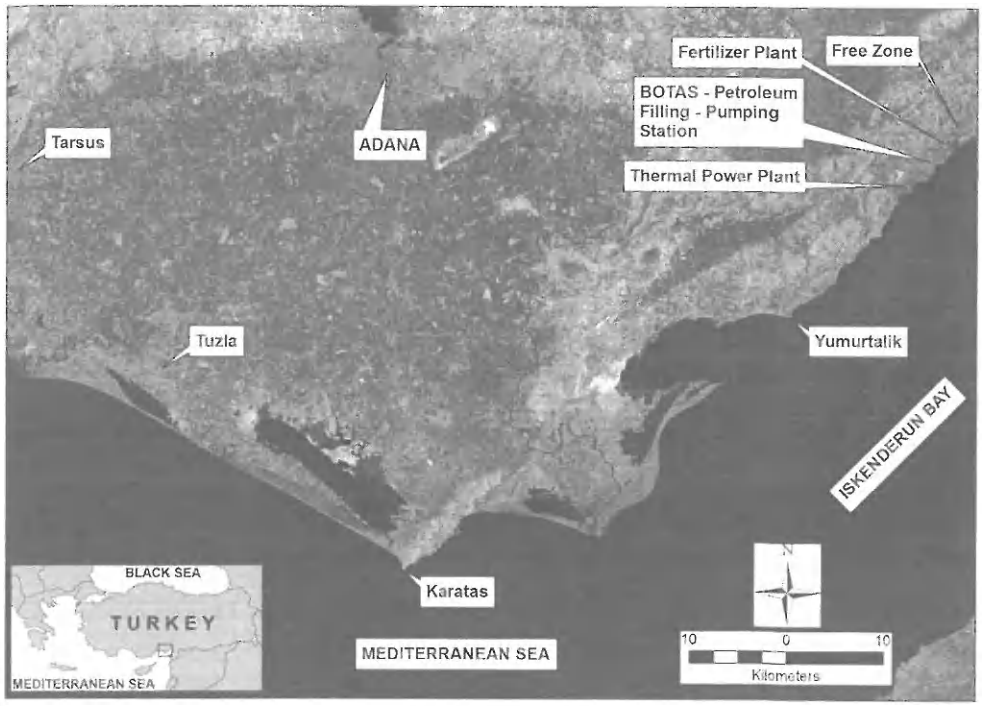

Figure 1. Study area

Landuse-Infrastructure	Sea Level			
	0-1 m (52.447,0 ha)	1-2 m (16.352 ha)	2-3 m (32.600 ha)	Total 0-3 m (101.399 ha)
Wetland (ha)	35.430,00			35.430,00
Agriculture (ha) Dry Irrigation	 3.940,61 1.716,51	 6.217,510 1.061,180	 13.916,10 5.541,57	 24.074,22 8.319,26
Sand dune (ha)	2.271,34	1.150	929,94	4.351,28
Salt marshes-swamp (ha)	1.976,60	617,950	773,95	3.368,50
Pasture (ha)	4.025,35	3.700,100	5.476,92	13.202,37
Settlement (ha)	40,275	30,929	224,192	295,40
River, road, power line etc. – No data	3046,315	3574,331	5737,328	12.357,974
Soil Class (ha) I II III IV V VI VII				 3748,300 4047,430 2318,480 7732,490 445,918 18659,100 11619,000
Population (person)	3313	-	2714	6027
Settlement (number)	7	1	13	21
Transformer station	15	3	28	46
Water source	-	-	1	1
Bridge	23	17	142	182
Health office	-	1	1	2
School	6	1	12	19
Oil station	1	-	-	1

Table 1. Land use and infrastructure between 0 and 1m, 1 and 2m, 2 and 3m and 0 and 3 m contour lines

P-004

A PARTICIPATORY GIS METHODOLOGY FOR STRUCTURING GROUP COLLABORATIONS WITH MARXAN ON MULTI-USER TOUCH TABLES: APPLICATIONS FOR MARINE CONSERVATION AREAS PLANNING

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Keywords: *participatory GIS, Marxan, collaboration, multi-user touch table, group decision-making*

ABSTRACT

This research proposes a methodology for structuring group decision-making for marine spatial planning with Marxan and GIS on multi-user touch tables. Marxan is a software used in conservation planning for the design of marine and terrestrial reserves, and is subject to flexible input parameters regarding costs, planning unit size and shape, biodiversity conservation targets, and available data on species, habitat, and cultural heritage features. The input parameters are highly subjective, and therefore, a decision-making process that involves multiple participants collaborating over these parameters creates a more robust marine planning process. Innovative technologies for structuring these group processes are also explored with the use of multi-user touch tables.

Methodology
Collaborative GIS studies the process of structuring group decision-making of spatial problems using GIS technology. A collaborative GIS approach is developed to accommodate the software Marxan in determining input parameters with multiple participants. The collaborative GIS method involves the following phases: identifying participants; a problem definition phase used to identify key concerns, priorities, objectives and considerations of participants; spatial exploration of data; spatial deliberations finalizing the input parameters; and an evaluation phase that measures the effectiveness of the collaborative process with Marxan and GIS.

Methods
The technology used in participatory processes with GIS guide the way in which group decision-making can be structured. This research was carried out in the Coastal and Ocean Resource Analysis Group's geovisualization lab in the Department of Geography at the University of Victoria. The geovisualization lab consists of three multi-user touch tables developed by DiamondTouch technologies and an immersive geovisualization screen. Participants explored marine geographic data regarding planning units and species data in ArcGIS 9.3. An ArcGIS extension was used that interfaces with the touch tables was used to record individual participant interactions with the GIS and marine geographic data. The ArcGIS extension can record points, lines, and polygons created by each user and saves them as individual layers within ArcGIS. The users interact with ArcGIS and the ArcGIS extension on the touch tables by touch with their fingers acting as a mouse. Using the ArcGIS extension for the touch tables, up to four participants can interact with the data at the same time. Spatial data exploration in GIS is a key step in the collaborative decision-making process for Marxan input parameters.

Discussion and Conclusion

The two aspects under review are the use of multi-user touch tables during group use of Marxan and GIS, and the way in which group processes were structured around the determination of Marxan input parameters. The use of multi-user touch tables allows all participants to interact and explore the spatial data provided. The ArcGIS extension allows all four participants to interact with the GIS without the users' actions affecting the others. When the ArcGIS extension is not enabled, group use of the GIS becomes more complex. Social protocols determining who can "drive" the technology is very useful. Conflict can arise when one user's actions cancel out another's and when the technology becomes dominated by a single user. A limitation of using ArcGIS on the DiamondTouch table is that the DiamondTouch table is top projected, so the ArcGIS layers menu remains on the far left side of the table which limits the interaction participants on the right side of the table can have with it. This can result in dominance of interactions by participants on the left side of the table because those on the right side cannot reach the menus, which reduces the ability for some to explore the data. The ArcGIS extension used as a default can also limit exploration of data in other ways by being used as a default by participants. Structured tasks could also be developed to guide the data exploration process.

P-005

ESTABLISHMENT OF AN INTEGRATED GIS AND DB SYSTEM FOR MARINE GEOLOGICAL DATA AND GEOPHYSICAL DATA OF KOREAN WATERS

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Keywords: *Integrated GIS and DB, Marine Geological data, Marine Geophysical data, ArcGIS*

ABSTRACT

An integrated Database and GIS is developed to manage and provide marine geological data and marine geophysical data obtained by several Korean institutes during the research projects. The system consists of two sub systems. One is the archive DB system which manages original data submitted by research scientists, the other is geographic information system which manages GIS data and provides information to the users.

Archive DB system

Establishment of the archive DB system was accomplished through 7 steps, (1) checking the format of submitted data files (2) grouping data files by data items and research (3) retrieving metadata (position, date and time, etc.) from the submitted data files (4) validation of metadata and observation data (5) making the connection between metadata and observed data (6) rearrange matched metadata and observation data according to the DB structure (7) storing rearranged data into DB system. To make a reliable integrated DB of oceanographic data, we spent much time to validate submitted marine geological data and geophysical data. In case of marine geological data, we collected size analysis data, columnar section image, photographic data, X-ray data, heavy metal analysis data, organic carbon analysis data obtained from surface sediment samples and core sediment samples. The data formats were image file, ASCII text file and Microsoft Excel file. In case of marine geophysical data, seismic data, magnetic data and gravity data were collected in formats of SEG-Y binary file, image file and ASCII text file. We could retrieve metadata from ASCII files and Excel files directly and specialized software (Seisview2 software or BATHY2000) was used to retrieve metadata from SEG-Y data files. After validation work which checks the observation location and time using the positioning maps, some of the submitted data were excluded from collected data files. Finally we could establish the integrated DB system contains 3,393 seismic data files, 811,897 magnetic data, 402,755 gravity data, 1,345 surface sediment data and 4,783 core sediment data. Oracle RDBMS was adopted to manage the collected data and Oracle 11g was installed on UNIX system. Considering the data characteristics, DB structure was designed and 26 DB tables were created in the DB system. All data was stored into DB system using Oracle SQL Loader.

Geographic Information System

The geographic information system was introduced to manage spatial information of oceanographic data and provide data effectively using map interface. All collected position data of the marine geological data and geophysical data was converted to Esri shapefile

format using UTM coordination system based on WGS 84 datum. ArcGIS desktop software was utilized to import position data from ASCII files, manipulate data and produce shapefile data. To save and manage shapefile data systematically, a GeoDatabse was devloped using the Oracle RDBMS and ArcGIS SDE (Spatial Database Engine). Total 40 DB tables were created in the Oracle 11g and all shapefile data was stored into DB system. We made the linkage between data of the GeoDatabase and data of the Archive DB for comprephensive data and information provision. Finally, we created 1,217,480 points, 99 sets of polylines and 165 sets of polygons.

A GIS application based on ArcGIS Engine installed on Windows system was developed to provide geographic information and observed values of oceanogrpahic data. The ArcObjects were utilized to support GIS interface and several GIS programs were coded with the C# language in the .NET framwork environment. The window of the GIS application consists of map window, image viewer, graph viewer and SEG-Y viewer. The map window displays selected base map layers and selected data layers extracted form the GeoDatabse and it supports basic GIS functions like scale-up, scale-down, panning, positioning, etc. Photographic images, X-ray images and columnar section images are displayed in the image viewer and various graph of ananlized data are visualized dynamically in the graph viewer. The SEG-Y viewer displays a header information and observed values of SEG-Y files in formats of text and image.

SEA LEVEL RISE FLOOD HAZARD MAPPING IN THE CATALAN COAST (NW MEDITERRANEAN)

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Keywords: *sea level rise, GIS, flooding, land covers, coastal management*

ABSTRACT

The Mediterranean coast is considered particularly vulnerable to sea level rise (SLR)-induced flooding due to its environmental and socio-economic characteristics. It hosts valuable and sensitive habitats, such as coastal wetlands, as well as densely populated and urban developed areas and highly important economic sectors like tourism. The *Protocol on Integrated Management of Coastal Areas for the Mediterranean* and the *Recommendation of the European Parliament and of the Council of 30 May 2002 concerning the implementation of Integrated Coastal Zone Management in Europe* call for the consideration of SLR within Mediterranean countries and EU Member States to reduce future impacts in coastal areas. However, SLR has been widely neglected in coastal management and planning along most of the Mediterranean coast. In Spain, estimations of SLR–induced flooding are scarce and restricted to relatively small low-lying coastal areas. Within this context, the aim of this study was to undertake a first regional assessment of the potential permanent inundation due to SLR in the Catalan coast (Spain, NW Mediterranean). The analysis included the delimitation of areas prone to be flooded and the potential impact to coastal land covers of the Catalan coast.

Catalonia has a ~700 km long coastline which includes diverse coastal environments, from cliffs to low-lying areas. The coastal zone is densely urbanized although it also maintains some well preserved areas with high environmental values. Flood hazard to SLR was analysed under two scenarios corresponding to the last IPCC projections of global SLR for the end of this century: the low scenario (0.18 m of SLR) and the high scenario (0.59 m). The analysis was done using ArcGIS Desktop 9.3 (ESRI). Areas prone to be flooded were identified by selecting in a digital elevation model (DEM) those areas located below the target water level (SLR scenario) and hydraulically connected to the shoreline. This assumes that the coastal behaviour under SLR is passive, i.e. there is no adjustment of the coastal profile to a new (rise) mean water level. As a first approach and due to the regional scale of the study, a DEM with a 15 m horizontal resolution, a mean vertical error of ±0.16 m and a RMS error of ±0.96 was used. Delimitated flooded areas were afterwards combined with a high resolution up-to-date land cover dataset. To analyse land cover flooding in absolute terms, the percentage of each land cover inundated area with respect to the total flooded extent in Catalonia was estimated. To analyse the potential impact of flooding on a specific land cover, the "relative land cover inundation" was estimated as the percentage of each land cover inundated area with respect to the total extent of each land cover within the Catalan coastal *comarcas* (an administrative level similar to counties and widely used for coastal management in Catalonia). This gives an indication of the sensitivity of a given land cover within a coastal management unit for a given SLR scenario.

Results showed large differences in flooding extent between scenarios, although in both cases the flooded area was relatively small. Under the low scenario, the area prone to be flooded was 49 km^2 (<1% of the Catalan coastal *comarcas* area), whereas under the high scenario it increased to 187 km^2 (3%). Flooding was mainly found in low-lying coastal areas with high environmental values, typically in two coastal plains (Muga, Fluvià and Ter rivers coastal plains) and three deltas (Tordera, Llobregat and Ebro deltas). In fact, >80% of the flooded area was within the Ebro Delta, the largest low-lying area in Catalonia, as well as a valuable protected natural zone. Under the low scenario, 75% of the flooded extent corresponded to typical low-lying coastal land covers (beaches, dune and sand vegetation, riparian vegetation, rivers and wetlands and lakes). Conversely, in the high scenario, agriculture and tree plantations concentrated 60% of the flooded extent, a common land cover in Catalan coastal low-lying areas. In both scenarios urban developed areas were not significantly affected and they only represented around 1% of the flooded extent. Results showed that the most affected land covers were mainly restricted to those intrinsic to low-lying coastal areas (beaches, dune and sand vegetation, riparian vegetation, rivers and wetlands and lakes) with percentages of relative land cover inundation ranging from 5 to 60% under the low scenario and from 10 to 90% under the high one. The highest percentages were found for wetlands and lakes (90%), dune and sand vegetation (60%) and beaches (60%) under the high scenario. Less than 1% of the surface of the remaining land covers was flooded.

Results from this study suggest that SLR flooding could significantly impact valuable coastal habitats and coastal resources in Catalonia. Although horizontal migration and vertical accretion could occur as a natural response to flooding, these processes are limited in most areas due to coastal squeeze and lack of sediment supply. Consequently, an inundation-driven net loss of some habitats, such as beaches, should be expected in some coastal zones, which could be aggravated by other coastal processes (e.g. erosion, storms). This could cause not only large impacts to environmental aspects but also to socio-economic ones, especially coastal tourism (e.g. by a decrease in available beach area). Overall, results from this study justify the need to consider SLR in coastal management and represent a tool for the identification of early planned adaptation strategies in the Catalan coast.

DEVELOPMENT OF THE MOBILE GIS SERVICES OF KOREA OCEAN BIOGEOGRAPHIC INFORMATION SYSTEM

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Keywords: *Mobile Marine GIS, KOBIS, occurrence information, marine organism, OBIS*

ABSTRACT

Korea Ocean Research & Development Institute (KORDI) started to develop Korea Biogeographic Information System (KOBIS) in 2007, which is the Korea node of international Ocean Biogeographic Information System (iOBIS). The main missions of KOBIS are collection, management, and provision of occurrence information on marine organisms appeared in Korean waters. KOBIS started its official data service from the mid of 2008 with the internet web-site and the mobile services of KOBIS are opened in 2010.

Occurrence DB system

To compile as many as marine occurrence data, we collected data from reports of research projects and research articles printed in Korean journals. Some appearance information, which was obtained from in-situ observation by KORDI(Korea Ocean Research & Development Institute) scientists during the KORDI research projects, was directly submitted to KOBIS. The additional environmental data and DNA barcode information on marine organisms was also collected concurrently when such data exist. Data retrieval work was a long haul because the data was included in texts, tables and maps in arbitrary format. During the quality processes, some data whose position or time was wrong was deleted from the data set. Through the constant effort for collecting data, a total of 97,275 occurrence data of 10,265 marine species was gathered at the end of 2010. The total number of books surveyed was 148. Oracle relational database management system was introduced to manage the collected data on marine organisms and Oracle 11g was installed on Windows server system. Considering the data characteristics, DB structure was designed and 11 DB tables were created in the DB system. According to the DB structure, the collected data was rearranged and stored into DB system using Oracle data loader.

Web GIS of KOBIS

The KOBIS web-site (http://kobis.kordi.re.kr) was established to share the biogeographic information on Korea marine organisms with world-wide marine biologist. The GIS interface and several GIS functions were adopted by the KOBIS web-site for selection of search conditions, mapping of the query result and visualization of distribution statistics. For DB data retrieval, users can choose geographical search area using the Google map or typing latitude and longitude in text. Users can also use name of organism as search condition by typing species name in text or select it from hierarchy tree of marine organisms. Appearance

locations queried by DB search are displayed on the Google map and detail species information including DNA barcode data is also provided in format of texts and images. We calculated monthly occurrence frequencies of each species at each 1/4° grid to understand the monthly variation of marine organisms and relationship between occurrence and marine environment. The KORDI TS data set is used as environment data, which is a monthly 1/4° grid data set of temperature and salinity at 14 standard depths produced by KORDI members using more than 1,000,000 temperature/salinity profile data of the West Pacific Marginal Seas. Monthly water temperatures of each grid at surface and at bottom were extracted from KORDI TS data set and stored at the DB system for comparison and data provision. The comparison results between monthly occurrence frequencies and water temperatures are displayed with various colors as 1/4° grid mesh format on Google map. A number of GIS programs were developed based on Google map API and various JAVA scripts were prepared to show appearance location and GIS statistics on the map. Several ASP programs were developed to retrieve data from DB system and produce HTML pages of search results.

Mobile GIS of KOBIS

Two mobile GIS services of KOBIS were developed to provide occurrence information to the mobile internet users. One is the KOBIS mobile web-site (http://kobis.kordi.re.kr/mobile), the other is the mobile application for I-Phone system. The mobile web-site is designed for small size devices, but provides almost same data service as the original one. Becasue most mobile devices detect the touch of finger instead of the mouse click and there is no right button click, a few additional GIS programs were developed to respond to the finger touch. I-Phone application, its name is "KOBIS", was programmed with Objective-C language and registed in I-Phone App Store. It supports XML data communication between DB server and I-Phone device, and data visualization based on Google map API. The KOBIS I-Phone application also has almost same function as original KOBIS web-site.

Fig. 1. KOBIS Web site (left) and I-Phone Application (right)

P-009

DEVELOPMENT OF AN INTEGRATED DB/GIS FOR OCEAN TEMPERATURE-SALINITY DATA OF THE NORTH PACIFIC MARGINAL SEAS

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Keywords: *Marine Internet GIS, Ocean Temperature Salinity, Integrated Ocean DB, North Pacific Marginal Seas*

ABSTRACT

An integrated ocean temperature-salinity (TS) database and geographic information system of the North Pacific marginal seas, were established to provide environmental information for marine activities to the general public and the ocean experts. Almost TS data available in the public domain and TS data produced by the Korean organizations were gathered for the DB system. The enterprise version of Oracle relational database system installed on the Unix operating system was introduced to manage collected TS data. An internet GIS was set up to provide oceanographic data using map interface. Spatial data for GIS was collected from numerical hydrographic charts and several programs were developed for instant mapping and visualization of TS data.

Integrated Ocean TS Database

The northern limit and the southern limit of the spatial coverage of the integrated TS database are 20°N and 50°N, and the western limit and the eastern are 115°E and 145°E, respectively. Korean data are mainly produced by Korea Ocean Research & Development Institute (KORDI), National Fisheries Research and Development Institute (NFRDI) and National Ocean Research Institute (NORI). In the public domain, many TS data was retreived from World Ocean Database managed by US National Oceanographic Data Center (NODC) and ARGO data was collected from Coriolis ARGO System. Total 19,900,601 temperature salinity values of 1,117,341 vertical profiles observed by the several organizations and countries from 1907 to 2004 was collected. KORDI CTD data, whose depth interval is 1m and maximum depths are more than 2000m, can much contribute better understanding of ocean environment. Because Oracle is a relational DBMS, appropriate designing of DB system is important and it decides efficiency and data search ability. According to the procedures of relational DB designing, 34 DB tables were disgined for the TS DB, which would store metadata (information about data; observation date and time, observation gear, researcher, etc.) and observation data separately and link each other with primary keys and foreign keys. After table space (logical storage area) and user account were prepared in the Oracle database system, DB tables were created according to the DB design. All collected data was rearranged according to the DB structure and inputted into the DB system by the Oracle SQL Loader.

Internet Geographic Information System

Because the precise spatial data is required to set up GIS for coastal area, we made an earnest effort to collect geographic information of coast lines, depths, obstacle, rocks, etc. Marine

geographic information contained in numerical hydrographic chart published by NORI and coastal information stored in Coastal Information System developed by Ministry of Maritime Affairs and Fisheries (MOMAF) were collected. The collected spatial data was processed, transformed and merged to 7 ARCGIS shape files which contain 7 map data from large scale to small scale. An interactive internet GIS was developed to provide oceanographic data using iWorld software, which is the GIS engine developed by Korean company, BNT solutions. Internet users can select interest geographic area with the mouse, watch search result with maps and retrieve numerical data. Some additional functions were developed to plot the selected data points on the GIS map dynamically and allow users to choose data point on the map. Several Active-X controls were programmed to produce various x-y graphs and distribution maps which can be used for analyzing ocean phenomena. They can generate vertical profile graphs, time series graphs, vertical distribution maps, and horizontal distribution maps of temperature and salinity dynamically.

Fig. 1. Internet GIS for the integrated TS Database

P-010

CLIMATE CHANGE AND COASTAL ADAPTATION: USING GIS AND VISUALISATION TO IDENTIFY ISSUES AFFECTING COASTAL COMMUNITIES IN ABERDEEN, SCOTLAND, UK

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Keywords: *IMCORE, GIS, Flooding, Scenario, Visualisation*

ABSTRACT

IMCORE (Innovative Management for Europe's Changing Coastal Resource) is an EU funded INTERREG IVB project focusing on how the coastal areas of North West Europe can best be adapted to climate change.

As part of this project a number of practical GIS-based workshops were designed to explore the various different ways that GIS and related geovisualisation tools can be used to engage local communities in climate change issues that will have a potential impact on their physical, human and economic environment, livelihood, and the local infrastructure.

Geographical Information Systems (GIS) have been very widely applied to environmental problems and issues over the past twenty years, including many different aspects of coastal management. While there are many definitions of GIS, ranging from simple mapping systems to large corporate organizational systems used for managing multiple databases, many customised examples of GIS have also been developed to provide the basis for applied planning and decision support systems (DSS). Although GIS are often considered to be academic tools that are typically used only by the specialist or scientist, their rapid evolution into commercially available and affordable software packages has greatly raised public awareness of the role that geographical or spatial data can play in planning and decision making. Furthermore, it has also led to a broader and more informed GIS end-user community through the many social and environmental applications developed.

The use of GIS technology with a number of different end-user communities and methodologies has ultimately led to a specialised form of GIS commonly referred to as Participatory GIS (PGIS) Public Participatory GIS (PPGIS), or Community Integrated GIS. Public Participation or Participatory GIS or PPGIS/PGIS was initially developed to provide the basis for the public or stakeholder to become more actively involved in the planning and decision making process through better and improved access to local geographical data and information stored in a GIS. As a technology, GIS has been used to enhance the more traditional and familiar public participation techniques such as media campaigns, guided tours, and group meetings to the use of computer simulation exercises. Visualisation was identified as one way to share information with community groups, to generate scenarios, and to provide insight into the impacts of climate change on the coast.

The paper outlines the development and hosting of a number of these workshops designed to engage the local stakeholders in identifying the impacts of climate change. The examples focus on one climate change scenario, namely that of flooding. The study areas, Aberdeen

City and Stonehaven in Scotland, are both coastal settlements on the east coast of the UK. The UKCIP report identifies increased rainfall as a significant feature of Scotland's future climate. Already there is some evidence that rainfall has increased in frequency, intensity and duration. The end result has been increased flooding incidents where areas are flooded more frequently, whilst high run-off and high tides often leads to flooding of the areas surrounding rivers and small streams, as well as low-lying coastal areas. The use of GIS and geovisualisation tools offers a more interactive and experimental environment for people to engage with local issues by providing the means to examine different information in the form of spatial datasets.

A COMPREHENSIVE GIS APPROACH TO DREDGING-RELATED STUDIES AND DATASETS FOR THE BELGIAN COASTAL WATERS AND THE SCHELDT ESTUARY

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Keywords: *Maritime Access, Maritieme Toegang, GIS, dredging, studies, coastal waters*

ABSTRACT

The web application 'Data Viewer', developed by the Flemish Maritime Access division of the Flemish Ministry of Mobility and Public Works, supports the operation of dredging and environment-related activities in the access channels to the Flemish harbours. This application enables the geographical visualisation and a limited analysis of various complex dataset types. The present database contains dredging intensity data, various hydrodynamic measurements and density profiles on silt accretion locations. The advantages of the Data Viewer are numerous: data in this central database is accessible, easy to consult and to interpret, in relation to various dredging monitoring and reporting activities.

Currently, the Data Viewer is only internally accessible because of security reasons. As soon as the security issue is solved external third parties can register in order to log on to this site.

The Environment and Information Portal is a JAVA based web application connected with an Oracle 11g database and an Arc SDE 10 GIS database engine. The GIS data are published in the form of web map services (WMS) and web feature services (WFS) through an Arc GIS server 10. The visualisation of the geographic data is implemented by an Openlayers javascript library.

Dredging Intensity data

The accessibility of the Flemish harbours requires continuous maintenance dredging activities in the navigation channels in the Belgian coastal waters and in the Scheldt estuary. The dredged sediment is transported to allocated relocations sites by trailer suction hopper dredgers. A Dredging Information System stores all information related to the dredging and relocation process, which allows the retrieval of intensity maps of the dredging and relocation sites. The intensity maps, showing the spatial distribution of weight and volume of dredged sediment, are very useful for morphological analysis in the framework of optimisation of the dredging and relocation process, environmental monitoring and environmental impact assessment.

The user interface allows querying on time and space. The cumulated intensity map is visualised over the requested time period from 1 week up to several years and multiple dredging or relocation sites in a standard colour legend.

The web based GIS viewer offers standard viewing facilities, an identify tool, multiple background layers and export features.

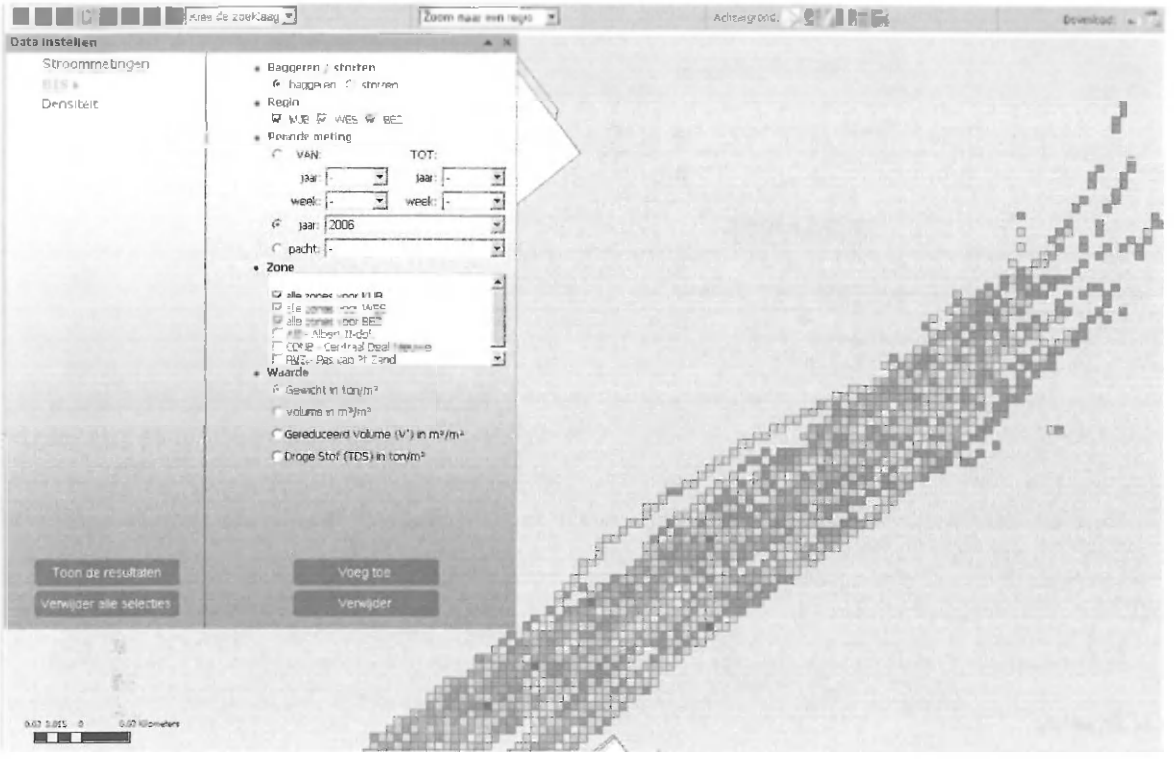

Fig. 1. Visualisation of Dredging Intensity data. The pop up window allows the user to make a search query in the dredging intensity database.

Cross-sectional current velocity measurements

The Belgian Coastal waters and the Scheldt estuary are subject to a tidal regime. Cross-sectional hydrodynamic measurements during a tidal cycle are executed regularly within the framework of the monitoring programs along a series of predefined transects or at request during additional research surveys. The cross-sectional hydrodynamic measurements consist of a set of consecutive acoustic recordings along a transect of current velocity and suspended sediment concentration, of which discharge, and sediment flux through the transect can be deduced. The data obtained during the cross sectional hydrodynamic measurements are imported in the ArcSDE 10 database by a customised Python® script.

The user interface allows querying on time period, the location of a cross section and on the measured time interval during the cycle. The queried sectional hydrodynamic measurements are visualised as current velocity vectors on the geographic map, indicating the current velocity and current direction at a chosen depth. The Data Viewer is not designed to show suspended sediment concentrations.

The web based GIS viewer offers standard viewing facilities, an identify tool, multiple background layers and export features.

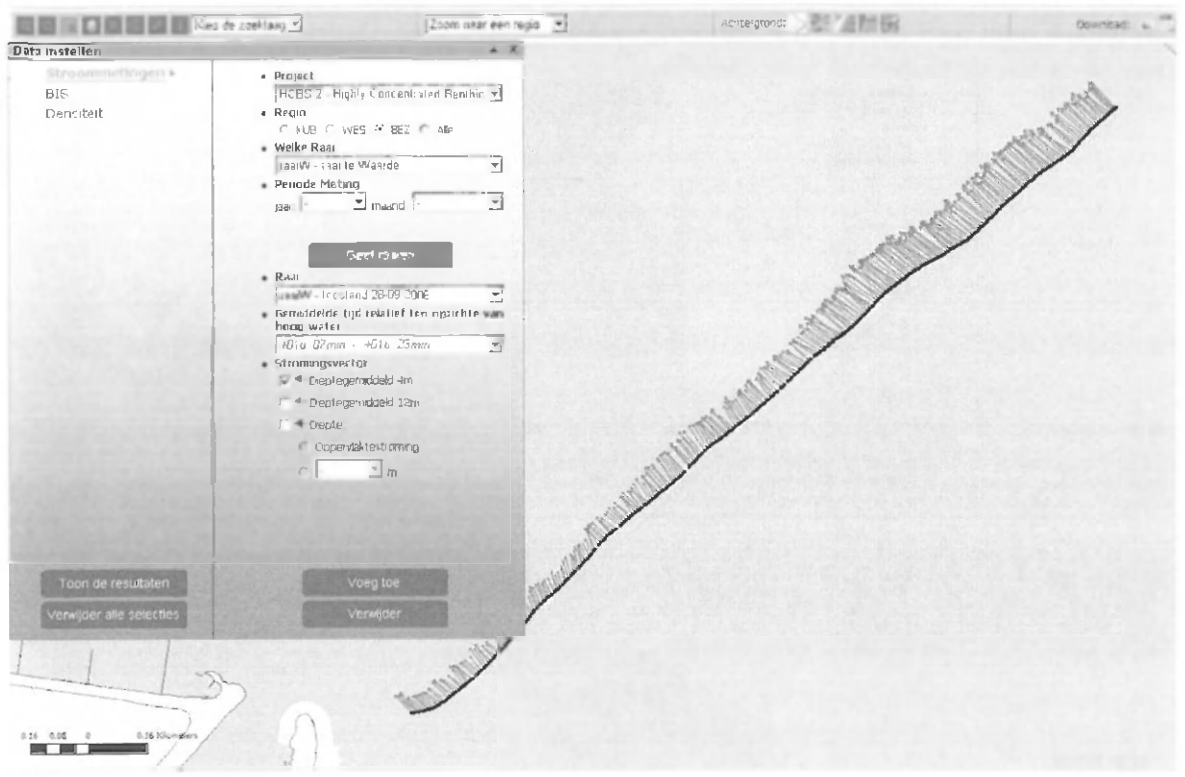

Fig. 2. Visualisation of cross- sectional current velocity measurements. The pop up window allows the user to make a search query in the cross section current velocity measurement database.

Density profiles in silt layers

The neighbourhood of the harbour of Zeebrugge at the Belgian coast and the harbour of Antwerp in the Scheldt estuary are characterised by the presence of a turbidity maximum of fine cohesive sediments. These sediments accumulate in harbour basins, resulting in the formation of cohesive silt layers.

The cohesive silt layers are surveyed by a dual-frequency echo sounder (210 and 33 kHz) and by density profiles of which the depth of equal density layers and the nautical depth (defined as the 1.2 t/m³ density) can be determined in a certain area of interest.

The survey results are visualised on the geographic map of the application. All points are labelled with the depth value of the selected density values and the dual-frequency soundings.

At the moment of writing, the functionality to visualise isobaths between the selected data, was still in a developing phase. The solution for the visualisation of the interpolation or other geospatial processes could be delivered by the implementation of so called Web Processing services (WPS). A WPS allows the user to request a certain image processing algorithm on the available data. The execution of this algorithm delivers an output which could be directly returned to the client or could be saved as resource data at the server side of the web application.

Fig. 3. Visualisation of density measurements. The pop up window allows the user to make a search query in the density measurement database.

Conclusion

The Data Viewer provides the possibility to manage coastal (and estuarine) information in an easy accessible and clarifying manner. Maritime Access established a viewing portal for various dataset types with GIS tools such as standard viewing facilities, an identify tool, multiple background layers and map export features.

The Openlayers JavaScript library, which supports the common Open Geospatial Consortium (OGC) standards, gives a powerful geographic map visualisation which is independent of the implemented client and server.

The scalability and maintainability of this web based GIS viewer is optimized by using a REST architecture in the application code. The separation between server and client allows to develop both independently. Other Maritime Access applications, such as Matador (a search-, view- and metadata managing- portal of GIS related data available at Maritime Access) and the Grid database (a search and viewing portal of Bathymetric data), can be integrated with the Data Viewer.

All this features makes the Data Viewer an efficient tool for various dredging monitoring and reporting activities. Because of its scalable characteristics, the Data Viewer has also the potential to become a powerful module for the implementation of different analyses.

P-017

OCEAN TRACKİNG NETWORK - DATA POLİCY, METHODS AND FİRST YEAR COLLECTİON RESULTS

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Keywords: *Ocean Tracking Network, tracking, GOOS*

ABSTRACT

The Ocean Tracking Network (OTN) is a Global Ocean Observing System (GOOS) pilot project headquartered at Dalhousie University in Halifax, Nova Scotia, Canada whereby researchers worldwide can monitor the behavior of individual marine animals in terms of where they go, what conditions they experience, and how they interact. In this presentation we describe technologies and policies on how information are submitted, accessed and used; and methods being used to track deployment activity and resolve problematic detections. Given that OTN has secure funding until 2017 and is partly deployed with much yet to come, we conclude with a dynamic overview of deployment and tracking activity at local, ocean and global scales.

P-018

WEB-GIS BASED SAEMANGEUM COASTAL INFORMATION SYSTEM

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Keywords: *Saemangeum, coastal environment, Web-GIS, scientific visualization, spatial analysis, decision making*

ABSTRACT

A WebGIS-based coastal information system is developed and applied to the Saemangeum coast in Korea. The Saemangeum coast, located in the mid-west of the Korean Peninsula, is now undergoing coastal development, such as constructing a 33 km long sea dyke with two sluice gates and yielding 40,100 ha of artificial lakes and reclamation land. The artificial lakes are accepting the terrigenous effluents as well as exchanging with the coastal waters through the sluice gates. Due to the coastal development project running longer than 10 years, environmental management focusing on water quality control and protection of environmental vulnerability is the major concern of stakeholders.

Figure 1. Saemangeum Development

From the early stage of the Saemangeum project, we have observed periodically and in real-time parameters about water quality, ocean physics and circulation, marine meteorology and the ocean ecosystem from 2002 through real-time monitoring, periodic survey or satellite image analysis. Also to predict the change of ocean environment, such as water quality and ocean physics and circulation owing to the artificial ocean development, we have tried to

forecast exactly through a 3-dimensional ocean numerical model. This ocean environmental information has certain properies, such as vast amounts of geo-referenced spatio-temporal data.

To process, integrate the geospatial database and analyze the environmental assessment of specific parameters, and to compare the real-time observed data with predicted values, a WebGIS-based coastal information system for Saemangeum has been developed and applied for public service. This system consists of three types of geospatial data - historic data from periodic observations, present situation data from real-time monitoring, and future predicted data (forecasts) from numerical model data. The historic database provides the background status of the varying environment; real-time data provides the mapping of true evaluation of environmental assess; and the predicted values are used to find a rule to relate the geospatial database.

The three modules of the system show a very useful tool for understanding the transition of ocean environment from artifical ocean development by GIS-based geospatial analysis, scientific visualization of multi-dimensional data. Furthermore, this sytem provides the possibility for comprehensive and innovative decision making for coastal management and knowlege discovery by data mining.

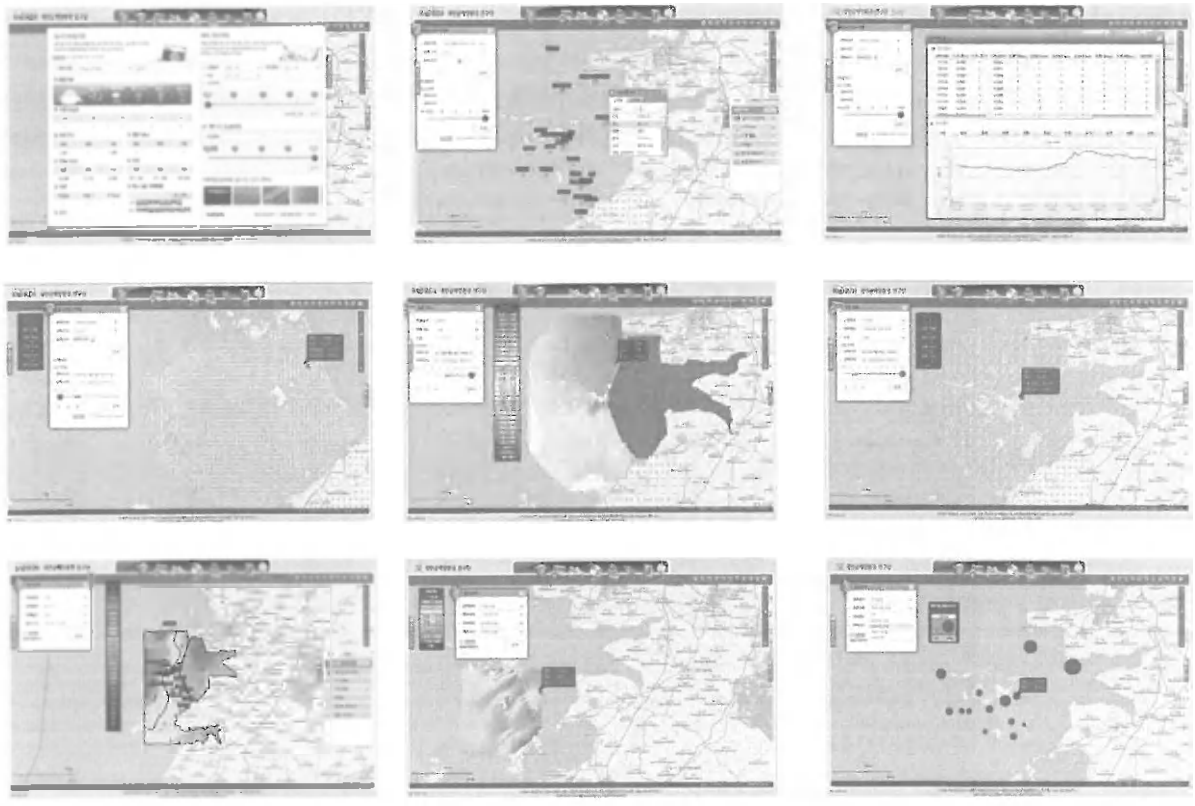

Figure 2. Some services on the Saemangeum Coastal Information System

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